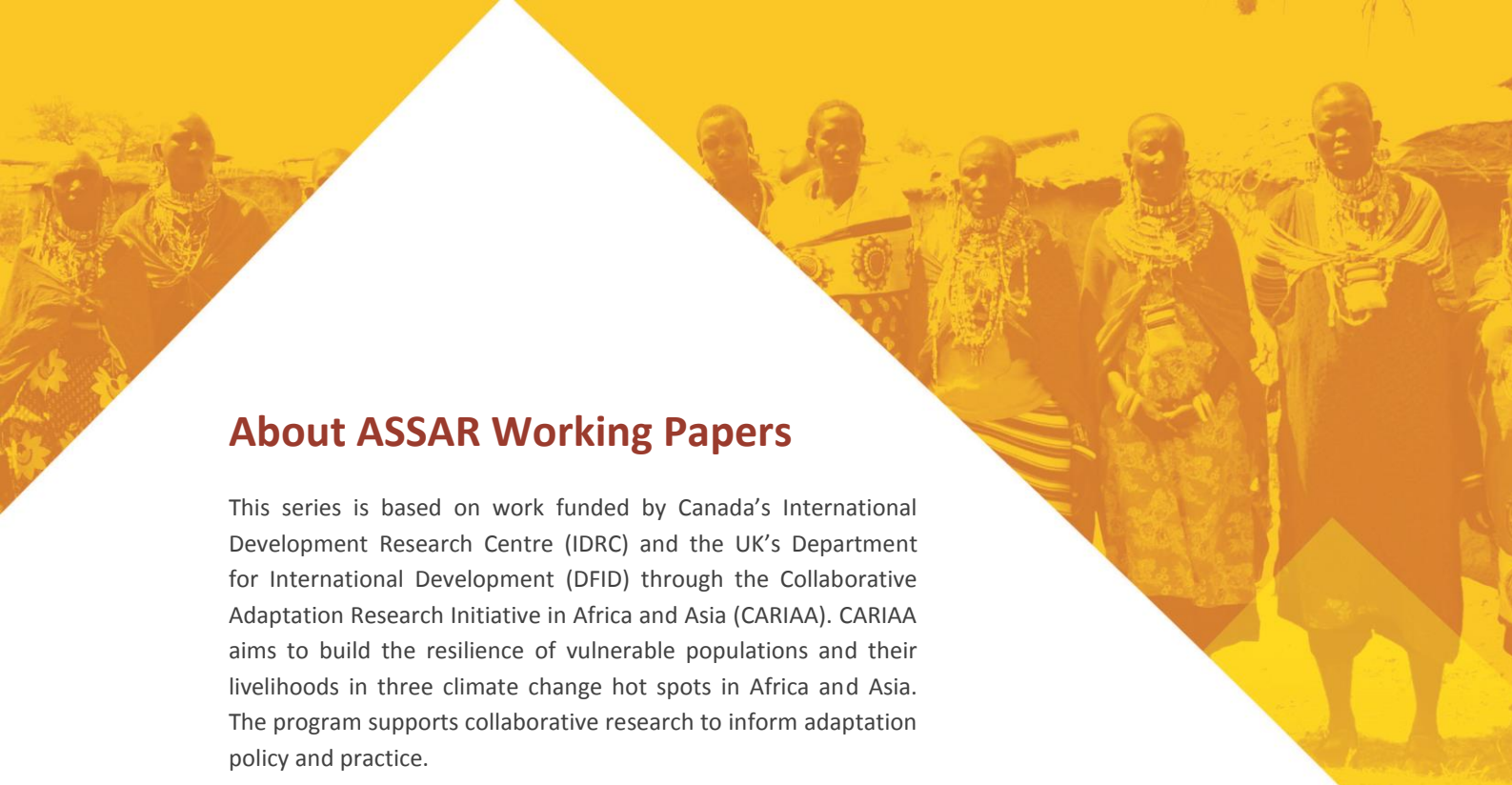
Vulnerability and Adaptation to Climate Change in the Semi-Arid Regions of East Africa

CARIAA
Collaborative Adaptation Research Initiative in Africa and Asia

ASSAR
Adaptation at Scale in Semi-Arid Regions



About ASSAR Working Papers

This series is based on work funded by Canada's International Development Research Centre (IDRC) and the UK's Department for International Development (DFID) through the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA). CARIAA aims to build the resilience of vulnerable populations and their livelihoods in three climate change hot spots in Africa and Asia. The program supports collaborative research to inform adaptation policy and practice.

Titles in this series are intended to share initial findings and lessons from research and background studies commissioned by the program. Papers are intended to foster exchange and dialogue within science and policy circles concerned with climate change adaptation in vulnerability hotspots. As an interim output of the CARIAA program, they have not undergone an external review process. Opinions stated are those of the author(s) and do not necessarily reflect the policies or opinions of IDRC, DFID, or partners. Feedback is welcomed as a means to strengthen these works: some may later be revised for peer-reviewed publication.

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CHAPTER 1

Introducing the Regional Diagnostic Studies Report

Introducing the Regional Diagnostic Study

The Adaptation at Scale in Semi-Arid Regions (ASSAR) Consortium seeks to deepen understanding of climate vulnerability and adaptation in semi-arid regions, and help transform current adaptation practice to a mode that achieves proactive, widespread adaptation embedded in development activities. The project works at multiple scales, but with a central focus on advancing adaptive livelihoods for vulnerable groups. As part of the ASSAR project, the East Africa team's work concentrates especially on dryland zones of Ethiopia, Kenya and Uganda.

This report summarises key findings from the regional diagnostic study (RDS) of the ASSAR East Africa team, and identifies major gaps in the existing literature on areas of vulnerability and adaptation in East Africa. The discussion provides the foundation for detailed case study work planned for the major phase of research, the Regional Research Programme (RRP), as well as an underpinning guide to develop a dialogue on adaptation options.

The ASSAR East Africa team for the RDS phase consists of the University of East Anglia (UEA), African Wildlife Foundation (AWF), Addis Ababa University (AAU), and The INTASAVE Partnership (INTASAVE). The full ASSAR consortium works in India and Southern, West and East Africa. It is led by the University of Cape Town (South Africa) together with UEA, START, Oxfam GB and the Indian Institute for Human Settlements.

ASSAR is one of four consortia funded by DFID – Department for International Development (UK) and the IDRC – International Development Research Centre (Canada), through the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA) programme. The research of ASSAR consortium and CARIAA programme is aimed at new knowledge generation related to deepening understanding of the underlying drivers and determinants of vulnerability of livelihood systems, the strengths and weaknesses of current adaptation practices and policies, and advancing understanding of the constraining and enabling factors that determine successful adaptation.

1.1 RDS objectives and framework

The objectives of the RDS phase are mainly twofold. First, it is aimed at developing a systematic understanding of existing knowledge and perceptions of climate change trends, impacts, vulnerability, adaptation strategies, and barriers and enablers to effective adaptation in semi-arid regions. As an information product from the RDS, this report attempts to provide a synthesis of the current state of affairs in semi-arid East Africa, and to enrich understandings of common and divergent system-scale climate-change adaptation issues across the region. Second, gaps in knowledge, policy and practice of climate change adaptation, as identified in the RDS phase, will also help our team design the research in the RRP from a system-scale perspective, and also help inform and refine the more detailed sets of specific research foci at each research site. The RDS thus provides a broad regional-scale context into which the RRP can be designed to focus on achieving deeper understanding of the multi-faceted nature of local vulnerability, adaptation enablers and adaptation barriers.

The RDS employed a combination of desk-based studies (review of academic and grey literature, policy analysis, project mapping) with a round of stakeholder interviews at regional, national and subnational levels. Our RDS framework thus combined a number of diagnostic tools so as to develop a framing of vulnerability and adaptation drivers, capturing biophysical, socioeconomic, political and institutional processes operating at a range of spatial and temporal scales.

1.2 Audience for this report

The primary purpose of the report is to capture the current state of affairs and evaluate trajectories of change with respect to vulnerability, impacts and adaptation across semi-arid regions in East Africa, with a particular focus on Ethiopia, Kenya and Uganda. It also identifies gaps in knowledge, policy and practice with respect to climate change adaptation in the region. Therefore, the report can be useful for a wide variety of target audience working in the area of climate change adaptation in the region – including academics and researchers, stakeholders from government, economy and policy as well as climate change practitioners, I/NGOs, media, grassroots organisations, community groups and the wider public.

1.3 Data gathering methods

We employed a variety of data gathering methods. An initial stakeholder identification exercise helped us to list key country-level (Ethiopia, Kenya and Uganda) and regional level (East Africa and Africa) organisations and their key policies, strategies, programmes, projects, and events. These include international agencies, governmental, non-governmental and private sector organisations, and they are involved in various areas of climate change, vulnerability, and disaster risk reduction, with major emphasis on sectors such as agriculture, water, economic livelihoods, health, social protection, migration, environmental management and conservation.

Similarly, a project identification exercise was applied for the East Africa region and in the focal countries of study (Ethiopia, Kenya and Uganda). A variety of recent and ongoing projects were found to be interesting and relevant for our purpose; some of these projects are focused on climate change adaptation, vulnerability and resilience themes whereas others are broader environment and development projects with close relevance for climate change themes. The projects also differ in terms of their scope of operation, geographical coverage, area of focus, source of funding and involvement of stakeholders.

The main component of the RDS was an academic and grey literature review, for which a range of documents were collected for East Africa (Ethiopia, Kenya and Uganda) that cut across the ASSAR research streams of climate, vulnerability, SEPG (social-economic, political and governance dimensions) and adaptation.

The *grey literature search* produced an initial listing of identified documents and their major highlights. In total, there were 109 grey literature documents that were found to be relevant: Kenya (47); Ethiopia (20); Uganda (18); Regional (24). These were further screened and then reviewed using a standardised template.

The *academic literature search* was carried out using the RDS methodology shared across the ASSAR consortium. It consisted of all relevant literature (peer reviewed articles and book chapters) published between 2005 and 2014. The search included Web of Science/ Web of Knowledge bibliographic database, using a range of potentially applicable keywords and their combinations: 'climate change adaptation AND east Africa'; 'climate change adaptation AND Ethiopia'; 'climate change adaptation AND Kenya'; 'climate change adaptation AND Uganda'; 'climate change AND vulnerability AND east Africa'; 'semi arid AND east Africa AND adaptation'; 'semi arid AND east Africa AND climate change'.

Non-relevant literature and duplications were discarded. In total 150 relevant academic publications were identified for further review. These were the categories of literature based on their country of focus: Kenya (67); Uganda (14); Ethiopia (43); and Regional (26). Information from these articles was then entered in the spreadsheet template developed for use across the consortium.

The articles identified in the academic review were diverse, covering: a wide range of biophysical and socio-economic issues; a number of sectors (e.g. agriculture, environment/resource management, disaster risk reduction, development, infrastructure, water, health, communication), various themes (e.g. adaptation, impacts, vulnerability, enablers and barriers), geographies (rural, peri-urban, urban) and climatic trends (past and future scenarios). While these articles focus on east African nations of Uganda, Kenya, and Ethiopia, there are also some articles referring to other parts of eastern Africa (e.g. South Sudan, Somalia, Tanzania) or other parts of sub-Saharan Africa. The review also drew on broader articles on themes of climate change, vulnerability and development that do not have a regional focus.

We also carried out preliminary governance analysis of risk management issues and climate change adaptation in East Africa and the three focal countries, through interviews in November 2014 and February 2015 with a number of stakeholders in Ethiopia, Kenya and Uganda. These interviews were focused on exploring the governance-adaptation nexus in these countries. The round of interviews are seen as a scene-setting stage for a much more detailed analysis of governance at multiple scales planned in the RRP.

1.4 Entry point of the RDS in the development-climate space

In East Africa the RDS takes a people-centred approach meaning that we view people as the vulnerable 'units' of interest, not sectors or system properties *per se*. So the scale of focus of vulnerability and response to risk is inherently local – but rooted in an understanding of how that vulnerability and adaptive capacity is affected by (and interacts with) social-ecological factors and processes operating at higher scales. We also aim to take an integrated approach in that we try to conceive of vulnerability and adaptation existing within a complex web of climatic and non-climatic conditions and dynamics. As literature sources from the RDS phase of research suggest, there are a number of key determinants and drivers shaping vulnerability of the poor in East Africa.

In our analysis, we seek to explore how people's vulnerability to climate change is rooted in wider aspects of livelihoods and development trajectories, but also how adaptation to

climate change may need to look beyond business-as-usual approaches in development and environmental management. The slightly contradictory implications of these two points are important to tease out. The first suggests that adaptation actions should effectively be mainstreamed within wider development goals and practice, which might also smooth the path to their implementation. The second suggests, however, that effective adaptation may in some cases require transformational rather than incremental change (which is seldom likely to face a smooth path to implementation).

Based on the findings from the RDS discussed in this report, our intention in the RRP is to research potential adaptation across a spectrum of incremental to transformative forms, but to do this in a critical manner. This goes beyond looking just in terms of narrow fit to the problem and to practicalities of implementation. It also includes the wider social (including gender) and governmental dimensions, including implications of adaptation options for unintended social consequences, justice and equity issues, and wider impacts on poverty reduction.

1.5 Structure of the report

The structure of this report is as follows. After this Introduction Chapter, there are six other chapters:

- Chapter 2 outlines the regional to sub-national context of East Africa.
- Chapter 3 discusses climate change, trends and projections in the region.
- Chapter 4 focuses on risks, social dimensions of vulnerability, and their dynamics.
- Chapter 5 explores the adaptation-development spectrum of actual and potential responses to risks.
- Chapter 6 offers a preliminary analysis of the issues of governance that surround climate risk management.
- Chapter 7 provides concluding discussions on barriers and enablers to adaptation and knowledge/research gaps.

CHAPTER 2

Regional to sub-national context in southern Africa

East Africa: The Regional to Sub-national Context

To provide the context for analysis of vulnerability and adaptation interventions, this chapter provides a brief overview of socio-economic, political and environmental/ecological characteristics of East Africa region and the three target countries of the RDS (i.e. Ethiopia, Kenya and Uganda).

2.1 Socio-economic, governmental and environmental characteristics and dynamics of the region

2.1.1 *Environmental characteristics and dynamics*

East Africa is characterized by great topographical diversity with elevation that ranges below sea level in the rift valley system to high and rugged mountains and flat-topped plateaus. The highlands are commonly dissected by deep gorges and incised river valleys. The complex topography has created many local climatic conditions that range from hot deserts over the lowlands to very cold mountain ranges like the Simien Mountains and Ars-Bale Highlands in Ethiopia, and Eastern Arc Mountains in Kenya.

There are also complex annual rainfall cycles in the region. For example, over much part of Ethiopia, Kiremt (June – September) is the main rainy season (NMA, 2007; Mekasha et al., 2014), while March-May and September/October-November are the main and small rainfall seasons in Kenya, Tanzania, Uganda and southern part of Ethiopia (Omondi et al., 2014; Dinku et al., 2008). In Ethiopia, the mean annual rainfall ranges from 1,600–2,122 mm in the highlands of the western part of the country, and a lowest rainfall from 91-600 mm in the eastern lowlands of the country. Similarly, the mean annual temperature in the country ranges from 22.2^0 C in the lowlands to 4^0 C in the highlands, and the highest mean temperature is 31^0 C in the lowlands at the Denakil Depression (Awulachew et al., 2010).

In East Africa, rainfall variability is the main climate and weather element affecting ecosystem services, agricultural production, and socio-economic development of the region - exacerbated by frequent drought and flood events (Demeke et al., 2011; Dinku et al., 2008; Omondi et al., 2014). The rainfall pattern also influences water availability and food security in the region. For example, about 60% of the total land area of the Inter Governmental Authority on Development (IGAD) sub-region comprising of Djibouti, Eritrea, Ethiopia, Kenya, Somalia and Uganda is classified as arid, receiving less than 500 mm of rainfall annually (Funk et al., 2008).

Due to the complex topography and microclimatic conditions, the region harbours many types of flora and fauna and is rich in wildlife and biodiversity (NMA, 2007). National parks and protected areas cover 16% of the land area in East Africa (UNEP, 2013). However, due to extreme climatic factors (especially recurrent drought) and human interventions (e.g. charcoal production, agricultural expansion and illegal hunting), the biodiversity of the region has been negatively affected during recent decades. For example, in Kenya there has been a national and local decline in wildlife populations by over half, as recorded from aerial censuses between 1977 and 2007 (Homewood et al., 2009; UNEP, 2013). Lack of alignment of conservation priorities at macro-level with development priorities at household and

community levels, and inadequate distribution of benefits from wildlife tourism income are often cited as the challenges to integrating conservation and development goals (ibid).

2.1.2 *Demographic characteristics and dynamics*

East Africa is a region of rapidly growing population, typified by its rich diversity of ethnic groups. In particular, the semi-arid regions of East Africa are home to an ethnically heterogeneous population consisting of a variety of pastoralist and agro-pastoralist groups. The region's pastoralist groups can be broadly divided into four main clusters – although each of these include a rich diversity of socio-cultural norms (and gendered cultures), production forms and strategies, including varying degrees of mobility or sedentarisation, key livestock types, and engagement and dependence on pastoral activities. These include: (i) the Karamoja cluster comprising of groups in north-eastern Uganda, south-eastern Sudan, north-western Kenya and south-western Ethiopia; (ii) the Boran cluster which includes peoples of southern Ethiopia's border region and northern Kenya; (iii) the Somali cluster which covers Somalia, Somaliland, Puntland, Djibouti, north-eastern Kenya and the Ogaden region of Ethiopia; and finally (iv) the Maasai cluster of southern Kenya and northern Tanzania which includes a small number of agro-pastoralist groups affiliated to the Maasai (ODI, 2010).

One of the important drivers of change in East Africa is the rising population and high population growth rate in the region. For example, Uganda has one of the world's highest fertility rates (5.97 children per woman) (World Bank, 2013). Ethiopia is the second most populous country in Africa with an annual population growth of more than 2% (FDRE, 2011). It is estimated that the country will have more than 120 million people by 2030. Rising population and high population growth rates across East Africa have the potential to greatly increase the demand for food, water and livestock forage in the region (Davidson et al., 2003). Population redistribution through sedenterisation, migration and urbanization are also key dynamics in the region.

2.1.3 *Economic characteristics and development dynamics*

East Africa has a largely agrarian political economy, with high dependence of the local communities on crop production and pastoralism for their livelihood and employment. Agriculture is a major contributor to the regional economy, contributing to 40% of GDP in the region as a whole (Nyasimi et al., 2013), and about 75% of labour force across East Africa is engaged in agriculture (Salami et al., 2010).

The constraints for development and service delivery in arid and semi-arid areas of East Africa include: remoteness, low population density, pastoral mobility and poor infrastructure (Morton and Kerven, 2013). However, agricultural, industrial and infrastructure development trends act as drivers of change in the region, and Kenya, Uganda and Ethiopia have seen rapid development of the service sector in recent years (Salami et al., 2010). For example, Ethiopia is experiencing rapid economic changes in recent years. In 2012/13 the respective shares of agriculture, industry and service sectors in the GDP in Ethiopia stood at 43%, 12% and 45%. The share of the service sector to GDP increased from 38% to 45% in the past 10 years while the share of agricultural declined from 52%t to 43% in

the same period (UNDP, 2014). However, agriculture will continue to be the main source of employment.

Countries in East Africa have outlined ambitious long-term development plans (e.g. Kenya's Vision 2030, Uganda's Vision 2040) to transform into industrialising middle income nations. The Ethiopian government has developed a Growth and Transformation Plan that lays out growth, development, and industrialization targets up to 2015. The plan is directed towards lifting the country to middle-income status by 2025 and sustaining rapid and broad based economic growth through programmes such as agricultural intensification, small to large scale irrigation, infrastructural development, and food security programmes (FDRE, 2010, 2011; MoFED, 2012).

Amid these development dynamics and drivers, climate change is bringing a new dimension to East Africa's vulnerability and food security. The region is considered highly vulnerable to climate variability and change (as detailed in the following sections), in part due to low economic and institutional capacity to deal with the impacts (SID, 2012; UNEP, 2013). Indeed it is claimed that climate change is already negatively impacting upon development progress and will continue to undermine socioeconomic wellbeing of East African people (Davidson et al., 2003). While most of the semi-arid regions in East Africa are prone to droughts, there are also instances of frequent floods (e.g. Awash area of Ethiopia).

2.1.4 *Agriculture sector and dynamics*

Most of the farming activities are rainfed (Varghase, 2007). For example, Ethiopia's agriculture is dominated by rain-fed, small scale production systems (Bryan et al., 2009; Deressa et al., 2009; Demeke et al., 2011; Di Falco et al., 2012). Irrigation development in the country is estimated at merely 5 to 6% of the developable potential of 3.7 million ha (Awulachew et al., 2010). The cultivated land in Ethiopia is estimated to be 16.5 million ha (22% of the total land suitable for agriculture) and per capita cultivated land holding averages only around 0.5 ha (FDRE, 2011).

Similarly, in Kenya potentially irrigable land is estimated to be 540,000 ha of which only 52,000 ha or 9.6% of the potential has been developed (UNEP, 2006). Cultivated land area is estimated to be 4.5 million ha, which comprise 28.5% of the total potential suitable for agriculture (FAO, 2003). However, land productivity potential in high and medium potential lands in Kenya is affected by a number of factors: soil erosion, decline in soil fertility, soil salinization, crop and livestock diseases and fragmentation of landholdings (UNEP, 2006). Particularly, in the pastoralism predominant areas of the Kenyan lowlands, crop productivity is reported to be hampered by a combination of physical, environmental and socioeconomic factors, including gradual resource shrinkage and tenure insecurity (ibid.).

In the case of Uganda, cultivated arable land area is estimated to be 6.8 million ha, which is only 48% of the total potential (FAO, 2003). Land constitutes between 50-60% of the asset endowment of the poorest households in the country (World Bank, 2003). Crop and livestock disease, soil degradation, lack of access to improved agricultural inputs, weak agricultural extension systems, inefficient markets, increasing land fragmentation and unreliable weather are some of the factors reported to be contributing to the declining crop yield of smallholder farmers in Uganda (UNEP, 2006, 2011; Devereux 2009).

2.1.4.1 Pastoralism and agro-pastoralism

In East African countries, pastoral communities live in arid and semi-arid areas making their living from rangelands or from a mix of livestock-crop system in the case of agropastoral communities (Slegers and Stroosnijder, 2008). Hence pastoralism and agro-pastoralism play an important role in the livelihood of local communities and economy of East Africa's semi-arid regions. For example, in Ethiopia, which has largest livestock population in Africa, livestock production contributes about 30% of Gross National Product (GNP) and 12–15% of total export earnings (Biazin and Sterk, 2013). Since pastoralists are living in areas of harsh climate characterized by very low and erratic rainfall, their livelihoods have traditionally been built around coping mechanisms (e.g. indigenous water resources and rangeland management strategies) to manage chronic water and pasture shortages (Homann et al., 2005).

2.1.4.2 Food security

One of the major drivers for development dynamics in the region of East Africa and Ethiopia in particular is the increasing food insecurity and poverty associated with climate variability and environmental degradation (e.g. soil erosion, water shortage etc.) (NMA, 2007; FDRE, 2010, 2011; Brown et al., 2011; Funk et al., 2008). East Africa is one the most food insecure regions due to frequent climate risks (Slegers and Stroosnijder, 2008; Demeke et al., 2011; Gray and Muller, 2012). The strong dependence on rainfed agriculture in these areas results in a quasilinear relationship between grain yields, seasonal rainfall receipts and food deficits (Funk et al., 2008). For example, in Ethiopia, chronic food insecurity affects 10% of the population; even in average rainfall years these households cannot meet their food needs and rely partly on food assistance (Fraser, 2007; Demeke et al., 2011). It is estimated that over 10 million suffer from chronic food insecurity and poor nutrition in Kenya, and 1 to 2 million are annually reliant on emergency food assistance (30% of children aged 5 years and below are still classified as undernourished) (GoK, 2010). In the 25 years to 2006, the population of food insecure people is said to have doubled in East Africa, while per capita cropped area has declined by 33% and numbers of undernourished people has risen by 80% in the region (FAO, 2006). In 2011 the region was hit by a major, drought-related food crisis, with an estimated 13 million people affected across Somalia (where famine was declared), Kenya and Ethiopia (Oxfam, 2012).

2.1.5 *Infrastructure and hydropower development*

During the last few years, there has also been a huge capital investment in East Africa in various areas of infrastructure development, mainly in road networks and transportation, communication, and power supply with an aim of expanding the delivery of services (FDRE, 2010; Block and Strzepek, 2012).

The global concern towards renewable energy resources (e.g. hydropower) and the rising fuel price has prompted the East African governments to promote hydropower development to provide carbon-free electric power for domestic consumption and export any excess energy to the neighbouring countries. For example, the Ethiopian government is currently working to increase the hydroelectric generating capacity from 2,000 MW to 8,000-10,000 MW at the end of 2015 by constructing three large-scale hydropower projects (FDRE, 2010).

Dam construction in dryland Ethiopia raises issues of internal displacement of pastoralists as well as changes in the landscape and increased risk of flooding downstream.

Climate change is also predicted to impact negatively on infrastructure and other vulnerable sectors such as energy given the dependence on hydropower. Droughts in East Africa over the past several years have caused volatility in inter-annual lake level fluctuations and a consequent drop in hydropower production that has reportedly been associated with declines in GDP in the range of 1 to 2 % per year (in those years when capacity has been significantly reduced) (Nyasimi et al., 2013).

2.1.6 *Politics and governance dynamics*

In terms of the political and government structures, countries in East Africa are generally democratic constitutional republics with legislatures determined through periodic multi-party elections (SID, 2012). Governments across the region have developed short- to long-term development plans that generally look to achieve economic growth and poverty reduction through infrastructure development, human development, capacity building and sustainable natural resource management (ibid.). It also needs to be noted that there has been a general trend towards decentralisation especially after the 1990s in many countries of East Africa. This has been particularly so in the case of the target countries (Ethiopia, Kenya and Uganda), as all of them have adopted and promoted policies for decentralisation.

2.1.6.1 Conflicts and displacement

Instances of communal conflict and resulting population displacement and migration at times have challenged regional security and peace in East Africa. Geographical complexity, natural resources scarcity (e.g. famine) and environmental change (e.g. drought and desertification), combined with profound poverty and underdevelopment in the region pose further challenges. The link between rainfall variability and small-scale conflict and insecurity in the semi-arid zones of East Africa are closely linked and also predicted to be exacerbated by climate change (Raleigh and Kniveton, 2012). For example, the semi-arid zones of the lowlands of the Horn of Africa suffer frequent and sometimes devastating droughts, which make the region prone to communal conflicts over pasture and access to water (USAID, 2012). Among the many reported factors intensifying pastoral and agro-pastoral clashes in semi-arid zones of East Africa are: higher population growth, long-term climate change, increased alienation of land for irrigated farms or ranches, and disruptions of pastoral movements (ibid.).

Changing settlement patterns have long been noted as a source of crises. For example, in Kenya the sedentary settlement pattern among the Turkana was cited as one of the recurrent crises in as early as 1985 (ODI, 2010). Due to a lack of security caused by cattle rustling and raiding in areas that had better water sources, rainfall and pasture, the dominant settlement was in the harshest areas. A similar pattern exists among the Karamojong in Uganda (ibid.).

Some key characteristics of the three target countries Ethiopia, Kenya and Uganda are summarized in Table 1.

Table 1. Target country summary characteristics

	ETHIOPIA	KENYA	UGANDA
Population (2013)	94 million (19% urban)	44 million (25% urban)	38 million (15% urban)
Human Development Index (2013)	0.435; rank 173rd (annual HDI growth 2000-2013 = 3.35)	0.535; rank 147th (annual HDI growth 2000-2013 = 1.25)	0.484; rank 164th (annual HDI growth 2000-2013 = 1.63)
Dryland areas	Ethiopia's drylands are mainly found in the south, east and north. Arid and semi-arid lands cover 63% of the country.	Kenya's drylands lie mainly across the north and east and in the south of the country, constituting 84% of the land area.	True drylands in Uganda occur mainly in the north-east, but a semi-arid to sub-humid central strip (known as the 'Cattle Corridor') continues to the southern border.

Sources: World Bank 2014, UNDP 2015, CIA 2014, ODI 2010

2.2 Key socio-ecological systems and dominant livelihoods in the drylands of the region.

In general, socio-ecological systems and livelihoods in the East Africa region remain closely tied to the natural resource base. In the dryland areas of East Africa, a majority of the local communities earn their livelihood from pastoralism (livestock) and agro-pastoralism (crop-livestock mix).

The main agro-ecological systems in dryland zones of East Africa range from arid to sub-humid (Kruska et al., 2003; Seré and Steinfeld, 1996). The dryland in East Africa is mainly dominated by pastoralism (often mobile) with some rainfed crop production but also with increasing use of irrigated farming (both small- and large-scale) in some areas. There also exist fisheries in some wetland areas within drylands, particularly Uganda, as well as peri-urban and urbanised environments.

The dominant factor in dryland agro-ecological systems is the availability of water, mainly determined by mean rainfall and its reliability and distribution (Seré and Steinfeld, 1996; Kruska et al., 2003). Rainfed agro-pastoralism remains the dominant source of livelihoods for the rural poor in these areas, however intensification and transition to mixed agro-pastoralism systems are increasingly marginalizing nomadic and pastoralist systems. For example, in Kenya the horticulture sector has experienced significant growth, yet only 150,000 small-scale farmers are said to participate in this sector, which produces annual revenues of about US $2 billion (Salami et al., 2010).

Estimates vary but there are approximately 8 million pastoralists in Kenya, 3 million each in Tanzania and Uganda, 10 million in Ethiopia, and 8 million in Sudan (Markakis, 1998). East Africa's cattle population is reported to have increased from almost 39 million in 2005 to 47 million in 2010 (SID, 2012). However, there are some issues related to unreliability of data on cattle holding by pastoralist communities due to their high mobility and the ability of census methods to reach arid and semi-arid areas.

It also needs to be noted that the dryland pastoral economy in East Africa is characterized by high levels of diversification in response to both trends towards sedentarisation and fragmentation of rangelands (SID, 2012). For example, in northern Kenya pastoralists have increasingly diversified herd structures to include camels given their increased resilience to drought. Pastoralists are also increasingly diversifying off-farm income activities such as charcoal production, migrant seasonal labour, arable agriculture and eco-tourism to support livestock based livelihoods (Naimir-Fuller, 1999; Morton and Kerven, 2013). All of these have gendered implications in terms of labour allocations within and across households and communities, but these are as yet little understood. Lakeshore communities in East Africa already engage in diverse range of activities such as fishing, cultivation, rearing livestock and harvesting natural swamp products such as papyrus (Conway et al., 2005). Inland fisheries dependency is particularly high for Uganda (Allison et al, 2009).

Key development indices illuminate the stark socio-economic disparities that remain between populations residing within favourable agro-ecological zones and the vast semi-arid and arid lands of the region (ODI, 2010). Indicators for life expectancy, school enrolment and the Human Development Index are far lower and poverty levels far higher in arid and semi-arid lands. For example, in Kenya, poverty levels in the arid North Eastern Province were 70% in 2005/06 compared to the national average of 46.6% (GoK, 2010). Net school enrolment rates in primary education have risen nationally from 70% in 2000 to 92% in 2008, yet comparable improvements have not occurred in North Eastern Province where the net enrolment rate was 31.9% in 2008 (Middleton et al., 2011). Box 1 describes recent efforts in Kenya to focus political-administrative attention on the development challenges of the country's drylands.

Box 1.

Drylands governance in Kenya

Poor progress in Millennium Development Goals and recurrent food crises in Kenya's drylands led to the establishment in 2008 of a specific drylands ministry, the Ministry for the Development of Northern Kenya and Other Arid Lands (MDNKOAL), and a national arid and semi-arid land (ASAL) policy for sustainable development in drylands was launched in 2012 (Birch and Elmi, 2013).

Policy attention on ASAL development issues may reduce again since the responsibility for it now rests within a national ministry (i.e. Ministry of Devolution and Planning) following the 2013 elections. However, significant achievements can be attributed to MDNKOAL such as the establishment of various permanent institutions focused on ASAL development organizations and coordination mechanisms (including ASAL Secretariat, ASAL Stakeholder Forum, National Drought Management Authority, National Council on Nomadic Education in Kenya) and various ongoing projects such as development of a specific nomadic education programme (Birch and Elmi, 2013).

CHAPTER 3

Climate Change trends and projections

Climate Change, Trends and Projections

As a parallel output of the RDS phase, Daron (2014) produced a climatological report for the East Africa region. Box 2 reproduces the summary points from that report, and the remainder of this chapter expands briefly on these points.

Box 2.

Summary Messages from ASSAR (Daron, 2014)

The climate across East Africa varies from arid to tropical monsoon conditions.

It is mainly influenced by large scale seasonal atmospheric patterns as well as the proximity of the Indian Ocean. Temperatures are relatively high throughout the year for much of the region with cooler temperatures experienced in the highland regions of Ethiopia, Kenya and Tanzania. Northern regions receive the majority of rainfall in the June to August period, southern regions receive the majority of rainfall in the December to February period, and equatorial regions experience two rainfall seasons with peaks in October and April.

Temperature and rainfall vary on seasonal, annual and decadal timescales.

Over the past half century there has been substantial multi-decadal variability in rainfall. Some locations, such as parts of central Ethiopia were unusually wet in the 1970s and unusually dry in the 1980s and 1990s. Other regions show the opposite pattern.

Mean temperatures across the region have increased by 1 to 3°C over the past 50 years.

The greatest increases are found in central regions, particularly in South Sudan where increases in the March to August period have exceeded 3°C.

Future projections of temperature change show significant increases across the region.

Temperatures in the central and northern regions are projected to experience the largest increases. Though model projections are subject to uncertainties, the projected increases in average annual temperatures range from no change to 4°C by 2050. Higher increases are more likely under a higher greenhouse gas emissions scenario, and vice versa.

Rainfall trends over the past 50 years are less evident than for temperature, and there are large variations in the direction and magnitude of changes across the region.

An increase in rainfall in some locations for some seasons is observed but a decrease in rainfall is observed in other regions. Overall, trends are weak and hard to detect.

Future projections of rainfall change show both potential increases and decreases.

Projections of rainfall vary considerably. There is a tendency of models to project drying across the region in the October to March period but at present there is insufficient evidence to support either a shift to drier or wetter conditions in the future in most locations.

The impacts of future climate change on different sectors are complicated by the spread of model projections and the complex nature of natural and societal systems.

The impacts of climate change on water availability are unclear but the increased evaporation that is likely to occur with increased temperatures may put additional stress onto vulnerable systems.

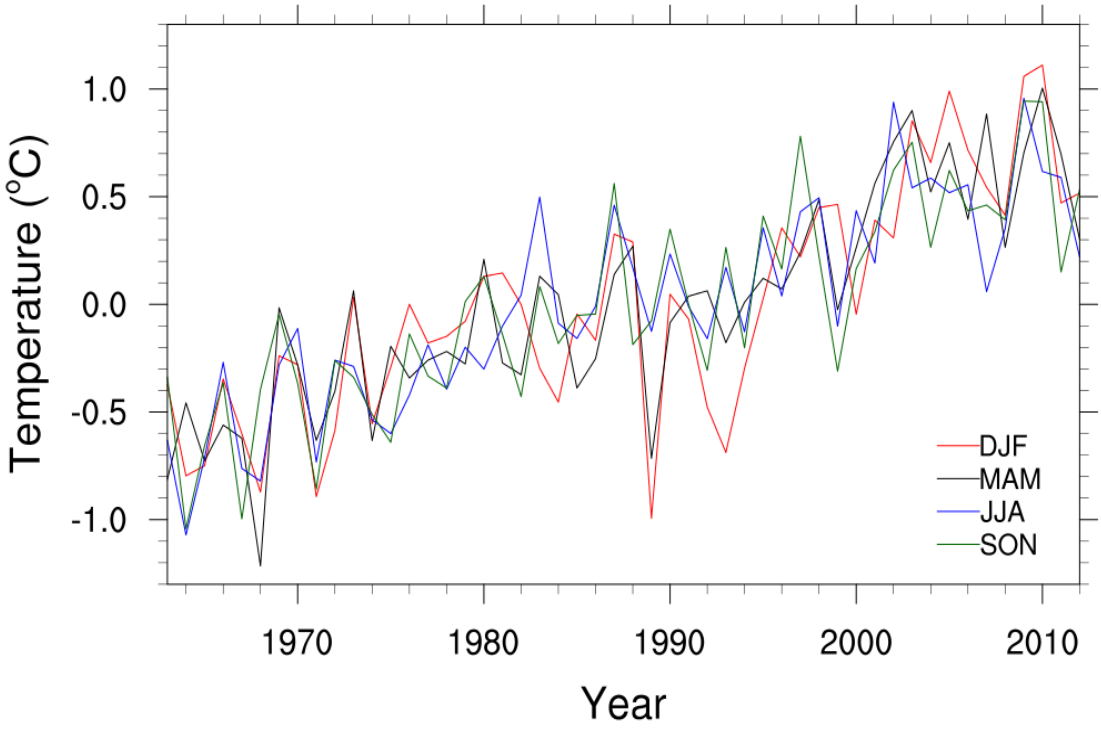
3.1 Historical climate dynamics

3.1.1 *Broad evidence of increasing temperature trend*

There is broad evidence at the regional level supporting increasing trends in temperature from climate baselines. Mean temperatures across the region have increased by 1 to 3°C over the past 50 years (See figure 1 below). Several works have reported a warming trend has occurred in the region during the last five to six decades rate broadly consistent with wider African and global trends (Christy et al., 2009). There is also evidence of increasing changes in extreme temperature events such as extreme maximum temperature, warm days, warm nights and the duration of warm spells (Mekasha et al., 2013; Omondi et al., 2014).

Figure 1

Time series of the land area averaged seasonal temperature changes between 1963 and 2012, for the four seasons: DJF, MAM, JJA and SON. Source: Daron (2014), using data from the CRU TS3.22 dataset.



Regional trends are supported by climate research at the national level. In the Ethiopian Blue Nile Basin Mengistu et al. (2013) reported the presence of statistically significant increasing trend for minimum temperature over much of the Blue Nile Basin, while contrasting trends for maximum temperatures analyzed at the annual and seasonal time scales. Historical data from 1951-2006 from Ethiopia shows a warming trend of approximately 0.37 °C every ten years in the country (Meikle, 2010). Compared to the national average as well as data from the highland regions in the country, the temperature increase in the semi-arid lowland regions has been more pronounced. For example, in the

southern lowland regions of Borena, Guji and South Omo temperature has increased by 0.4^0C in per decade in the period 1950-2000 (Amsalu and Adem, 2009).

In Kenya mean annual temperatures have increased by 1.0°C since 1960, an average rate of 0.21°C per decade (McSweeny et al., 2009). A visible indicator of this warming trend has been the decline of the Lewis Glacier on Mount Kenya, which has lost 40 per cent of its mass since 1963 (MENR, 2002). A climate analysis for East Africa was conducted by Christy and co-authors examining air temperature trends at 60 stations across Kenya (Christy *et al.*, 2009). After spatially interpolating the station based data, the study reports finding a statistically significant upward trend in minimum temperature (Tn) in the Kenyan Highlands region. Omumbo et al. (2011) found evidence of a warming trend in observed maximum, minimum and mean temperatures at Kericho during the period 1979–2009.

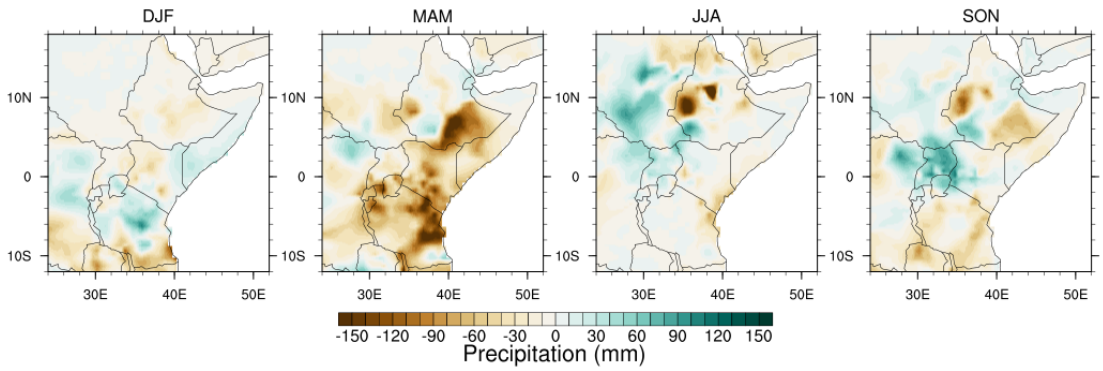
3.1.2 *Less discernible regional trend in rainfall record*

Rainfall trends over the past 50 years are less evident than for temperature, and there are large variations in the direction and magnitude of changes across the region. An increase in rainfall in some locations for some seasons is observed but a decrease in rainfall is observed in other regions and overall, trends are weak and hard to detect (Daron, 2014). Over past half century there has been substantial multi-decadal variability in rainfall. Some locations, such as parts of central Ethiopia were unusually wet in the 1970s and unusually dry in the 1980s and 1990s. Other regions show the opposite pattern (ibid).

Figure 2 shows changes to total rainfall for each season for the period 1963 to 2012. Notable rainfall change appears to have occurred in the MAM (March to May) season over large parts of the region, specifically Tanzania, Kenya and southeast Ethiopia, which have seen decreases in rainfall exceeding 100mm. Some highland regions of Ethiopia show drying in the JJA (summer) season, whereas areas of South Sudan show increasing rainfall in this season. In general, these patterns of change are not consistent across the region and therefore signals indicating systematic change are weak.

Figure 2

The change in rainfall between 1963 and 2012 at each grid cell, according to a linear trend, for the four seasons: DJF, MAM, JJA and SON. Source: Daron (2014), using data from the CRU TS3.22 dataset.



There are major data and knowledge gaps in terms of creating a complete understanding of regional trends to the rainfall record, however. Some studies in Ethiopia have identified downward trends in some parts of the country - mainly in the eastern, southern and southeastern regions (Seleshi and Zanke, 2004; Seleshi and Camberlin, 2006). Similarly Conway and Schipper (2011) reported a tendency of downward trends for the Belg rainfall, particularly over the eastern part of Ethiopia. However, other studies over central and northern parts of Ethiopia failed to show significant trends (Bewket and Conway, 2007; Mengistu et al., 2013; Mekasha et al., 2013).

In Kenya at the subnational level, greater rainfall has occurred during the short rains of October to December, particularly in northern Kenya, where the rains have begun to extend into the hot and dry months of January and February (AEA Group, 2008; GOK, 2010). In contrast, local observations suggest that the long rains of March and April have become increasingly unreliable in locations such as Eastern Province (Awuor, 2009). Rainfall intensity has also changed, becoming more intense along the coast (MENR, 2002).

Less discernible regional trend in rainfall intensity

Studies in Ethiopia have reported the absence of systematic evidence for consistent changes in the amount, frequency or intensity of extreme events in the country (Seleshi and Zanke, 2004; Seleshi and Camberlin, 2006; Bewket and Conwy, 2007; Mekasha et al., 2013). However, Omondi et al. (2014) reported the presence of statistically significant decreasing trends in total precipitation in wet days greater than one mm over the greater Horn of Africa region. However, all the above studies confirmed the presence of high inter-annual and intra-seasonal rainfall variability, which is accompanied by drought and flood risks.

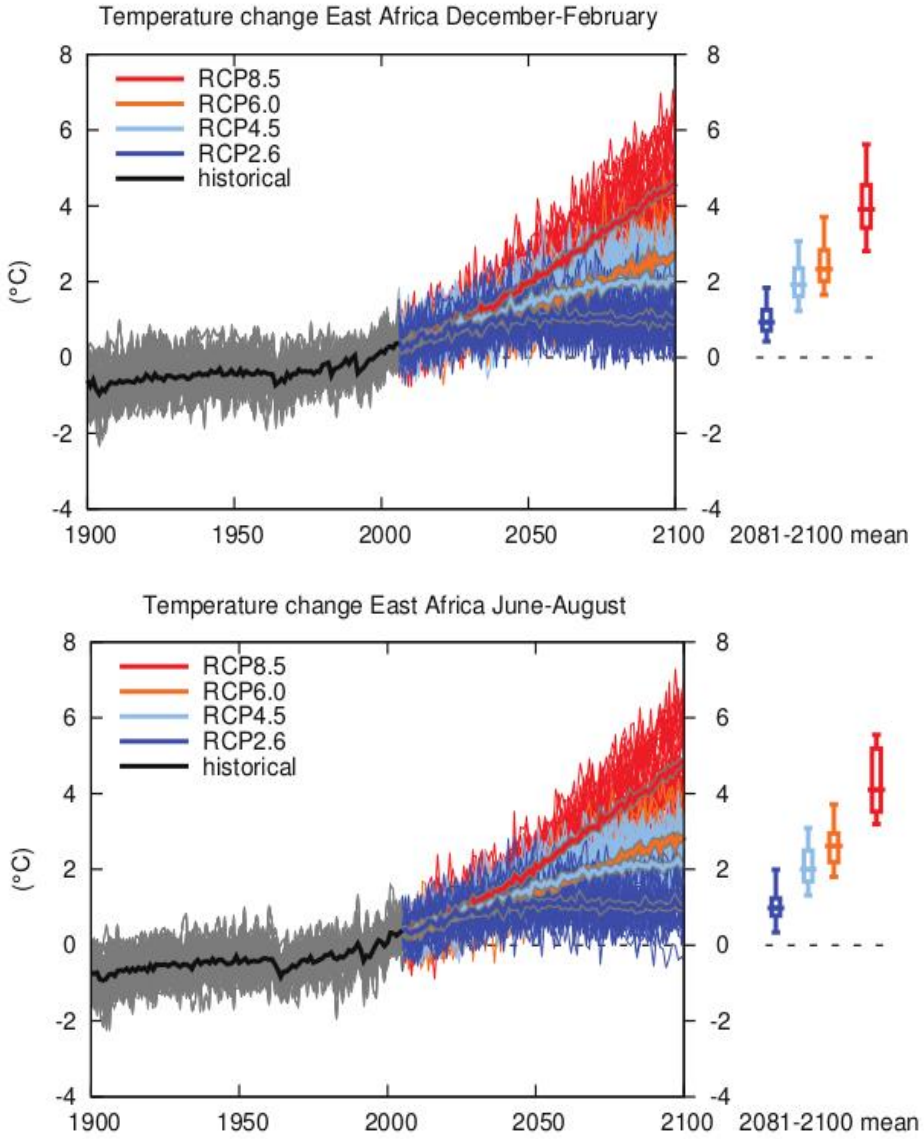
3.2 Future climate changes

3.2.1 *Temperature changes*

Future projections of temperature change show significant increases across the region. Temperatures in the central and northern regions are projected to experience the largest increases (Daron, 2014). Though model projections are subject to uncertainties, the projected increases in average annual temperatures range from no change to 4°C by 2050 (see figure 3). Higher increases are more likely under a higher greenhouse gas emissions scenario, and vice versa. IPCC projections for East Africa include warming of 0.2°C (low scenario) to more than 0.5°C (high scenario), 5-20% increase in precipitation from December-February (wet months) and 5-10% decrease in precipitation from June-August (dry months) (IPCC, 2014).

Figure 3

Time series of temperature change relative to 1986–2005 averaged over land grid points in East Africa in December to February and June to August. Thin lines denote one model simulation and thick lines are the multi-model mean. On the right the 5th, 25th, 50th, 75th and 95th percentiles of the distribution of 20-year mean changes are given for 2081–2100 for the four RCP scenarios. Source: IPCC (2013).



In Kenya the country's plateaus and mountain ranges may remain much cooler than the lowlands (Funk et al., 2010). By 2025, western Kenya is projected to see temperature increases ranging from 0.9°C to 1.1°C, while temperatures in the southern coastal area could increase by an average of 0.5°C and in northeastern Kenya temperatures could rise by 1.1°C (Funk et al., 2010).

Climate projections generated by UNDP (cited in DFID, 2009) for Ethiopia highlight the likelihood of mean temperature increases of 1°C in 2020s and up to 3.9°C to 2080s. Using a

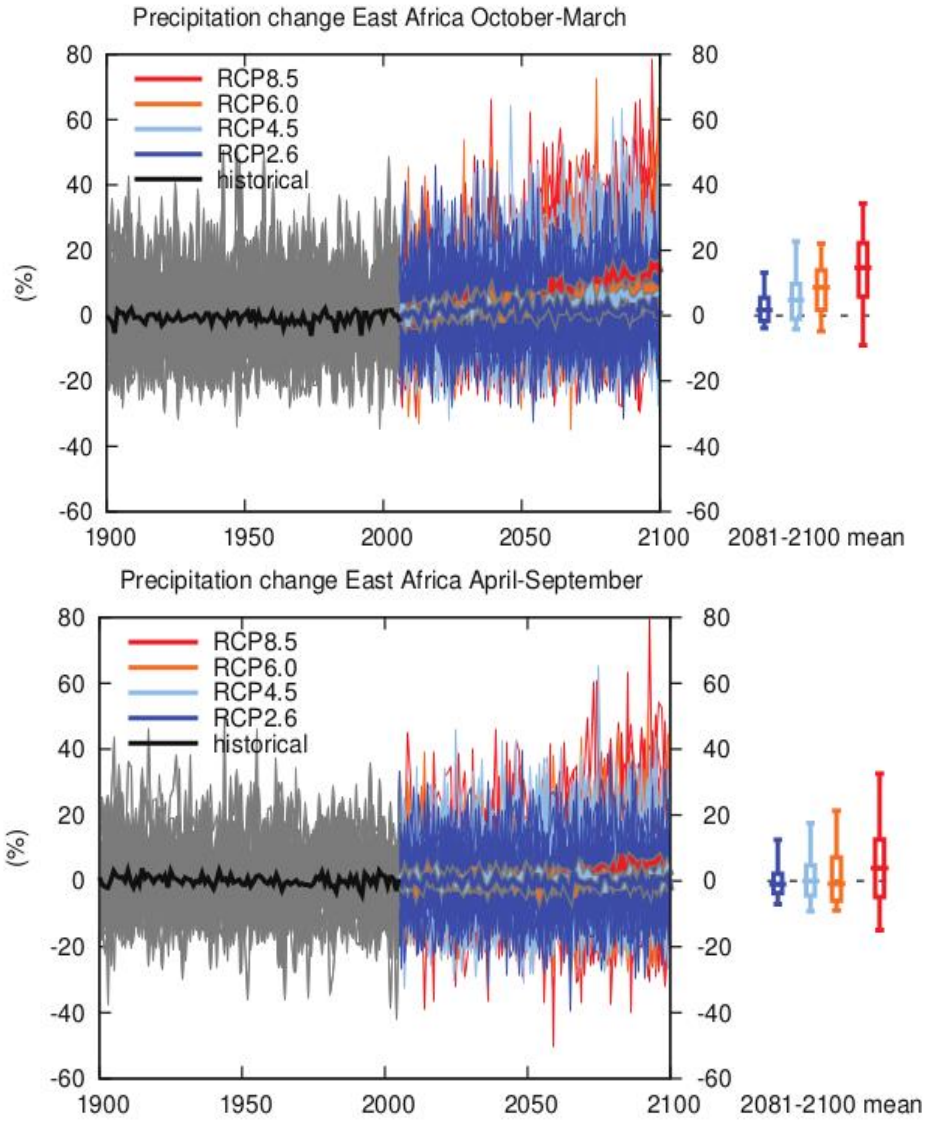
multi-model dataset the National Meteorological Agency of Ethiopia indicates that the mean annual temperature is likely to rise significantly when compared with the 1961-90 level by a maximum of 1.1°C by 2030, 2.1°C by 2050 and 3.4°C by 2080 (Weldegebriel and Prowse, 2013).

3.2.2 *Rainfall changes East Africa*

There is a tendency of models to project drying across the region in the October to March period but at present there is insufficient evidence to support either a shift to drier or wetter conditions in the future in most locations (Daron, 2014). The impacts of future climate change on different sectors are complicated by the spread of model projections (see figure 4) and the complex nature of natural and societal systems in eastern Africa.

Figure 4

Time series of precipitation change relative to 1986–2005 averaged over land grid points in East Africa in October to March and April to September. Source: IPCC (2013).



Mean annual precipitation in East Africa is projected to increase by 7 per cent by the decade of 2080 to 2090, though projections range from a decline of 3 per cent to an increase of 25 per cent (Christensen et al., 2007). Seasonal variations in rainfall patterns are also expected, with some models projecting a mean increase in East Africa of 13 per cent from December to February and 4 per cent from June to August by the period from 2080 to 2090 (Christensen et al., 2007). The number of extreme wet seasons in East Africa may increase by 5 to 20 per cent (Christensen et al., 2007; Seitz and Nyangena, 2009). However, several studies have stressed the disagreement between global climate models in representing rainfall amounts over east African highlands (Conway and Schipper, 2011) and topographic influences on models are not well understood. That said regional climate modelling work has substantially improved precipitation simulation compared to their driving general circulation models (GCMs) (Nikulin et al., 2012; Endris, 2013; Buontempo et al., 2014).

Several hydrological modelling studies have been completed in Ethiopia using downscaled GCMs and these have projected future rainfall changes. Using the single HadCM3 GCM Abdo et al (2009) examine changes to rainfall in the Blue Nile region of Ethiopia and find that the mean monthly rainfall shows a decreasing trend at the beginning of the rainy season (May and June) and an increasing trend towards the end of the rainy season (September and October). Dile et al (2013) modelled runoff in the Gilgel Abay catchment using the same GCM and found a decrease in rainfall of up to 30% in the near decades, but an increase in rainfall of 30% in the latter half of the century.

Funk et al. (2010) project that annual average precipitation will decline by 50 to 150 millimetres throughout most of Kenya's interior by 2025, while a large part of Kenya will experience a decline in precipitation during the long rains of more than 100 millimetres (Funk et al., 2010). Wetter conditions are likely to occur during the short rains of October to December, particularly in northern Kenya, where projections based on general circulation models suggest that rainfall could increase by as much as 40 per cent by the end of this century (AEA Group, 2008)

3.2.3 *Utility of climate model information*

Box 3 provides some preliminary reflections on the utility of current climate model information for the region. This is a theme that we plan to explore in greater depth through the ASSAR project.

Box 3.

How relevant is this climate model information to near and medium-term decision making?

The use of climate model data from general circulation models (GCMs) and regional climate models (RCMs) for both seasonal near-term forecasting and more medium-term decision making and planning has increased in recent decades across the region. National efforts across the region are underway to mainstream climate change concerns into existing or planned policies, projects and institutions of government and multilateral organisations, donor agencies and relevant bodies. Cross-referencing knowledge of climate change with plans such as the Poverty Reduction Strategy Papers (PRSPs, country-based strategies for poverty reduction), for example, can provide a useful starting point to identify national level risks from climate change (Conway and Schipper, 2011).

However, based on work in Ethiopia, Conway and Schipper (2011) found that even where rainfall model convergence is apparent, current trends and physical interpretations on the ground often counter IPCC multimodel projections. GCM uncertainties remain a barrier to prioritization of climate change adaptation by decision makers, and improvements are needed in how uncertainties in projections are articulated and approaches should be guided more by management objectives. There remains a shortage of accurate regional climate model (RCMs) data and lack of capacity to interpret inherent uncertainties within climate model outputs (NMA, 2007; Conway and Schipper, 2011). ClimDev-Africa, a programme of the African Development Bank, the African Union and the UN Economic Commission for Africa (UNECA), is one project that seeks to improve the supply of relevant climate information services in various East African countries.

CHAPTER 4

Risks, Vulnerability and Impacts

Risks, Impacts and Vulnerability

This chapter focuses on risks, impacts and vulnerability in the semi-arid areas of East Africa. It considers the important risks and impacts facing vulnerable groups, both climatic and non-climatic, highlighted in the literature, as well as who is vulnerable, in what ways, and the factors that make them so. Important gender and other socially differentiated dimensions of vulnerability are also considered. Development trends, such as demographic change related to population growth and movement of people, also intersect with and change vulnerability and the main themes emerging from the literature are described in the third section, linking these to important climate dimensions of changed vulnerability. Key governance dimensions of vulnerability, related to both institutional structures and direct policies are highlighted later in the report (see chapter 6).

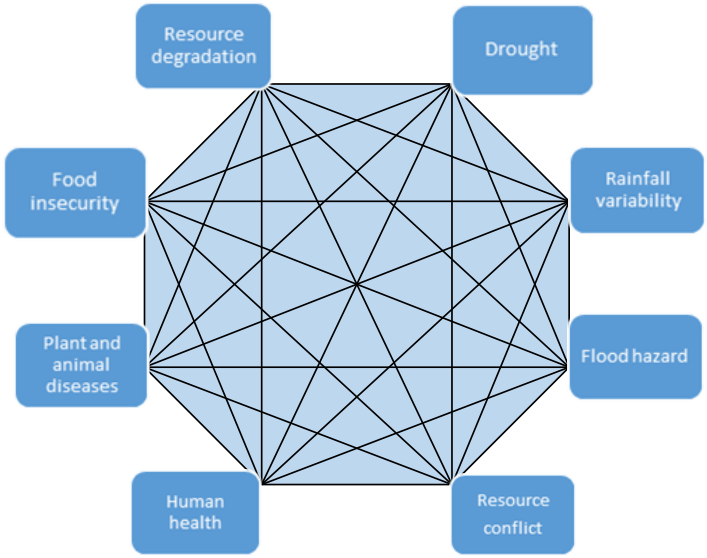
4.1 Important risks and impacts (climatic and non-climatic)

This section looks at the social-ecological risks associated with environmental dynamics, of which climate change is only one of several interlinked drivers of change. As Davidson et al. (2003) and Omondi et al. (2014) underline, in East Africa the effects of climate change will be compounded by widespread poverty, human diseases and high population growth rates that are expected to intensify demand for food, water and livestock forage within the region. When analyzing risks, as emphasized in chapter 2, we therefore need to root our understanding in a wider and complex context of stresses and risks such as high levels of poverty and economic crisis in some areas (Cross et al., 2011; Roncoli et al., 2010; RoK, 2012), HIV/AIDS (Hepworth and Goulden, 2008), low diversity of livelihoods with dependence on primary production and resource use (Hepworth and Goulden, 2008) dependency on climate change sensitive activities such as tourism in Kenya, and poor and poorly maintained infrastructure and services (Norrington-Davies and Thornton, 2011; COBRA, 2014; RoK, 2012; CARE ALP, 2013).

Here we identify 8 inter-related risks (see Figure 5) that affect people's livelihoods and wellbeing in semi-arid areas of East Africa: rainfall variability, drought, flood hazards, resource degradation, resource conflict, food insecurity, human health, and plant and animal diseases. We can refer to all of these as climate-related social-ecological risks, recognizing that each is a product of multiple factors and causes.

Figure 5.

Climate-related social-ecological risks to wellbeing



4.1.1 *Rainfall variability*

Currently, the main climate risks in Ethiopia are associated with rainfall variability in terms of timing and amount: delay in onset and/or early end of rains, intermittence, long or short dry spells, and sometimes even the loss of the entire rainy season (World Bank, 2006; Bryan et al., 2009; Conway and Schipper, 2011; Aberra, 2012). This impacts on rain-fed agricultural production, food security and environmental functions (Bewket and Conway, 2007; Demeke et al., 2011; Di Falco et al., 2012). It has also affected water resources, drying up rivers, springs, lakes and wetlands; for example, the falls in the levels of Lakes Abijata and Shala and drying up of the Bulbula River, an outflow of Lake Zeway. Water shortage in rivers and reservoirs also affects economic productivity by reducing the potential for hydroelectric power production (World Bank, 2006). In Kenya reduced rainfall and increased average temperature lead to increasing intensity of drought (Cross et al., 2011; RoK, 2012), while in Uganda, rainfall variability affects rain-fed agriculture (Mubiru et al., 2012) and makes particular crops vulnerable (USAID, 2013).

4.1.2 *Drought*

Drought is the most common climate related risk in Ethiopia, and becomes more frequent and severe in arid and semi-arid parts areas (Amsalu and Adem, 2009; Degefu and Bewket, 2014). Increases in temperature affect the soil and surface water resources by affecting the atmospheric moisture holding capacity and rate of actual evaporation and evapotranspiration (NMA, 2007; Conway and Schipper, 2011). In Kenya the frequency of drought has increased as failure of the rains has become a common event (once every two or three years) rather than something that occurred once every decade (*The Economist*, 2009). In Uganda drought is concentrated in Eastern sub-regions such as Karamoja and Teso (Kristjanson et al., 2012; Egeru, 2012). Webber et al. (2014: 162) note that "repeated

extreme events like droughts or heat waves reduce poor people's ability to cope with crop failures or maintain food security as their savings, productive assets and human capital are more frequently diminished". Consequently, poor farmers are not adapting at the speed that the climate is changing.

4.1.3 *Flood hazards*

Flood is a significant and increasingly prevalent risk in Ethiopia, particularly among the pastoral communities who are living in the lowlands (World Bank, 2006; NMA, 2007; Amsalu and Adem, 2009). This can take the form of flash floods (ibid) or riverine floods originating from highlands (World Bank, 2006; Degefu and Asfaw, 2006). Kenya is affected by severe flooding (Norrington-Davies and Thornton 2011), and there has been an increase in the proportion of rain falling as heavy events. Flooding has also been observed in Uganda from extreme rainfall events (Conway et al., 2005), and is often combined with landslides (Kansiime 2012).

4.1.4 *Resource degradation*

In Ethiopia there is visible rangeland degradation as a result of frequent drought, bush encroachment and livestock grazing pressure (Tesfay and Tafere, 2004). Kenya has experienced increased soil erosion and siltation of water courses (Roncoli et al., 2010; CARE ALP, 2013) and exposure to invasive species (Norrington-Davies and Thornton 2011; Roncoli et al., 2010. See also Box 4). These risks are exacerbated by unsustainable land management practices (Shames 2012; Roncoli et al., 2010). A similar decline in the resource base, including eco-system services, can be observed in Uganda, partly due to declining soil fertility (*Uganda CCVAR*, GoU, 2012).

Box 4

Invasive Alien Species (IAS)

IAS are also commonly referred to as invasive, aliens, exotics or nonindigenous species. IAS are species, native to one area or region, that have been introduced into an area outside their normal distribution, either by accident or on purpose, and which have colonized or invaded their new home, threatening biological diversity, ecosystems and habitats, and human well-being. The extent to which introduced species may proliferate and spread is affected by the state of the receiving ecosystem.

Invasive alien species may threaten native species as direct predators or competitors, as vectors of disease, or by modifying the habitat or altering native species dynamics (MA, 2006). Invasive alien species impact on land resources, and agriculture and livestock production systems, in multiple ways, potentially threatening food security. Some IAS transform grasslands that support grazing. For example, Lantana camara poisons cattle and destroys understorey species (IUCN/SSC/ISSG, 2004). Parthenium hysterophorus (congress weed), originally introduced into Ethiopia through contaminated food imports, has had devastating impacts on agriculture – earning it the local name, "no crop". Similarly, Prosopsis juliflora, has invaded large areas of grazing and farming land in drylands of Ethiopia since its introduction in the 1970s for land reclamation and use as a windbreak (Tessema, 2012).

With high levels of environmental change, such as deforestation, growing extractive timber use, and ecological changes associated with climate change, IAS are likely to be a growing problem. (Bingelli et al., 1998). The Millennium Ecosystem Assessment found that climate change and the introduction of IAS are the two drivers of environmental change that are the most difficult to reverse (MA, 2006).

4.1.5 *Resource conflict*

Resource degradation – especially of water sources and pasture - leads to increasing competition and conflict over resources. For example, in Ethiopia this has been linked with multiple types of conflict: cross-border, inter-community and community with National Parks (Gebremichael et al., 2005; Amsalu and Adem, 2009; USAID, 2012; Gebresenbet and Kefale, 2012), although some of these conflicts may be an expression of older tensions (Goulden et al., 2011). They may also be exacerbated by government and private investment programmes if these create displacement and rangeland scarcity for the pastoral communities (Homann et al., 2005; Gebresenbet and Kefale, 2012).

In Kenya there is reduced water availability for domestic, crop and livestock (Norrington-Davies and Thornton, 2011; Shames, 2012; COBRA, 2014; Cross et al., 2011), which in some cases has led to violent conflict (CARE ALP, 2013), particularly within new urban settlements. These conflicts feed into existing security concerns in particular regions (COBRA, 2014; Roncoli et al., 2010; CARE ALP, 2013).

The Ugandan government also noted limited storage for water (*Government of Uganda Ministerial policy statement for water 2010/11 and 13/14*), which relates to the ways in which inadequate infrastructure exacerbates the risks associated with climate change. The proliferation of borehole technology has been a mixed blessing across much of Kenya's SARs causing groundwater depletion, overgrazing and inequitable distribution of water resources. In some drought prone dryland areas of Kenya 58% of water demand is met by utilizing groundwater in districts where only about 20% of the area has good groundwater potential (Secretariat for Convention of Biodiversity, 2010). During droughts this often means there is insufficient supply to meet demand resulting in the drying and siltation of water sources and disruption of natural water flow. (ibid) Changes in seasonal rainfall also impacts in some areas on water availability for animals, bringing increased competition between humans and animals over resources (see Box 5).

Box 5.

Biodiversity impacts

Climate change has become a concern in the field of biodiversity protection. Changes in the world's ecosystems are already being seen (Root et al. 2003; Hughes 2000). The Intergovernmental Panel on Climate Change (IPCC 2007) conclude that these changes are occurring at a faster than expected rate. The numbers of mammal species in the national parks in sub-Saharan Africa could decline by 24 to 40% (IPCC 2007). From the perspective of the tourism industry alone, such a loss would be devastating to the economy.

An example of the impacts of climate change on wildlife can be seen as the patterns of seasonal rain change over the Serengeti, animals are likely to spend more time outside of these protected areas. This is likely to increase conflict with human agriculture and may also lead to an increase in poaching. In addition, any changes in the migratory routes required to move between new areas of peak seasonal grass growth, as rain patterns change, may be blocked by agricultural land and, in particular, cattle fences, limiting the ability of the migratory mammals to respond successfully to climate change. (Robinson et al., 2005).

The government of Ethiopia has recognised the increasing threat to the country's biodiversity resources and has developed various policies and legislations during the last few years, including a biodiversity action plan that includes sustainable land use management. Kenya's Wildlife Bill of 2007 singled out the SAR areas of Mara, Amboseli and Kitengela as critically endangered ecosystems citing land subdivision, overgrazing and the impact of tourism development as key drivers of biodiversity loss (MTR 2007). There has been a national and local decline in wildlife populations by over half from aerial censuses recorded 1977-2007 (Homewood et al. 2009). There are trade-offs associated with conservancy management for wildlife and land use for livestock, and implications for societal vulnerability during drought events (Osano et al., 2013). However, lack of alignment of conservation priorities at macro-level with development priorities at household level, and inadequate distribution of benefits from wildlife tourism income were cited as discouraging conservation-compatible land use decisions at the local level (Homewood et al., 2009).

4.1.6 *Food insecurity*

Sub-Saharan Africa has been dubbed 'the food crisis epicentre of the world' and the risks are particularly acute in arid and semi-arid regions (Thornton et al., 2007: 4). Rainfall variability and associated droughts have been major causes of food production crises, food shortage and famine in Ethiopia during the past few decades (Conway and Schipper, 2011; Demeke et al., 2011). For example, local and regional food insecurity problems were reported during the 1970s, 1980s and early 1990s in the north eastern (Wollo and Tigray), in the east (Harar), and central Ethiopia (Shewa) (World Bank, 2006). This is expected to continue in the future (NMA, 2007) as even with normal rainfall approximately ten percent of the population cannot meet their food needs and rely partly on food assistance (Conway and Schipper, 2011). Beyond climate related impacts, there are multiple drivers of food insecurity in Ethiopia – including environmental degradation, demographic pressure, rural-urban migration, and conflict (Biazen and Sterk, 2013; Amsalu and Adem, 2009). In Kenya there has been widespread food insecurity and malnutrition, which is reflected in the extent of stunting among the under-fives (Bernard et al., 2012; Shames, 2012; Cross et al., 2011; RoK, 2012). A similar picture is evident in Uganda where key crops are vulnerable to climate variability (Liu et al., 2008; James, 2010; Mubiru et al., 2012). Webber et al. (2014) reports that many poor Ugandans are becoming net food buyers and are therefore affected by global price variability and volatility (Kristjanson et al., 2012).

4.1.7 *Human health*

In Ethiopia the prevalence of diseases is exacerbated by drought and flood (Homann et al., 2005; Amsalu and Adem, 2009) and by temperature change more broadly, which is predicted to continue increasing at an even higher rate (Boelee et al., 2013). There are also growing social and environmental problems, including those associated with pressures of population growth, housing quality, air pollution and water and sanitation (Kitha and Lyth, 2011). Access to safe drinking water is far lower in Kenya's SARs. For example, data from North Eastern Province's rate is 9.9% compared to national average of 56.3% (RoK, 2012; ODI, 2010). In Kenya farmers have observed the effects of environmental degradation such as rapid deforestation, loss of biodiversity and degradation of water resources, as contributing to increasing prevalence of malaria (Okoba et al., 2011), cholera and other diseases (Kabubo-Mariara, 2009). An estimated 25 million people are at risk of malaria every year in Kenya, and 40,000 die annually from the disease. Moreover, the economic burden of malaria is estimated at US$45 million to US$99 million annually in terms of direct costs and between US$18 million and US$144 million (including disutility from pain and suffering) (SEI, 2009) A significant number of Kenyans still rely on traditional medicines gathered from the surrounding ecosystem and their capacity to access these is reduced by climatic events, such as drought, and environmental degradation. In Uganda, fisheries have been particularly affected, and Allison et al. (2009) observes a higher incidence of disease in these communities.

Box 6.

Health service challenges

Governments face challenges in reaching semi-arid areas in the region with essential healthcare services, contributing to greater vulnerability of people living in these areas. In Kenya's pastoral SARs healthcare coverage and provision are well below national average. For example, Ali and Hobson (2009) found that the rate of coverage of measles vaccinations was 33.4% in pastoral areas compared to a 72.1% national average; similarly coverage of other vaccinations was 6.4% compared to a national average of other vaccination coverage of 51.5%. Official data from Kenya also illustrates the governance healthcare challenges of reaching the SARs. Access to healthcare data shows that the dryland Northeastern Province falls below the national average. The percentage of women using antenatal care was 31.7% in Northeastern province compared to 89.9% as the national average. Similarly, the proportion of vaccinated children among those of 12–23 months age was just 54.3% in northeastern province compared to 92.6% as the national average (ODI, 2010). Provision of basic healthcare services and improvement in human health in Horn of Africa SARs is further challenged by a highly mobile population and the high cost of mobile healthcare service provision.

4.1.8 *Plant and animal diseases*

Changes in temperature and humidity in Ethiopia are reported to have increased vector-borne diseases and helminthes infections, particularly in small ruminants. However, there is little information on how current and future climate change and variability affect animal and plant diseases across different agro-ecology zones in the country. Exposure to pathogens has also increased in Kenya (Norrington-Davies and Thornton, 2011; Roncoli et al., 2010) and outbreaks of animal diseases are a major factor affecting the productivity of the livestock sector. For example, over the last decade the country has suffered outbreaks of several diseases including African swine disease, blue tongue, contagious bovine pleuro-pneumonia, foot and mouth disease, lumpy skin disease Newcastle disease, Rift valley fever, rinderpest and sheep and goat pox (Kabubo-Mariara, 2009).

Major food crops have also been affected by plant diseases. However, there is less information on this which hampers effective allocation of resources (for example, the distribution and severity of sorghum diseases, Ngugi, 2002). Maize Lethal Necrosis Disease spread to Kenya in 2011 and is currently found across various districts. **Infection rates and damage from MLN can be very high, seriously affecting yields and sometimes causing the complete loss of the crop.** Over 77,000 ha of maize were affected in 2012, translating into an estimated loss of 1.4 million bags (each of 90 kgs) worth about USD 52 Million (ibid.). In Uganda an increase in pests was observed (Hisali et al., 2011) with implications for post-harvest storage and drying (Stathers et al., 2013) and the need for new pest-resistant varieties (Kristjanson et al., 2012) (e.g. to counter the growing threat of bean root rot as noted by Farrow et al., 2011). Conway et al. (2005) also discuss increasing

livestock deaths due to disease and higher rainfall/flooding and depletion of fish stocks due to changes in temperature and wind speed.

4.2 Key vulnerable groups

It is clear from the literature that different groups and societies in semi-arid areas in the region experience vulnerability to the risks described in different ways. Those classified as most vulnerable include women, children (often grouped with women), pastoralists and smallholders. People living with HIV/AIDS are also marginalized and as such are more likely to be vulnerable. Females, disabled people, elders and children and the rural and urban poor are especially highly vulnerable to the impacts of climate change and variability (NMA, 2007; Amsalu and Adem, 2009), since these groups often have lower adaptive capacities and limited access to resources for adaptation practices.

It is important to acknowledge that these categories are not mutually exclusive, but are interconnected both in terms of their characteristics/ identities and in terms of vulnerability experiences that intersect. For example, Rovin et al. (2013) identified increased vulnerability to water and crop shortages in both rural and urban Ethiopia according to age and gender. Further, multiple dimensions of vulnerability tend to come together in 'vulnerable locales'.

4.2.1 *Women*

The literature describes how women, as a socially differentiated group (by wealth, ethnicity, age and status) living in semi-arid regions across a range of communities face gendered dimensions of vulnerability. These relate to differential access to resources, lack of decision-making power, the social and cultural norms and beliefs that deny equal opportunities and rights and the burden of care in the household falling disproportionately on women - and are most keenly felt by female headed households, identified in a number of contexts as being the most vulnerable (see for example the Uganda Climate Change vulnerability assessment report). For rural Kenyan women a lack of access to land and credit combined with a high dependence on rainfed agriculture is strongly associated with vulnerability (Caretta, 2014). For pastoralist women in Kenya their vulnerability relates to a lack of resources combined with lack of access to information and little decision-making power, embedded in gender prescribed norms and behaviours. This is compounded by frequent climate shocks with no time for recovery and weak governance and safety nets (*Joto Afrika 14*). According to CARE ALP (2013), the proximity to Somalia and the importance of Somali (Islamic) culture in Garissa County prevents women engaging in certain forms of labour, restricts the independent movement of women, and curbs their participation in household and community decision-making making them less able to participate in adaptive strategies.

Migration of men, single mothers and widows to urban areas in response to climatic stress can leave behind de facto female-headed households, many of which are headed by elderly women caring for the migrants' children. Further, climate variability has induced additional workloads for women (Amsalu and Adem, 2009). For example, during drought times women are forced to travel long distances to fetch water, collect wild food and generate addition income sources. As well as experiencing vulnerability differently, men and women also have different perspectives. Gender differences in perceptions of sources of vulnerability have

been reported in Kenya and Uganda (UNDP, 2014) in that women focused on access to water and men to peace (both groups felt education was important). In Ethiopia, men were concerned about livestock prices, while women were mostly concerned about about food availability.

4.2.2 *Children*

Children are often listed as an affected group in terms of having heightened vulnerability to climate change, although specific impacts on children are rarely mentioned in the literature, with the exception of some links to malnutrition. For the children of Kenyan pastoralists, reduced availability of food means they are at risk of malnutrition and dropping out of primary school (Roncoli et al., 2010). Children also engage in the herding of cattle, which puts them at the frontline of conflicts, and cattle rustling. In the pastoral zones, children may not get milk during drought times since the cattle are moved to remote locations (Gebresenbet and Kefale, 2012). Stunting is also observed in under-fives in pastoralist communities in Kenya due to erratic rainfall, high temperatures and high evapotranspiration (RoK, 2012).

4.2.3 *Pastoralists*

Pastoralists tend to face multiple and intersecting sources of vulnerability. For pastoralists, traditional adaptation mechanisms have commonly been disrupted, sometimes leading to pastoralism being stigmatised unfairly as associated with chronic food insecurity (*Joto Afrika 14*). Amsalu and Adem (2009) refer to rangeland degradation due to frequent droughts, over grazing and bush encroachment. According to Osano et al. (2013), Masai households in Kenya report reduction in livestock to less than 4.5 head per person due to drought and resulting increase in poverty. Pastoralist groups from Isiolo, Garissa, Wajir, Mandera, Moyale, Marsabit and Samburu in Kenya who collect gum as a coping strategy only make KSh 4,000 per month, making them the poorest sector of pastoralist society (Gachathi and Eriksen, 2011). Egeru (2012) describes pastoralists from Teso, in eastern Uganda, who are dependent on rainfed agriculture and freshwater fisheries as well as livestock, all of which have been affected by climate change (Egeru, 2012). A number of sources describe that the pastoral and agro-pastoral communities living in the arid and semi-arid parts of Ethiopia have lower adaptive capacities to the expected impacts of climate change due to lack of inputs (medicine, feed), lack of credit, isolation from market centres, low infrastructural development, and poor access to services (Homann et al., 2005; NMA, 2007; Amsalu and Adem, 2009; Gebresenbet and Kefale, 2012; *Joto Afrika 14*). However, against these assertions it is also key to note that many authors regard pastoralism as in many ways inherently adaptive (see Chapter 5).

4.2.4 *Smallholder farmers*

Vulnerabilities faced by smallholder farmers overlap with those faced by pastoralist groups. Farmers in Rural Eastern Kenya experience vulnerability related to reliance on rainfed agriculture, with cropping patterns disrupted by changes in seasonal rainfall patterns (see for example, Eriksen and O'Brien, 2007; Claessens et al., 2012; Leclerc et al., 2014; Mwongera et al., 2014, in relation to the eastern slope of Mt. Kenya, Ogalleh et al., 2012 in

relation to Laikipia district, Olsson and Jerneck, 2010 for western Kenya). Similar problems are reported by Bezabih and di Falco (2012) in Ethiopia and in *Joto Afrika 12*, which describes how farmers' planting patterns and calendar no longer match seasonal rainfall, leading to crop loss. Unpredictable outputs and incomes lead to shifts in gendered work patterns, including male seasonal migration and the intensification of female work especially in periods of food shortage. This affects food availability and security, with food insecurity and poor nutrition reported across smallholders in Kenya, Uganda, Ethiopia and Tanzania, across a range of livelihood systems and crops (Kristjanson et al, 2012). Liu et al. (2008) describe how small holders experience lowered productivity due to water/ nutrient shortages, high temperatures, and inadequate soil aeration. The category of 'net food buyers' are also particularly vulnerable to drought and heat waves, across East Africa (Webber et al., 2014). Vermuelen et al. (2013), at a global level, note shifts to off-farm employment and reductions in consumption in this group. In Ethiopia, smallholder farmers depending on low productive rain-fed agriculture, particularly in the arid and semi-arid areas are highly vulnerable to climate change and climate variability (NMA, 2007). Lack of climate information is also identified as an important compounding factor. This relates to both the availability of data at the appropriate level, and the usability of and access to data (Roncoli et al., 2010; CARE ALP, 2013).

4.2.5 *Conflict-affected communities*

The interlinking of different sources of vulnerability are illustrated by the way conflict and political unrest in semi-arid areas underpin and run alongside other sources of vulnerability. Conflict has long been a traditional element of pastoralism in East Africa, with practices such as livestock raiding sanctioned by customary authorities in many of the region's pastoral societies often as a restocking response after drought or disease outbreaks (Schilling et al., 2012). Conflict can significantly hinder livestock mobility in the region's SARs leaving vast areas of rangeland under-grazed causing encroachment by shrubs, while intensive grazing pressure around defensible areas leads to desertification and increased vulnerability (Blench, 1998). Decades of conflict in Karamoja, Uganda, for example, has prevented the optimum use of rangelands and has been the main cause of land use change as herders either seek protection by congregating together around settlements or disperse to higher mountainous areas where settlements can be hidden and agro-pastoralism can be practiced (Naimir Fuller, 1999).

Several studies have reported an increase in conflict within recent years, particularly between groups in north-western Kenya (Schilling et al., 2012; UNDP, 2011; Omolo, 2010; Mkutu, 2008). Various causal factors have been advanced to explain this phenomenon from increases in poverty, payments of dowry, tribal-based politics (McCabe, 2004), increased availability of small arms to an increase in climate change related stressors (Schilling et al., 2012). In many areas conflicts and raiding have become increasingly commercially orientated and used a strategy to accumulate wealth. In Karamoja increasing commercialization of livestock raiding has been observed with traders using inside information to rapidly purchase and market stolen livestock (Eaton, 2010). Conflicts hinder development progress by favoring short term crisis management approaches, but at the same time conflict-management programmes in pastoral systems can be an opportunity to

strengthen traditional institutions and create new informal and formal mechanisms that enable more long term effective, equitable participation in development processes. Classifying conflicts in pastoral systems into "management problems", "disputes" and "conflicts" is a helpful step towards systematically determining suitable resolution mechanisms, but in practice there are often multiple layers and scales of complexity associated with the region's pastoral conflicts and it may be more constructive to consider the phases associated with conflicts (Naimir Fuller, 1999). The most effective approaches to conflict mitigation in pastoral systems are those that recognize the complexity of the issues and enable the system to maintain flexibility; rather than seeking to support or strengthen formalized systems that seek to stabilize pastoral groups within defined territories (Naimir Fuller, 1999). Women can also play a vital role in conflict-resolution and peace-building activities as their kinship ties and non-combatant status can enable them to enlist the support of elites, warriors, elders and government to resolve conflicts in ways not open to other actors.

4.3 How have recent development trends changed vulnerability?

Development trends are changing vulnerability in semi-arid areas, and there are climate dimensions to this: as livelihood strategies and access to resources and assets respond to broader development changes taking place such as agricultural development, land use policy and urbanisation, these can have an impact on climate-related risk and knock-on effects on people's ability to cope. The main trends highlighted in the literature relate to population growth, land (distribution and land use change), and migration and urbanization. These themes are interconnected. For example, land use change could have even larger impacts than climate change on flood risk. This does not in any way negate the importance of problems posed by climate change, but highlights the fact that climate change and responses to it cannot be considered in isolation from other changes (Gathenya et al., 2011).

4.3.1 *Population growth*

Population growth, especially in rural areas, is affecting access to land and resources and there is evidence reported for this across the region. Resource scarcity – not just land but also water and forestry products is seen to potentially hamper people's ability to adapt to climate change (Homann et al., 2005; Gebresenbet and Kefale, 2012; Norrington-Davies and Thornton, 2011, Droogers, 2009; CARE ALP, 2013; SEI, 2009).

In the face of population pressure, specialisation of agricultural systems is seen by some to be inevitable to ensure regional food security. This intersects with climate change impacts as more marginal extensive systems are becoming increasingly risky to the point where livelihoods may have to change substantially, as climate change effects exacerbate problems for vulnerable and poor people living in these marginal areas. (Thornton et al., 2010). In Ethiopia for example, Gunasekara et al. (2013) suggest that the effects of population growth supersede changes in climate scenarios, especially at already water-stressed lower latitudes

4.3.2 *Land distribution*

Changes in land distribution also affect vulnerability via a number of channels, and lack of access to land and other natural resources may be a key constraint to improved livelihood opportunities for the poorest and most vulnerable (USAID, 2012). Context is important. In relation to arid and semi-arid areas more broadly, exclusionary land title may be "counterproductive to sustainable land use", as the associated land fragmentation provides fewer opportunities for pastoralists to relocate (Galvin, 2009: 189). However, in Uganda a more secure land tenure arrangement is associated with an increase in the chances of adapting to drought through technology and reduced consumption (Hisali et al., 2011).

In the case of Ethiopia, although the government has set policies for equitable distribution in land access and use, there is substantial evidence that this may not hold in practice and land is fragmented into tiny parcels. More than 85% of farming households operate on less than 2 hectares and, about 40% operate on less than 0.5 hectares (USAID, 2012). Fragmentation in this context arguably discourages sustainable land management practices like rotation, agroforestry, inter-cropping and soil erosion control, as well as acting as a barrier to modernised agricultural activity as economies of scale cannot be achieved (USAID, 2012). Restrictions on land redistribution means access is severely constrained for smallholder farmers. At the same time, there are programmes to transform large tracts of former rangeland in the lowland (lower Awash and Omo) for sugarcane plantation and lease out land to domestic and foreign investors both for rain-fed and irrigation agriculture. This is impacting on resource access and livelihoods of those living in these semi-arid areas (Gebresenbet and Kefale, 2012; FDRE, 2011). For pastoralists in these areas this has led to shortage of rangeland and inter-community conflicts due to increasing competition for water and pasture resources (Homann et al., 2005; Gebresenbet and Kefale, 2012).

4.3.3 *4.3.3 Land use change*

Population growth, land fragmentation, pressure on resources and land use change are strongly interlinked. At Mt Kenya, rapid demographic and economic change including the intensification of irrigated agriculture in the footzone and along the rivers in the plateau have dramatically raised water demand in the past decades (Huq et al., 2005). As a result, the Ewaso Ng'iro and its tributaries fall dry with increasing frequency. This leads to conflicts between upstream and downstream water users (Notter et al., 2007).

There are rapid land use and cover changes in Ethiopia due to rapid population growth, urbanisation and economic development with impacts on resource availability (water and wood), soil erosion and local climate changes (Bewket and Sterk, 2005; Worku et al., 2014). Household farm sizes have become smaller, particularly for the youth, leading to expansion of farmlands into marginal and deforested areas with very poor soil and poor water management practices, and increased drought hazard (Biazin and Sterk, 2013). This has resulted in deforestation and loss of biodiversity, soil erosion, depletion of organic matter, reduced rainwater infiltration and water holding capacity of the soil and loss of productivity and effects on wider ecosystem services (Demeke et al., 2011).

In the case of Kenya's SARs some land use changes are related to an overall transition into agropastoralism and sedentarisation of pastoral groups, plus in-migration of agricultural groups into SARs and increasing land use change and urbanisation in SAR areas close to urban centres (see also ODI, 2010). Pastoralist transitions, combined with unprecedented high population growth, mean there has been excessive cropping pressure and overgrazing leading to degradation which in turn has impacted negatively on livestock production and productive capacity of the land.

A major, large-scale infrastructure and transport development project - The Lamu Port Southern Sudan-Ethiopia Transport (LAPSSET) Corridor project (LAPSSET) - linking Kenya, Ethiopia and South Sudan (and later Uganda, Rwanda, Central and Western Africa) is likely to further impact on the lives of the migrant nomadic pastoral communities who make up the majority of communities living in the LAPSSET Corridor. While there are potential economic and social gains from improved transport infrastructure, (which includes the 32 berth Lamu Port, a Standard Gauge Railway line, crude oil pipeline, product oil refinery, resort cities and airports between Kenya, Ethiopia and South Sudan; see http://allafrica.com/stories/201502231043.html), as land is cleared to make way for the development there is a risk that this will exacerbate cross-border conflict and conflict over resources, and have profound impacts on people's livelihoods (Ndiku, 2014: http://www.insightonconflict.org/2014/12/kenya-lapsset-conflict/).

4.3.4 *Crop choice*

National agricultural policies have a profound impact on the lives and livelihoods of those living in rural areas. In some cases, while policies may work for people living in particular agro-climatic zones, in other regions policies may act to exacerbate vulnerability. Policy focus on certain forms of crop agriculture, for example, has been highlighted as a key contributor to the marginalisation of, and development failures in, drylands of Africa (Galvin, 2009), as described below.

The adoption of maize as a staple and commodity crop, over more drought-tolerant species such as millet and sorghum, is widely supported by government programmes and extension services in Kenya's SARs and this has led to increasing adoption by pastoral groups transitioning towards agro pastoral production. Several studies have explored how this has increased pre- and post-harvest vulnerability (Stathers et al., 2013). The claim is that policies and programmes promoting a new Green Revolution in Kenyan maize production have failed dryland farmers by undermining informal systems of seed and food security through favouring formal seed systems and crop research, and lobbying government to abandon plans to integrate informal seed systems into national seed policies and laws (Odame and Muange, 2011 cited in Brooks, 2014. Kenya). One key finding is that policy measures and programmes intended to increase resilience of smallholder agriculture in Kenya drylands have reinforced and intensified trends which are likely to exacerbate existing vulnerabilities. Green revolution policies and programmes tend to take approaches relevant for Kenyan western/high potential "maize basket" and replicate these in semi-arid mixed farming areas of Eastern Kenya. Emerging evidence is that this has eroded biological and institutional

diversity of informal seed systems causing increased vulnerability and threat to food security.

4.3.5 *Pressures on pastoralism*

Agriculture policies also impact on groups whose identity and way of life are tied to the land and natural resources, such a pastoralists, but for whom farming may not be their main concern. This often stems from a general neglect at higher policy level. Several authors argue that, in Kenya, political marginalisation and a lack of focused dryland governance or development agenda in the past has created poor policy support for dryland-compatible land use options, such as pastoralism, and a focus on sedentarisation and diversification into more climate sensitive but potentially riskier alternatives (e.g. irrigated agriculture and commercial fishing). This is seen to have undermined pastoral livelihoods and increased vulnerability to climate variability (Eriksen and Lind, 2009; Gachathi and Eriksen, 2011). (See also CARE ALP, 2013).

According to Owuor et al. (2011), governance and policy focus have to some extent also contributed to tension and conflicts between and within agro-pastoral and pastoral groups in Kenya's drylands, hindering animal movements, access to natural resources critical for managing drought, and creating vulnerable groups as well as leading to loss of social, political and human rights. This has undermined sustainable adaptation and human security (Owuor et al., 2011).

While there has been a tendency for government policy to be predicated on the attitude that the lands of pastoralists as idle and in need of development, the new *Policy Framework for Pastoralism in Africa* (African Union, 2010) stresses the rights of pastoralists, including the right of access to spatially distributed resources, and the urgency of maintaining and enhancing pastoral mobility. Despite cultural and power biases toward settled farming, in some ways Ethiopia's pastoralist policies have been constructive, and the rights of pastoralists are protected by the Ethiopian constitution. A Pastoralist Affairs Standing Committee has been established with pastoralist representatives integrated in national planning effort to help end pastoral marginalisation. Pastoral development policies include drought management (Fratkin, 2014). Regional states with a high proportion of pastoralists, such as the Afar Regional State, have started to develop their own land policies, which to some extent take the needs of pastoralists into account (Fratkin, 2014, Abbink et al., 2014).

CHAPTER 5

The Adaptation-Development Spectrum

The Adaptation-Development Spectrum

This chapter describes and analyses some of the principal forms of response to the social-ecological risks set out in chapter 4, and reflects on dimensions of governance surrounding risk management in general as well as actions specifically oriented to climate change adaptation.

Given the multi-sectoral nature of the risks described in chapter 4, it is also the case that response needs are broad in scope. Even if we were to narrow the analysis to specific dynamics caused by climate change risks we would also see the need for a broad terrain of response measures, because the environmental and social impacts of climate change alone are so complex – in Ethiopia, for example, cutting across food and water security, infrastructure, public health, natural resources, and biodiversity (Conway, 2005; Deressa et al., 2009; Robinson et al., 2012; Boelee et al., 2013). Importantly, climate change affects both agricultural and non-agricultural economic production (Mideksa, 2010). This underlines still further that climate change adaptation cannot readily be viewed in isolation from wider societal and environmental concerns (Simane et al., 2012), and hence this chapter refers to responses within an 'adaptation-development spectrum'.

Within the spectrum of responses we can see a diversity of actions according to spatial scale (local, national, regional), types of actors (private, public, civil society), the time-frame of response (short-,medium-, long-term), and whether the response is reactive or anticipatory in nature (or, autonomous or planned) - though in practice few of these distinctions are clear-cut.

5.1 Coping and risk management strategies

This extended section indicates the range of both current and potential responses relevant to the East African region and to the drylands of Ethiopia, Kenya and Uganda in particular. Some are strategic in nature, designed to reduce underlying vulnerability of people and society in semi-arid areas; others are more akin to coping responses, through which actors attempt to deal with the immediate ramifications of shocks and stresses.

Modes of response

Understanding the 'adaptation space' requires first an understanding of historic and contemporary responses: how have and how are people and society responding to the risks? Understanding this is important not just in terms of generating a baseline of current response modes, but also because progress in adaptation can conceivably come through the reinforcement of pre-existing adaptability (Deressa, et al., 2009). Thornton et al. (2007), for example, recommend analysis of different economic coping options of households and communities as a first step to targeting appropriate technology, policy and adaptation interventions. As noted in the subsection on Migration below, some authors highlight that mobile pastoralism, itself, can be seen as an 'indigenous' adaptation strategy, in that as a livelihood system it is inherently responsive to climate variability under dryland conditions

(Catley et al., 2013; Haselio et al., 2013; McGahey et al., 2014). Many historic and contemporary responses can be described as reactive, but by no means all (see Box 7).

Box 7.

Example: responses to climate variability in Choke, Ethiopia

Simane et al. (2013) have identified a range of responses by farmers to climate variability in the Choke mountain watershed in Ethiopia, a zone of varied topography and rainfall including hot, dry valleys. The responses include: reducing spending in favor of saving; storing grain; reducing food consumption; selling livestock; inter-household transfers and loans; selling forest products; wage labour; credit from merchants or money lenders; migration in search of employment; and sale of household assets. Note that this includes a mixture of immediate reactive measures (thereby often reducing household assets) and more strategic medium-term actions designed to anticipate future crises (such as increasing savings and storing grain).

Often, adaptive response (reactive and anticipatory) comes in the form of innovation – development and adoption of new approaches and technologies such as forms of irrigation and water source development – either implemented externally or driven by communities (EAC, 2011; ADB, 2013; Ruijs et al., 2011). Innovation clearly has a key role to play in the adaptation process, though, it also has the potential to be 'maladaptive' (see section 5.3).

Ultimately there may also be a limit to the effectiveness of 'incremental' approaches to adaptation. Severe pressures on the agricultural resources base interacting with increasingly intensive climate change suggest there may well be a need for larger-scale systemic and transformative changes. Vermuelen et al. (2013) indicate the range of ways in which we make think of transformative change, such as shifts in diets, food supply chains, sites of agricultural production, systems of land allocation, and incentives for linking land and water use to ecosystem service functions.

On a slightly different tack, there are also calls to recognize the potential role of development itself in building adaptive capacity and enabling effective response. Leary et al. (2007) suggest that economic development in general can bring about adaptation because it reduces dependency on particular sectors and makes more (financial) resources available for responses. This adaptive function of economic development is argued to operate at different scales from individual to international, through for example: increasing the capacity of households to bear losses by accumulating food surpluses, livestock, financial savings and other assets (Leary et al., 2007); development of local and national economies, markets and private sector as a core 'green growth' strategy (ADB, 2013; EAC, 2006b; IBRD/World Bank, 2010) (see Box 8); and promoting regional economic integration (in e.g. trade and markets) (ADB, 2013).

Box 8.

The prominence of risk management strategies in Ethiopia's GTP

Approaches to risk management related to climate stresses feature prominently in Ethiopia's key strategic development document, the Growth and Transformation Plan (GTP). Key aspects of the strategy include: growth based on infrastructure investment (roads, dams, hydropower, water management, irrigation); improved agricultural productivity; improved hydrological and meteorological forecasting; risk-based investment planning; economic stability and diversification (reduced dependence on agriculture); labour skills upgrading; and resolution of water conflicts (IBRD/WB, 2010).

However, it is important to consider wider aspects of human development – recognizing that while it's a fundamental component of livelihood strengthening macro-economic development alone may not deliver the equitable and sustainable strengthening of wellbeing that will increase the chances of reducing vulnerability to long-term risks for the most marginalized. Adaptive capacity in the face of risks is just as inherently related to issues of culture, gender, knowledge, power, entitlements, participation and governance – all of which are key facets of human development that can reinforce or undermine resilience (Leach et al., 1999; Wisner et al., 2004; Gallopin, 2006; Lopez-Marrero and Tschakert, 2011). Marriage, for instance, is not just an important element of social relations and status-building, but equally a key adaptive strategy in times of crisis.

Response fields

Based on review of literature for East Africa, we can identify the following main fields of activity that relate to the short term and long term management of risks identified in chapter 4. These reflect both traditional sectors of activity and ASSAR's normative focus on supporting livelihoods and wellbeing of the most vulnerable. Note that these fields are overlapping in scope rather than discrete categories.

Sectoral strategies

- Ecosystem protection
- Pastoralism support
- Crop production
- Urban planning
- Water management (micro)
- Water management (macro)
- Health/Environmental health
- Disaster risk reduction
- Climate information services

Support for livelihoods and wellbeing

- Knowledge and awareness
- Extension Services
- Livelihood diversification
- Social safety nets
- Gender focused approaches
- Relocation and Migration
- Risk sharing

We now briefly examine each of these response fields in turn.

5.1.1 *Sectoral strategies*

5.1.1.1 Ecosystem protection

The need to respond to livelihood risks such as land and soil degradation, the erosion of biodiversity and water shortages or floods through approaches centering on ecosystem protection is a strong strand in the grey and academic adaptation literature. Many organizations and authors within the region and elsewhere see a route to vulnerability reduction through more sustainable natural resources management and conservation via changes including decentralization of resource management and recognition of the value of ecosystem services (e.g. EAC, 2006a; Leary et al., 2007; Alterra, 2010; EAC, 2011; Mango et al., 2011; ADB, 2013). The rationale is that healthy, functional ecosystems enhance natural resilience to the adverse impacts of climate change and reduce the vulnerability of people and biodiversity.

This builds on a wide range of existing resource conservation programmes and initiatives in East Africa on soil and forest rehabilitation, reforestation and conservation of watershed forests, and wetlands protection, often undertaken through collective labour mobilization of local communities. (IBRD/World Bank, 2010; Brown et al., 2011; Hove et al.; 2011b, 2011c, 2011d). The GEF-funded project 'Sustainable Land Management (SLM) in Agro-Pastoral Production Systems of Kenya' is one current governmental initiative designed to restore ecosystem services by providing support to farmers in semi-arid districts of Kenya on practices such as pasture re-seeding, terracing, trees nurseries and reforestation (http://slmkenya.org/).

Such approaches may be particularly valuable, given the climatological vulnerability of semi-arid environments. Bezabih and Di Falco (2012: 565), for example, recommend that: "agrobiodiversity conservation efforts could effectively target high rainfall uncertainty areas". One approach, so far little utilized in the region, known as 'Ecosystem-based Adaptation' (EbA), uses biodiversity and ecosystem services as part of an overall adaptation strategy to help people and communities adapt to the negative effects of climate change at local, national, regional and global levels (UNEP, 2015). In addition to protection from climate change impacts, EbA aims to provide many other benefits to communities, for example through the maintenance and enhancement of ecosystem services crucial for livelihoods and human well-being, such as clean water and food.

5.1.1.2 Pastoralism support

While widespread chronic poverty and periodic famines continue to prompt ongoing debates over the vulnerability and future of pastoralism in East Africa (cf. Devereux and Scoones, 2008; Headey et al., 2014), researchers stress the importance of dynamic innovations and trends such as increasing commercialisation, educational aspirations and diverse rural-urban livelihood strategies (Catley et al., 2013).

Mobility, land use rights and legitimized governance

Investing in economic diversification, strengthening pastoral institutions and resource rights necessary to enhance livestock mobility is increasingly seen as the key to facilitating resilience building within the pastoral system of East Africa. Pastoralists' livestock systems may be better at buffering against extreme weather events such as heat and droughts. Tessema et al. (2014), for example, stress that investment in pastoral institutions for enhanced mobility is one key to resilience building. Several projects have been completed or are ongoing seeking to understand vulnerability and coping strategies with respect to climate change in northern Kenya's arid and semi-arid lands. The DFID/IDRC funded "Enhancing adaptation to climate change amount pastoralists in northern Kenya" (2008-2010) has focused on developing understanding of pastoralist vulnerability and coping strategies in Turkana and Mandera districts. The project examined indigenous coping strategies, best practices and institutional arrangements for adapting to climate change (www.idrc.org/ccaa). Care International with bilateral donor support (from DFID, Ministry of Foreign Affairs Finland, DANIDA, Austrian Development Cooperation) have implemented the "Climate change vulnerability and adaptive capacity in Garissa, Kenya"(2011-2012). The project was part of wider Adaptation Learning Programme for Africa (ALP) which aims to increase the adaptive capacity of households and the project analysed the impact of climate change at the household level and identified key issues constraining adaptation.

Given the clear links between tenure insecurity, effective community rangeland governance and livestock mobility as key factors determining household resilience within pastoral areas, a number of initiatives have sought ways to strengthen customary rangeland governance as a means to build adaptive capacity. Both IIED and the IUCN Global Drylands Programme have been working with the Resource Advocacy Programme (RAP) to design and pilot an approach to decentralised planning in Isiolo County that uses the challenge of climate change to address rangeland governance and livestock mobility issues in a way that facilitates participation, equity and inclusivity of vulnerable groups (Hess and Pattison, 2013). Alongside building local capacity for natural resource management and planning, developing natural resource maps and legitimizing traditional Boran pastoralists *dheda* rangeland management by establishing local bylaws, the approach has piloted a Climate Adaptation Fund with funding from DFID to be locally managed by communities in partnership with county government (Roba, 2014). The project has recently begun scaling up the approach within four other ASAL counties. Similarly, Natural Justice is working with Kivulini Trust in northern Kenya to develop bio-cultural community protocols (BCP) as another means to document and legitimize local natural resource use systems (http://www.kivulinitrust.org/index.php/what-we-do1/focal-areas)

Market integration

Much of the literature argues that stimulating pro-poor forms of economic diversification is the key to enhancing the resilience of the pastoralist economy and addressing recurrent humanitarian disasters in East Africa's drylands (Little, 2012; Devereux and Scoones, 2008). The extent of market integration and economic diversification varies across the region. In the Somali region of Ethiopia, Devereux (2009) found that almost 70% of households engage in livestock rearing, yet large numbers also engage in cereal crop production (43.4%), firewood production (17%), and charcoal production (14.7%), while many households also engage in various cottage industries (e.g. mat making at 6.3%), petty trade or services, or higher value crop production.

The availability of formal markets for livestock products is poor across much of the region and most livestock sales are through burgeoning informal markets and trading networks. Ifejika Speranza (2010) found that limited responses to market dynamics and the collapse of livestock markets during droughts resulted in disadvantageous sales, resulting in declining incomes for pastoralists and increased vulnerability. Morton and Barton (2002) stress that importance of clarifying the pressure points within drought cycles where access to effective destocking projects provides a critical means to improve the purchasing power of vulnerable households.

Conflict management

Resource conflict is a major impediment to pastoralist herd mobility in many parts of East Africa, and spatial patterns of forage availability are explained by fear of conflict in some contested resource areas (Headey et al., 2014). For example, surveys in southern Ethiopia by McPeak et al. (2011) observed that water resources disputed by Borana and Somali groups were not being used by either side for fear of conflict.

Several sources claim a causal connection between increasing frequency of periods of climate stress (i.e. drought) due to climate change and increasing resource conflict in the region as water resources and declining agricultural yields increase the risk of violent conflict (Carius, 2009). However, counter evidence from northern Kenya illustrates that livestock raiding increases during wetter periods suggesting some raiding is opportunistic rather than drought induced (Witsenberg and Adano, 2009). Furthermore, studies show that during drought periods pastoralists in northern Kenya deploy social institutions that mediate cooperation and guarantee access rights to resources thereby reducing violent conflict. Owuor et al. (2011) finds that flexible interactions between agro-pastoralists and pastoralists in Kenyan easterndrylands are essential to sustainable adaptation. Their study in eastern Kenya's drylands recommended that for sustainable adaptation to occur fundamental changes in governance regime are needed to move from an approach imposing punitive measures on dynamic interactions such as resource conflict towards approaches that strengthen positive interactions between pastoral and agropastoral groups (ibid).

5.1.1.3 Crop production

The agricultural sector is another major focus of adaptation strategies emerging for East Africa. Risk management in this sector generally hinges on efforts to restore degraded lands, use drought resistant seed varieties, harvest rainfall, adopt irrigation, plant trees, develop index linked micro-insurance schemes and use seasonal forecasts and drought early warning systems to optimize farm management (Leary et al., 2007; Gebrehiwot and van der Veen, 2013). Within these efforts, planning for climate change adaptation should consider change and variability in the onset and ending of seasonal rains, length of growing season, dry and wet spells and effects of evapotranspiration (Demeke et al., 2011; Simane et al., 2013), taking into account that the degree and direction of change are as yet uncertain.

Farmers have undertaken a range of climate variability and environmental change strategies in the region (Bryan et al., 2009; Gebrehiwot and van der Veen, 2013), and some of these are noted in Table 2. Building on these, there are various ongoing initiatives across the region attempting to build the resilience of farming systems in SARs to current short term climate risks such as drought and longer term risks such as heat stress. Improving drought preparedness and planning for agricultural production is a major area of activity. For example, the European Union supported Kenya Rural Development Programme (KRDP) is working with the National Drought Management Authority (NDMA) across arid and semi-arid land (ASAL) counties to mainstream drought preparedness into development plans. The Kenya Agricultural Research Institute has also been piloting adaptation options at the field level in ASAL areas through the IDRC funded "Agricultural Productivity and Climate Change in Arid and Semiarid Kenya" project. The UNEP coordinated CC DARE project (climate change development – adapting by reducing vulnerability) has worked in Ethiopia on improving the resilience of agricultural production at the farm level through improved conservation of water resources through rainwater harvesting, and researching options to improve the resilience of indigenous livestock.

There is also increasing presence in the region of 'climate-smart agriculture' approaches, which aim to boost food security while limiting carbon emissions (Haselio et al., 2013). Various planned adaptation/mitigation approaches such as improving livestock feeding programmes or enhanced soil nutrient management are promoted to create 'win-win' strategies for boosting farm productivity and enhancing mitigation/adaptation. (Bryan et al., 2013)

Much depends on investment in new agricultural practices – either developed externally or adopted by communities independently (Ruijs et al., 2011; Kansiime, 2012; ADB, 2013; IDRC, 2012). It is stressed, however, that to be effective, external investment in projects that target improved agricultural productivity and resilience to climate change need to recognize that some smallholder farmers might have difficulties to apply new production techniques (FAO, 2013). In Kenya, recognition of the biophysical constraints presented by agricultural production in dryland areas led to the initiation of two large-scale research programmes for the development of drought tolerant maize varieties (Scoones and Thompson, 2011; Brooks, 2014). Brooks (2014) evaluated the extent to which smallholder maize productivity enhancement programmes in the dryland areas of Kenya have enhanced farmer capacity to adapt to climate change. Strong promotion of drought tolerant maize varieties and fertilizers

through input delivery systems designed for high potential agro-ecological zones involving agro-dealers was found to narrow options for smallholder farmers and undermine the development of adaptive capacities in the long term (ibid).

Dryland farmers in Kenya use crop diversification and informal systems of seed collection, saving and exchange to ensure food security in drought prone regions (Brooks, 2014). Some NGOs have sought to build upon these systems and organise seed fairs to facilitate the exchange of locally adapted seed following drought periods (Orindi and Ochieng, 2005). Brooks et al. (2009:36–37) document some programmes in Kenya that have attempted to bridge formal and informal seed systems using community-based seed bulking programmes where government scientists and extension agents use improved composite materials adapted to dryland areas.

Peterson (2012) investigated the potential of climate index-linked micro-insurance schemes to reduce current vulnerability for smallholders and found that while schemes may benefit some farmers, they have the potential to alter coping strategies and expose farmers to new risks associated with economic markets (see also 'Risk-sharing' below).

A key knowledge and policy gap exists in the issue of adaptation within the post-harvest context. Stathers et al. (2013) describe the typical grain post-harvest systems in East Africa and likely impacts of different climate change trends on post-harvest activities, assets and human well-being outcomes. They note that few projects or planning documents focus on smallholder agricultural adaptation to climate change and within East Africa only Uganda have included priorities for post-harvest aspects in adaptation projects as a consideration in the National Adaptation Programme of Action (NAPAs) (ibid).

Table 2. Common adaptation strategies in crop production

PRACTICE	RATIONALE
Use of different crops/varieties	**Growing early maturing crop varieties and increasing diversification by planting crops that are drought tolerant and/or resistant to temperature stresses serves as an important form of insurance against rainfall fluctuations. In addition, growing different crop varieties on the same plot or on different plots reduces the risk of complete crop failure as different crops are affected differently by climate events, and this in turn gives some minimum assured returns for livelihood security.**
Soil conservation (and see below)	Soil conservation practices and technologies that enhance vegetative soil coverage and control soil erosion are crucial to ensuring greater resilience of production systems to increased rainfall events, extended intervals between rainfall events, and to potential soil loss from extreme climate events. Improving soil management and conservation techniques assist to restore the soil while also capturing soil carbon and limiting the oxidation of organic matter in the soil.
Irrigation and water harvesting (and see below)	Improving the use of irrigation and water harvesting is intended to smooth out yield volatility in rain-fed systems, especially in areas subjected to recurrent cycle of drought. It has the potential to improve agricultural productivity through supplementing rainwater during dry spells and lengthening the growing season.
Changing planting dates	**Shifts in planting dates include early and late planting options as a strategy to adapt to the changing climate. This strategy helps to protect sensitive growth stages by managing the crops to ensure that these critical stages do not coincide with very harsh climatic conditions such as mid-season droughts.**

5.1.1.4 Urban planning

Urban populations in East Africa have grown rapidly since the 1960s due to the growth of existing populations and extensive migration from rural areas, partially because of declining agricultural productivity. Nonetheless, there is relatively little literature on responses specifically to urban problems in East African ASALs or research in towns and cities other than Nairobi, Mombasa, Kampala and Addis Ababa. Though urban planning is a growing sector in the cities of Africa, Kithiia (2011) argues that more robust urban planning is needed in the face of climate change impacts on cities in East Africa. This draws on research in Mombasa, which found no evidence that climate change adaptation is explicitly currently integrated into city planning (Kithiia and Dowling, 2010). IDRC (2012) also highlights the policy gap in consideration of the links between urban development and climate change.

Urban and peri-urban planning in the region may need to incorporate new infrastructure design standards that consider climate impacts, in addition to addressing related problems

of water availability/ sanitation, heat stress, flood protection and vulnerability to other extreme events (Satterthwaite et al.,2008). The scale of risk from these factors is influenced by the quality of housing and infrastructure and the level of preparedness on the part of key services. Cities are particularly vulnerable to damage to systems on which they depend such as electrical and water infrastructures.

5.1.1.5 Water management – micro

Improvement in micro-scale water management is needed in semi-arid areas to help communities to achieve food security, become less rainfall dependent, reduce drought impact (Conway, 2005), and to secure health benefits from cleaner potable water (Pacey and Cullis, 1986). Three approaches used to ensure the above points are achieved include:

Soil and Water Conservation (SWC)

This focuses on soil, and water conservation activities such as soil bunds, stone bunds, waterways, trees, contours, and irrigation. In Ethiopia, many such works take place through public programmes such as food-for-work under the Production Safety Net Program (PSNP) and community labor mobilization. It is reported that the implementation of soil and water conservation strategies has significant positive impacts on yields in low-rainfall areas, but not all show a correspondingly similar risk-reducing effect, which might explain their low adoption rates in these area (Kato et al., 2011). In Kenya, the Ministry of Agriculture adopted a Catchment Approach to SWC. This was seen as a way of concentrating technical effort in the management of soil and water conservation (Pretty et al., 1995). Much has also been written about the use of small scale sand dams. In Kitui Kenya it has been estimated that small scale sand dams will provide water for up to 100,000 inhabitants over the next few years. (Lasage et al., 2008).

Small-scale irrigation

The other major risk management strategy that is under implementation in the region is small scale irrigation using river diversion, motor pumping from rivers and groundwater sources (NMA, 2007; Awlachew et al., 2010; FDRE, 2010, 2011; Kato et al., 2011; Simane et al., 2013). There is empirical evidence that the application of irrigation in combination with other soil and water conservation technologies results in significant positive impacts on crop yields in both low- and high-rainfall areas in Ethiopia (Kato et al., 2011). It has also created job opportunities for the rural communities in the country (Awlachew et al., 2010). Investment in infrastructure to support irrigation and water resources development is one aspect worth considering for climate change adaptation since it can reduce dependencies on the rain-fed agriculture (Demeke et al., 2011), though such measures need to be carefully planned to ensure that they too are sustainable under varying patterns of rainfall. It is important to recognize, however, that small-scale irrigation has a long history in the region. Fleuret (1985) described indigenous irrigation systems in the Taita Hills in southeast Kenya, in which the layout and water flow management has been intricately linked to traditional social structures and their dynamics through the generations.

Rainwater harvesting

In addition, rainwater harvesting is another multipurpose strategy that is under implementation in the region. It creates opportunity to cultivate vegetation near to farmers home and increase their income and nutrition. It also supplies water for some domestic consumption and animal watering during long dry spell periods (Awlachew et al., 2010; FDRE, 2010, 2011). It is suggested that increased rainwater use efficiency will address both problems of land degradation and drought, thereby improving productivity and food security in semiarid East Africa (Slegers and Stroosnijder, 2008).

5.1.1.6 Water management – macro

Social, political and economic vulnerability needs to be considered in the large-scale management of waters from rivers (Conway, 2005). Key in this within the region is the current and planned construction of dams, particularly multi-purpose dams for river regulation, irrigation, and hydropower (IBRD/World Bank, 2010).

Currently the Ethiopian government is constructing multipurpose medium and large scale reservoirs along major river basins in the country, including basins within the semi-arid zones (FDRE, 2010, 2011; Block and Strzepek, 2012; McCartney and Girma, 2012; Jeuland and Whittington, 2014). These water reservoirs serve as a sources of water for irrigation, hydropower generation, fishing, recreation and used to regulate both flood and drought risks (FDRE, 2011; Robinson et al., 2012). Thus, it is claimed these interventions may have multiple advantages for development and climate change adaptation (FDRE, 2011). However, dam construction also has to take account of climate change impact and rainfall uncertainty, if operational failures and flood damage are to be avoided (Block and Strzepek, 2012). The negative hydrological and environmental and impacts of large scale storage dams has also been highlighted in a number of papers, including studies on the Tana and Turkwel Rivers in Kenya (Adams, 1989; Adams and Hughs, 1986; Maingi, and Marsh, 2002).

5.1.1.7 Health and environmental health

Climatic and environmental change has the potential to increase health burdens through changes in exposure to vector and pathogens, impacts on food supply, heat stress and exposure to injury from flooding, and psychosocial effects of hazard events (McMichael et al., 2003; Few, 2007; Smith et al., 2014). Many of the pathways for health impacts operate through routes such as inadequate access to water and sanitation, especially in situations of poor environmental health conditions such as rapidly urbanizing environments or rural areas facing prolonged drought.

Though public health issues are commonly referred to in adaptation strategy documents such as the NAPA for Ethiopia, projects concentrating on environmental health and environmental change tend to be few in the region, and our initial search has not found any focused on health in semi-arid lands. This may be because health (and environmental health), as a sectoral concern, tends not to be labelled in terms of socio-environmental factors, but in terms of public health, population health or nutrition. Development support to strengthen health systems and WATSAN certainly exists in the region, and organizations like the Population Health and Environment Ethiopia Consortium (www.phe-ethiopia.org/)

are engaged in collaborative interventions to strengthen services. Nevertheless, different sources argue that investment in health infrastructure and institutions of health governance needs to be improved across the region to cope with environmental health risks associated with environmental and social change, including climate-sensitive vector-borne and waterborne diseases (Olago et al., 2007; Bryan et al., 2009; IBRD / World Bank, 2010).

One approach that seems to have had positive results in Ethiopia is mobile outreach. A mobile outreach camp approach which aims to provide "one health services" for pastoralists and their livestock using community-based animal and human health workers has been implemented in Ethiopia and scaled up through the World Bank/IFAD Ethiopian Pastoral Development Project. The National Policy for the Sustainable Development of Northern Kenya and Other Arid Lands was approved by cabinet in 2012 and opens the way to new approaches to service delivery and governance in Kenya's SARs (RoK, 2012).

It is important to note that environmental health considerations are also relevant in the design of responses within other sectors. For example, Boelee et al. (2013) argue that water harvesting technologies should not only consider the needs of the agricultural sector but also health risks associated with water-related diseases. Appropriate design in water harvesting structures is important to avoid increasing exposure to disease risk.

5.1.1.8 Disaster risk reduction

It is widely recognized that extreme weather conditions (droughts and floods) are among the major risk factors affecting agricultural production, food security, socioeconomic development and ecosystem services (World Bank, 2006; Smucker and Wisner, 2008; Conway and Schipper, 2011; Demeke et al., 2011; Gray and Mueller, 2012).

Much of the focus in the drylands of East Africa is inevitably on drought. Drought is the most frequent and damaging of climate risks in Ethiopia, for example, and a variety of sources underline that it needs to be given high priority in climate change adaptation planning (World Bank, 2006; Fraser, 2007; NMA, 2007; Slegers and Stroosnijder, 2008). Reducing farmers' vulnerability to drought has been a key aspect of many projects in the country, including intervention funded through the Global Environment Facility. In Kenya, the EU is supporting the National Drought Management Authority (NDMA) to strengthen drought management capacity and support mainstreaming of drought risk into development planning.

Schilderinck (2009) tested the effectiveness of The Drought Cycle Management model at household level in four districts of Kenya and identified four strategies that appeared to be effective in reducing drought risk to livelihoods: establishing a livestock management structure; diversifying household income; taking measures to conserve water; and accessing credit facilities at the community level. However, it is important to note that drought, as a causative factor in affecting human wellbeing, has to be put into the context of dynamics of other socio-economic, political and environmental factors that can limit livelihood opportunities and impact on food security (Conway, 2005), including the intra-household allocational mechanisms that mediate outcomes.

Flood risk is also severe in some river basins of the region, and arguably strengthening of measures such as flood control infrastructure, building standards and flood early warning

systems should be prioritized too, given that rainfall intensity may increase (IBRD/World Bank, 2010; Haile et al., 2013; Bryan et al., 2013).

Measures to move toward more holistic disaster risk reduction (DRR) through strengthening capacity to reduce underlying vulnerability are strongly called for in the region (FAO, 2013; see also UNISDR, 2012). This is not least because coping strategies used by households following flood events are often found to be erosive and have a long term negative effect on household livelihood sustainability, thereby highlighting the importance of prevention and mitigation of floods through measures such as watershed management and land use planning (Opondo, 2013). A key part of the recent Kenya component of the Africa Adaptation Project (AAP) funded by the Japanese government and UNDP was oriented to building capacity in government to implement DRR.

5.1.1.9 Climate information services

Improvements in the quality and accessibility of climate information are essential for building adaptation to impacts of climate change (Osbahr et al., 2011). The effectiveness of climate services may be determined by its accuracy, access and applications by end users. Climate information may include early warning systems, weather forecasts, and research outputs relating to climate change adaptation in relation to food, health and conservation of natural resources (Kirui et al., 2010). Seasonal forecasting applications relevant to agricultural production in Africa include crop simulation for maize yield prediction and farm management, support to pastoralist communities and dam management (cf. Conway and Schipper, 2011). Hansen and Indeje (2004) demonstrated and evaluated methods to predict field-scale maize yields using downscaled seasonal forecasting and found potential for translating seasonal climate forecasts into predictions of crop response. Box X provides additional discussion on the potential of seasonal forecasting.

There are various sources for climate information and early warning system in East Africa, including:

i. National Meteorological Services. National meteorological agencies are playing a major role in generating climate, weather and climate forecasts and information dissemination. For example, national meteorological agencies in Ethiopia, Kenya and Uganda process meteorological data from a network of national weather stations and produce daily weather reports, decadal agro-meteorological reports, and forecasts on daily, weekly, decadal, monthly and seasonal bases.

ii. The regional Drought Monitoring Center, Nairobi (DMCN). The DMCN serves ten countries of the Greater Horn of Africa as a regional climate information provider. In 2003, DMCN was officially named a specialized institution of IGAD. The national meteorological services in the IGAD region send primary data to the DMCN where it is analyzed and used for regional statistical modeling for forecast purposes. The DMCN targets a variety of users in government, international organizations, early warning, food security, agriculture, research, livestock, water resources, health, and energy.

iii. FEWS NET. Another key source of regional climate information and early warning information for the East Africa region is the Famine Early Warning System Network (FEWS NET), established by USAID in 1985 to provide food security early warning systems to ten countries in the Greater Horn of Africa. This includes information on precipitation, vegetation density, market supply, food prices, crop growth, crop production, and insect infestation. The project provides early warning reports to the target government policymakers, donors, the UN agencies, and the NGO community.

Climate and weather forecast information is most commonly disseminated via electronic media and communication via community channels. In addition to mass media, in the semi-arid parts of Kenya mobile phone services, local extension service networks and indigenous knowledge informers are important means of information dissemination (Cherotich et al., 2012). However, the efficiency of all these means in reaching vulnerable groups is not well established (Bryan et al., 2009; Deressa et al., 2009; Kirui et al., 2010). There is empirical evidence that the availability of climate information, particularly in rural areas of east Africa, is very limited (Dinku, 2011). According to this later source, the available stations are unevenly distributed and are located in towns and along main roads and this imposes severe limitations on the availability of climate data on the farms and rangelands, where the data are needed most. To improve climate information services, more attention needs to be paid to user-friendly mechanisms for the flow of climate related information and services to the local community (Kirui et al., 2010)

Dinku et al. (2014) note a continued need for investment in climate services to improve data, information products and the integration of climate information into policy and practice. IRI's *Enhancing National Climate Services* (ENACTS) initiative works in Ethiopia to improve the availability and accessibly of reliable climate information for decision-making.

Box 9.

Seasonal climate forecasting for decision making in East African SARs

The development, use, and limitations of seasonal climate forecasts is a highly active area of climate research, with several studies focused on eastern Africa (cf. Meze-Hausken, 2004; Conway and Schipper, 2011; Broad and Agrawala, 2000; Hansen and Indeje, 2004). Significant donor and research investment has been placed on developing the use of climate data for a variety of near-term planning applications from seasonal forecasting for food security programmes, drought early warning, and index linked safety-net programmes. While there is weaker predictability for the boreal spring long rains in East Africa, skilful forecasts can be produced more than a month before the start of the growing season for the short rains (Hansen et al., 2011). A variety of agriculturally important climate variables are packaged into seasonal forecast systems across the region. In Ethiopia variables such as evapotranspiration, humidity, wind, solar radiation and crop water requirements are disseminated alongside rainfall projections (ibid). In Uganda, Ethiopia and Kenya anticipated impacts on agriculture and natural resources are provided, and in Uganda climate information is combined with agricultural management advisories in partnership with the Ministry of Agriculture (ibid). In Kenya, seasonal forecasting has been used for applications such as drought early warning for pastoralists (Luseno et al., 2003) and maize production in SARs (Hansen and Indeje, 2004).

Reliability, detail and communication of uncertainty are stressed as important barriers to uptake at the local level in Africa (Conway and Schipper, 2011), and these factors are echoed by regional research. Luseno et al. (2003) studied the use of seasonal climate forecasts by development planners to aid pastoralists in southern Ethiopia and western Kenya and found that they were rarely used or believed by pastoralists. However, evidence from schemes targeted at smallholder farmers in Kenya and Ethiopia demonstrates that with support farmers are able to incorporate probabilistic forecast information into their decision making process (Hansen et al., 2011; Lybbert et al., 2007; Suarez and Patt, 2004). In Machakos District, Kenya, a study reviewing uptake from a forecast information system found that the majority of smallholder farmers adopted management recommendations (Ngugi, 2002).

5.1.2 *Support for livelihoods and wellbeing*

Alongside sectoral measures there are other more generalized approaches to risk response at the grassroots level associated with building capacities and assets of the most vulnerable, seeking alternative livelihoods and life choices, and securing access to support (Leary et al., 2007). The need for capacity-building for management of risk in East Africa therefore extends beyond formal sectoral institutions to building the skills, decision-making and action capabilities of communities and individuals, giving them access to credit and tenure security and enhancing their ability to form associations/collective such as grazing associations (Mitchell and Tanner, 2006; Bryan et al., 2009; Eriksen and Lind, 2009).

5.1.2.1 Knowledge and awareness

Capacity has many 'enabling' facets beyond technical skills, yet building awareness and knowledge about risks and how to cope and adapt to reduce vulnerability remains key (Mitchell and Tanner, 2006; Kabubo-Mariara, 2008). This is currently built into a wide range of climate and non-climate interventions in the region. In Kenya, Uganda, and Ethiopia, for example, pastoralist field schools are one mechanism through which pastoralists learn through observation and experimentation how to deal with risks and hazards affecting their livelihood (UNISDR, 2012). The recent World Bank funded *Arid Lands Resource Management Project* in Kenya is one example of a major drylands programme aimed at raising knowledge and capacity at community level to manage drought. Capacity building for risk management at a range of governance and community scales is also the underlying objective of the *Africa Climate Change Resilience Alliance* (ACCRA) initiative, which works in Ethiopia and Uganda. A study by Okoba et al. (2011) observed that where farmers had access to information on crop and livestock management, weather and climate information, access to information was often reflected in adoption of risk management measures.

But it is also vital to recognize that those who use the land already possess stocks of detailed knowledge that should not be overlooked in adaptation policy development. Huq et al. (2005) stressed the importance of learning from existing coping mechanisms to current climate hazards as basis for adaptation planning for Kenya: intervention, they claim, is more likely to succeed if based on indigenous knowledge. Indeed, projects that seek to impose new forms of knowledge and training run the risk of failure in their objective unless they actively recognize and work with existing knowledge and management practices. IDRC and DFID have supported recent work in Kenya to integrate indigenous knowledge with scientific climate forecasts in support of community-based adaptation. Egeru (2012) found the farmers in Teso subdistrict complemented local forecasting indicators with meteorological information communicated via the radio to more accurately predict floods

The importance of farmer knowledge as an entry point to enhance adaptive capacity of smallholders was also stressed by Ogalleh et al. (2012), who assessed community observations of climate change in Kenya against a drought index record and found significant relationships between drought perceptions and historical climate data. The authors also found significant relationships between drought perceptions and certain adaptation strategies, indicating farmers use knowledge of climate variability to inform coping and adaptation. Hisali et al. (2011) recommend greater investment in policy level responses that complement autonomous adaptation in Uganda.

However, other authors also underline the limitations to lay knowledge. According to Rao et al. (2011), farmers' perceptions about climate are a combination of various factors that affect production and are not entirely based on climatic observations. Their paper examines farmer perceptions of short and long term climate variability in Kenya, finding that farmers were well aware of variability and impacts on crop production, but that their ability to discern long term trends was more subjective. The authors recommend that planners need to be aware of these risks when using farmer perceptions in development and promotion of technologies.

5.1.2.2 Extension Services

Closely associated with knowledge development is the call to embed adaptation within a strengthening of extension services, as a key means of reducing vulnerability/promoting adaptation to climate change (Leary et al., 2007; Deressa and Hassan, 2009; Bryan et al., 2009; Deressa et al., 2009). Reporting from Kenya, Bryan et al. (2013) argue that autonomous adaptation is likely to be insufficient to address climate threats and the rural poor need support from other stakeholders (public, private and civil sectors) to move beyond short-term coping measures in response to climate shocks and to invest in long-term anticipatory strategies (such as diversification and adoption of agricultural innovation). Extension officers can act as agents of change, but need to be supported by capacity building on how to effectively communicate and receive feedback from the farmers.

Extension service facilities in the region have been particularly important in supporting agriculture and health sectors in rural areas. Access to good extension services, for example, has been stressed as determinant factor in adoption of agroforestry practices (Bryan et al., 2013). They can be used as a means of information flow to and from farmers (bottom-up and top-down), facilitation of technology transfer, and capacity building for natural resources management (Bryan et al., 2009; FDRE, 2011; Hisali et al., 2011). The World Bank-funded programme Kenya Agricultural Productivity and Agribusiness Project (KAPAP) currently provides support to extension services, through a programme of integrated support to research, extension and farmer empowerment more broadly. The aim is to increase productivity and better integrate smallholders with local and national markets. Kabubo-Mariara (2009) discusses a need to build on traditional knowledge with added veterinary/agricultural extension in the face of climate impacts for Kenya.

5.1.2.3 Livelihood diversification

One key strategy often raised in connection with uncertainty over future climatic and other risks is the facilitation of livelihood/income diversification (Eriksen and Lind, 2009; Gachathi and Eriksen, 2011). This can encompass hedging risks by diversifying crops, income sources, food sources and locations of production activities, among others. According to Leary et al. (2007) economic diversification and off-farm employment in Ethiopia have protected GDP, reduced human welfare losses and lowered income variability.

Income diversification has long been viewed as a risk minimizing strategy in the face of increasing climatic and economic risks in developing countries (Bryan et al., 2009; Deressa et al., 2009). Farmers in east Africa use both on-farm and off-farm income diversifications (Wanyama et al., 2010). The on-farm income diversification include planting different crops and raising different animals, while off-farm income generation include casual labour, petty trading, and selling of natural resources (especially wood and charcoal) (Eriksen et al., 2005; Amsalu and Adem, 2009).

Evidence from empirical studies (Reardon, 1997; Barrett et al., 2001; Wanyama et al., 2010) for the arid and semi-arid areas of east Africa showed that income diversification options are varied according to gender and proximity to towns and settlements. Empirical research by Amsalu and Adem (2009), for example, described how options for women other than

agriculture were mainly petty trade and charcoal production while men tended to generate income from wage employment, livestock trade, and charcoal production. Though there is evidence that most households have opportunities in cash cropping and nonfarm activities, pricing, inefficiency in production and marketing negatively limit the extent to which this can raise them out of poverty and food insecurity (Barrett et al., 2001; Wanyama et al., 2010; Gachathi and Eriksen, 2011). In addition, lack of capital makes it difficult for farmers to diversify from subsistence agriculture to commercial farming. Some interventions in the region include support to livelihood diversification as a key measure. Part of the World Bank funded Kenya Adaptation to Climate Change in Arid and Semi-arid Lands (KACCAL) project, for example, involves promotion of alternative livelihoods such as beekeeping.

5.1.2.4 Social safety nets

Three main social safety net programmes cover semi-arid areas in Kenya, Ethiopia and Uganda: Kenyan Hunger Safety Net Programme (HSNP), Ethiopian Productive Safety Net Programme (PSNP) and Northern Uganda Social Action Fund (NUSAF).

The Ethiopian Productive Safety Net Programme (PSNP) is implemented by the Ethiopian government in drought-affected rural areas through food-for-work and cash-for-work schemes. The goals of the programme include reducing food insecurity, enhancing the livelihood of poor farmers, reducing flood risks and soil erosion, enhancing soil moisture and ground water level and restoration of environmental functions (FDRE, 2004; Weldegebriel and Prowse, 2013). Participants in the program work on environmental management (rehabilitation of degraded areas, soil and water conservation activities and afforestation) and construct small-scale infrastructure such as river diversion for irrigation, small dams for rainfall harvest, construction of rural roads, and flood protection structures, (FDRE, 2004; Hove et al., 2011).

The Kenyan Hunger Safety Net Programme (HSNP) is an unconditional cash transfer programme targeted at the chronically food insecure. Its goal is to reduce extreme poverty in Kenya by supporting the establishment of a government-led national social protection system delivering long-term, guaranteed cash transfers to the poorest and most vulnerable 10% of Kenyan households. The first phase implemented a cash transfer programme in the arid and semi-arid lands (ASAL) districts of northern Kenya (Mandera, Marsabit, Turkana and Wajir), making regular cash transfers to 60,000 households every 2 months for 3 years (initially KES 2,150, increasing to KES 3,500 by the end of the evaluation period). The evaluation of the first phase found that HSNP households were 10 percentage points less likely to fall into the bottom national poverty decile than control households and more likely to be food secure, despite the adverse effects of the 2011 drought (Merttens et al., 2013).

The Northern Uganda Social Action Fund (NUSAF) is a five year programme aimed at improving the livelihoods of people in the semi-arid Northern regions who were also affected by the civil war. The first phase included a component entitled Community Development Initiatives, which involves communities identifying a project (for example the construction of a classroom) to be implemented through public works on the part of community members. The second phase retained the community development initiative (now called the Public Works Programme), however the programme was refocused on social protection to complement the Northern reconstruction project, which was rebuilding the

social and physical infrastructure. The evaluation by Nahamya (2012) found that participants in the NUSAF program were four times more likely to come out of poverty compared to non-participants. However, the implementation and monitoring of the NUSAF program was weak and excluded some key stakeholders such as local leaders (see also Tonia et al., n/d who noted the politicization of the programme and poor linkages with other sectors in the economy).

5.1.2.5 Gender focused approaches

The rationale for gender-focused approaches is first of all to recognize the complementary and interconnected nature of gender roles and relations at different institutional levels and consequently the differentiated impacts of climate change on women, men and youth, and their roles, specifically of women, in addressing climate change (Mitchell and Tanner, 2006). Giving visibility can help strengthen the involvement of women in vulnerability reduction through local institutions, for examples, water management, or be specifically targeted towards livelihoods, either through collectives or on an individual basis. Figueiredo and Perkins (2013) describe the importance for sustainable water resource management in Kenya of involving women in water-related programme design and policy processes. According to Baguma et al. (2013), local associations in Uganda that involve women in key tasks and decisions can minimize water-related health risks. Goulden et al. (2013) found that female involvement in village-based institutions such as council committees and credit groups had a positive influence on adaptation in Uganda, Tanzania and South Africa. Gross et al (*CCVA Global Water Kenya*) also advocated the use of women's groups in Kenya to ensure CCA interventions were adopted by those most affected by risk. Finally, Oxfam has initiated an advocacy campaign entitled 'Our land, our lives' which uses rural women's assemblies and women's land tribunals/hearings and long marches to assert women's land rights and build women's movements in the context of increasing resources scarcity in East African ASALs.

Specifically in relation to livelihoods, Eriksen et al.'s (2005) study of smallholder responses to climate stress in Kenya and Tanzania noted that married women are excluded from profitable activities due to local taboos as well as domestic responsibilities and in Ethiopia women concentrate on food production rather than more lucrative activities such as livestock. Projects addressing this division of responsibility include the provision of credit and group training to women in agroforestry and business administration in Kisumu, Kenya (Caretta, 2014), collectives supporting Kenyan widows and divorcees affected by HIV and AIDs who are consequently able to invest in rain water harvesting and agroforestry (Gabriellson and Ramasar, 2013), and provision of services for female headed households in Uganda to switch to less climate sensitive crops (Farley and Farmer, *Ugandan CCVA*). The Ethiopian government has also individually targeted women in Amhara to enhance their farming practices and improve community-based natural resource management (*Coping with Drought and Climate Change in Ethiopia, UNDP-GEF 2009-2012*).

Apart from these separate spaces, however, it is equally important to provide women adequate representation in mainstream fora, given their centrality in response strategies.

5.1.2.6 Relocation and Migration

One response to risk is to avoid risk through migration: reducing exposures to climate hazards by relocating, either temporarily or permanently (Leary et al., 2007). This response was observed after the Kenya floods in 2011 when households engaged in asset sale and temporary migration (Opondo, 2013). Migration and population mobility is also a common response mechanism to drought, as falling agricultural and animal production pushes households and individuals to seek new opportunities elsewhere (Gray and Mueller, 2012; Clemens and Ogden, 2014), although Abebe (2014) notes that opportunities for female migration are limited. Land-poor households are commonly a major source of migrants, most likely due to lower ability to cope with drought (Gray and Muller, 2012).

As a fundamental practice of pastoral communities, mobility is also the most common drought and resources shortage coping and adaptation mechanism in the arid and semi-arid areas of Ethiopia (Desta, 2006) and Kenya (Homewood et al., 2009; Kaimba et al., 2011) – see Box 10. As discussed in chapter 4, this is often constrained by agricultural expansion, conservation (Butt and Turner, 2012), or in the case of Ethiopia, plantations funded by Foreign Direct Investment (Bossio et al., 2012). Ethiopian pastoralists have also experienced involuntary resettlement due to state development programmes (Fratkin, 2014).

Box 10.

Pastoralist Mobility

In the case of Ethiopian SARs, mobility is a common coping strategy for pastoralists for dealing with drought and risks induced by dry spells (Tesfay and Tafere, 2004; Holmann et al., 2005). Pastoralists typically move seasonally to overcome water and pasture shortages during the dry season. The time, direction, duration, and frequency of visit vary from one pastoral territory to another but all have the essential feature that they avoid heavy grazing pressure induced by repeated and longer period of time grazing and water shortage (Tesfay and Tafere, 2004). A major ecological advantage of mobility is thus there is little chance for pastoral stock to inflict long-term damage on the rangeland. This enables to perpetuate their rangelands for centuries due to their ability to regulate resource use level over a wider patchy landscape by employing different strategies of mobility (Tesfay and Tafere, 2004).

5.1.2.7 Risk sharing

Another key facet of risk management is the spreading of risk through a variety of means, including kinship networks, pooled community funds, weather insurance and disaster relief (Leary et al., 2007). The call for greater access to insurance, including crop insurance, is a major theme in the regional adaptation literature (e.g. Kabubo-Mariara, 2008). Writing on Ethiopia, Bezabih and Di Falco (2012) see crop insurance as a key way in which climate policy could be effectively linked with development policy, and encourage asset accumulation, although Peterson (2012:557) notes that in providing of micro-insurance in the semi-arid region of Tigray "greater attention needs to be paid to existing coping strategies, introduction of additional market risks, local capacity building and the socio-political context

of implementation". For example, the programme Peterson (2012) evaluated also had a community savings component to handle local fluctuations in productivity caused by smaller droughts or other events.

As part of the National Adaptation Programme of Action, the Ethiopian government, in conjunction with multiple donors, are exploring the extent to which the promotion of drought/crop insurance can be mainstreamed to minimize drought-induced shocks. The project involves capacity strengthening, especially around climate knowledge, developing drought Indices, designing insurance, and assessing various aspects of weather/drought insurance.

An important facilitator of risk sharing in Kenya, especially for households in semi-arid regions with migrant members, is the mobile money system MPesa. In the four years since its launch it has been adopted by nearly 70 percent of Kenyan adults and three quarters of households have at least one user. Jack and Suri (2014) found that while climate and other shocks reduce per capita consumption by 7 percent for non-user households, the consumption of households with access is unaffected as the mechanism allows for frequent delivery of remittances from multiple senders. Suri (2003) found that in rural Kenya (1996-2006) there was sharing of maize within villages, which enabled individual households to withstand shocks, and to some extent whole villages. He found, however, that when the shock affected the whole district there was a need for government intervention. Within Kenya, Ethiopia, and Uganda Rotating Savings and Credit Associations (ROSCAs) and Savings and Credit Cooperative Organization (SACCOs) also act a form of informal insurance, as do Iddir (traditional burial societies in Ethiopia) whom some have proposed can play a greater role in risk sharing (Aredo, 2010).

5.2 How have existing risk management strategies helped reduce climate risks and build adaptive capacities?

In this brief section we provide a preliminary attempt to link the fields of response to risks and results. We do this by selecting examples of activities under each response field, and tracing what main risks they relate to of those identified in Chapter 4, the associated benefits and their time-scale, and whether the activity demonstrates recent innovation that may be linked to the climate change adaptation agenda. It should be underlined that this is a draft table drawn from discussion among the ASSAR East Africa team. A more rigorous and detailed analysis of the functions, performance and innovation of selected adaptation programmes, policies and projects related to the case study sites for the region is planned to take place during the RRP phase of ASSAR.

Table 3. Sectoral strategies

RESPONSE FIELD	ACTIVITY	MAIN, DIRECTLY RELEVANT RISKS TO LIVELIHOOD/WELLBEING	NATURE OF BENEFIT	SHORT/MEDIUM TERM BENEFITS Short = in the next year/ Medium = up to 15 years	INNOVATIVE ASPECTS
Ecosystem protection	Community conservancies	Resource degradation, resource access/conflict (incl. human/wildlife)	Improved grazing and quality of livestock, reduced travel time, resource that potentially produces financial benefit	Medium	Holistic range management/ innovative fire management (e.g. burning earlier in the season)
	Riparian restoration	Resource degradation	Protected river banks, income from sale of bamboo, improving community governance through WRUAs	Medium	Sustainably harvestable species such as Bamboo
Pastoralism support	Legitimising and strengthening local rangeland governance systems	Resource degradation, resource access/conflict, drought, food insecurity	Empowered communities, improved rangeland health, improved livestock health, reduced food insecurity, strengthened land tenure rights	Medium	Community management of emergency response/ adaption funds, e.g. IIED/DFID; local byelaws enacted for customary rangeland management (bottom up vs. colonial system)
	Livestock marketing schemes		Improved income and buffer against drought by reducing herd sizes without losing money	Medium	Community-based abattoirs

Table 3 continued. Sectoral strategies

RESPONSE FIELD	ACTIVITY	MAIN, DIRECTLY RELEVANT RISKS TO LIVELIHOOD/WELLBEING	NATURE OF BENEFIT	SHORT/MEDIUM TERM BENEFITS Short = in the next year/ Medium = up to 15 years	INNOVATIVE ASPECTS
Agricultural production	Diversifying crop varieties	Rainfall variability, drought, food insecurity	Greater reliability of harvest, increasing yields	Medium	Indigenous varieties, Millennium/ drought recovery seed banks
	Soil conservation	Resource degradation	Increasing yields so less land needed, possible to sell surplus, able to grow cash crops	Medium	
	Changing planting dates	Rainfall variability, drought, food insecurity, extreme weather	Greater reliability of harvest, increasing yields, reduced chance of harvest loss	Medium	Changing planting dates
	Post-harvest storage and processing		Improved income, improved quality/ nutritional value of the stored crop, potential for shift in household dynamics if women gain increased control over income	Medium	Gender-sensitive interventions, micro processing plants
Urban planning and infrastructure	Climate sensitive design		Reduced vulnerability to flood	Medium	Climate sensitive design (potential)
	Growing cereal/vegetables in urban areas	Food insecurity	Increase food security, income, entrepreneurship, green spaces	Medium	Growing cereal/vegetables in urban areas – supported by NGOs/agribusiness

Table 3 continued. Sectoral strategies

RESPONSE FIELD	ACTIVITY	MAIN, DIRECTLY RELEVANT RISKS TO LIVELIHOOD/WELLBEING	NATURE OF BENEFIT	SHORT/MEDIUM TERM BENEFITS Short = in the next year/ Medium = up to 15 years	INNOVATIVE ASPECTS
Water management	Small-scale irrigation	Food insecurity, rainfall variability	Increased security of yields, increased income, ability to diversity crops and have all year round income	Medium	
	Rainwater harvesting	Human health, food insecurity, rainfall variability	Improved health, improved crops, reduced travel time to collect water (women/children)	Medium	Innovative design, small ponds (potential)
	Strengthening community water governance	Rainfall variability, drought, resource conflict, land degradation	Improved and more equitable resource access and reduced resource conflict, improved livestock mobility, empowerment of communities	Medium	Mechanisation of water sources, community-based management organisations (WRUAs)
Health and environmental health	Improving domestic water supply and sanitation	Human health	Reduction in disease risk, reduced health burden; reduced travel time to collect water (women/children)	Medium	
	Surveillance and control of vector-borne diseases	Human health	Reduction in disease risk, reduced health burden	Medium	Surveillance systems sensitive to changing ecological conditions for vectors
Disaster risk reduction	Drought risk management	Drought, food insecurity	Reduced livestock and crop losses	Medium	Drought management cycle approach
	Flood prevention and mitigation through land use planning	Extreme weather, human health	Reduced human exposure to hazards, reduced damage to infrastructure, soils and livelihoods	Medium	
Climate services	Provision of seasonal/hazards forecasts	rainfall variability, drought, extreme weather,	Enhanced capacity to anticipate hazards/reduce risks	Short	Models for hybrid technical-indigenous knowledge

Table 4. Livelihoods and wellbeing

RESPONSE FIELD	ACTIVITY	MAIN RELEVANT RISKS TO LIVELIHOOD/WELLBEING	NATURE OF BENEFIT	SHORT/ MEDIUM TERM IMPACT	INNOVATIVE ASPECTS
Knowledge and awareness	Integrating scientific and indigenous knowledge for forecasting	Rainfall variability, drought, extreme weather	Effectiveness and trust in forecasts	Short	Integrating scientific and indigenous knowledge for forecasting
	Strengthening farmer knowledge on climate and adaptation	Rainfall variability, drought	Capacity building for response at grassroots level	Medium	Strengthening farmer knowledge on climate and adaptation
Extension Services	Strengthening of agriculture/veterinary extension services	Resource degradation, plant and animal diseases	Improved resource management, better animal and crop production, improved income	Medium	Locally appropriate technologies in Ethiopia (versus blueprint approach)
Livelihood diversification	Production and marketing of drought-resistant fruit crops	Rainfall variability, Drought, Food insecurity	Improved incomes, enhanced nutrition and health	Medium	
	Charcoal production and sale of firewood (illegal)		Improved incomes	Short	
	Milk production and sale to urbanizing areas		Improved incomes	Medium	New activity responding to growth of urban areas in Ethiopia
Safety nets/social protection	Food-for-work and cash-for-work schemes	Food insecurity	Improved resource management, reduced food insecurity, improved income	Short (but medium term resource impact)	Voluntary basis in Ethiopia
Gender focused approaches	Livelihood strengthening targeted to women's productive roles	Resource access, Food insecurity	Improved incomes, reduced intra-household inequalities, empowerment	Medium	Gender transformative adaptation
Relocation and Migration	Resettlement/ villagization	Drought, Resource conflict, Animal diseases	Better animal health, access to social services, access to markets, access to extension services, access to technology (NB considerable negative implications too)	Medium	New as a strategy for the pastoral community
	Rural-urban migration	Resource degradation, Resource access	Access to alternative livelihoods, Easing pressure on resources	Medium	
Risk sharing	Micro-insurance schemes	Rainfall variability, drought Food insecurity	Reduced vulnerability to crop and livestock losses	Short	Weather-based insurance initiatives

5.3 Adaptation and development: some reflections from the review

In this section we present some preliminary thoughts on whether adaptation is strengthening or impeding development (or, more specifically, poverty reduction), and vice-versa. We look at issues of maladaptation and mainstreaming, drawn from the existing literature. These types of questions are core to the ASSAR research agenda, and we will be developing the analyses further during the course of the RRP phase.

5.3.1 *Are some adaptation efforts potentially maladaptive?*

Maladaptation refers to responses to climate-related risks that have perverse effects: serving ultimately to increase rather than reduce vulnerability. Strictly-speaking, virtually all practical responses are likely to entail at least some marginal maladaptive effect for someone – a purely positive form of adaptation is probably notional only. However, cases are already emerging in the region of maladaptation that is far from marginal in its impact, especially on the poor.

Maladaptation can result from inertia in risk management practices. Silvestri et al. (2012) argues that traditional coping and adaptation strategies to deal with climate variability may become less effective under future climate changes. Current practices, processes, systems and infrastructure that are more or less adapted to the present climate may easily become inappropriate as the climate changes and more fundamental adjustments will be needed.

Some established and new coping strategies may already be damaging under current conditions. In their study in a semi-arid district of Kenya, Smucker and Wisner (2008) noted that over a 30-year period communities had begun to adopt emergency drought coping responses incompatible with maintaining long term livelihood resilience. In relation to floods, Opondo (2013) similarly observed short-term coping responses that serve to devalue livelihood assets.

Speranza (2010) suggests that agro-pastoralists' responses to drought are commonly reactive and mainly involve intensifying exploitation of shared resources. However, it would be wrong to cast emergency coping activities as inherently negative for livelihoods. Eriksen et al. (2005) found that individuals that specialize in a favoured coping activity (such as charcoal production) were less vulnerable than households that engaged in a diversity of low-intensity coping activities. The paper argues that understanding the dynamism of coping and vulnerability is critical to developing adaptation measures that support people as active agents.

Moreover, maladaptation can also be the outcome of interventions undertaken in the name of adaptation. According to Boelee et al. (2013), for example, promotion of rainwater harvesting and water storage can expand the open water surface in susceptible areas and lead to increased transmission of water-related diseases. Bryan et al. (2009) pointed to certain soil and water conservation strategies and technologies that are not compatible with local conditions in parts of Ethiopia and could not support development. In some cases there is also a danger that communities become dependent on grant-funded projects that only work well as long as the funding continues: they may in fact increase vulnerabilities if people have switched to livelihood activities that cannot be sustained.

It is crucial to recognize that there may also be winners and losers from adaptation programmes (Brooks, 2014). Policies that focus on increasing resistance of agriculture to

climate variability through promotion of drought tolerant crops, for example, may reinforce the exclusion of marginalized social groups in dryland East Africa, who are challenged by high labour requirements and low market value of these varieties (Eriksen et al., 2005; Eriksen and O'Brien, 2007). Olsson and Jerneck (2010) noted a growing tension between villages benefiting from an intervention in western Kenya and disadvantaged neighboring villages, because unequal distribution of resources may result in increasing income stratification between poor households. This called into question the 'trickle down mechanism' tested in the intervention as a tool for equalizing incomes and life opportunities.

Even within a sector it is the net effect of adaptation policies and intervention that needs to be assessed (Huq et al., 2005). Trade-offs may arise between increasing the buffer capacity of individual farmers and that of the sectoral economy as labour-savings on-farm can translate to reduced job availability in the rural economy (Speranza, 2013).

5.3.2 *Are development trajectories impeding adaptation or leading to maladaptation?*

The socio-economic development context and the political/governance context affect the efficacy of adaptation processes in myriad ways, perhaps most prominently through external and domestic development interventions. Haselio et al. (2013) argue, on the one hand, that donor initiatives are generally too short term to generate lasting change, especially in conditions where there are weak local institutions. Drawing on work in the drylands of Kenya, Eriksen et al. (2005) emphasize that empowerment must be key component of any adaptive strategy, because power relations and structural inequalities are key barriers to adaptation. Arguably, adaptation policy needs to address power imbalances in political systems to decentralise power and create enabling conditions for local and regional adaptation options (Eriksen and Lind, 2009).

The maladaptive impact of certain development paths in pastoralist areas has been the subject of much debate. A commentary in the publication *Joto Afrika* claims that development interventions: "have often been designed and imposed… with little understanding of the dynamics of marginal lands. The disruption of traditional adaptation mechanisms that has followed has stigmatized pastoralists as chronically food insecure and created a vicious circle, further imposing inappropriate measures that climate change and increasing population growth and burden on natural resources are likely to exacerbate" (Manzano, 2014:1).

Owuor et al. (2005) find that development activities can exacerbate the conflicts around important hilltop resources in eastern Kenya drylands that exclude groups and constrain adaptation practices. In Ethiopia, some government investment on large-scale irrigation projects is reported to have had significant effects on communities in pastoral and agro-pastoral areas (Edossa et al., 2007; Gebresenbet and Kefale, 2012). Large tracts of land previously utilized by pastoralists are given over to sugarcane plantation and sugar factories. This has led to shortage of rangeland, forced settlement and competition with other communities for resources.

5.3.3 *Is there evidence of adaptation being mainstreamed into development?*

In the case of climate change, mainstreaming implies the integration of climate change concerns into existing or planned policies and institutions at national level, including also 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.

Mainstreaming of adaptation into development is arguably at an early stage in the region (Mitchell and Tanner, 2006; Sharkey, 2011): many initiatives labelled as adaptation remain quite localized and project and/or case study based. Climate change integration into relevant sector policies still show poor integration (Kansiime, 2012). Nevertheless, there are signs that integration is increasingly under way. Hove et al. (2011c) point to improved linkages and communication between early warning institutions, food security programs, and social safety net programmes. The government of Ethiopia has taken a major policy step to mainstream adaptation into development programming by developing the Climate Resilient Green Economy development pathway (FDRE, 2011). Kenya's National Climate Change Action Plan seeks to mainstream climate change in development action (GOK, 2013), and the Government of Uganda has taken steps to mainstream climate change within the National Development Plan (GOU, 2010),

Kenya and Ethiopia were among 20 countries targeted by the Africa Adaptation Programme (AAP), which provided support to identify and implement priority adaptation interventions. Kumamoto and Mills (2012) reviewed AAP project documents and found national scale soft adaptation interventions focusing on capacity development at the systemic, institutional and individual levels were predominately selected rather than hard or soft interventions at the local scale which they attributed to a concern over the risks and uncertainties associated with possible interventions.

Di Falco et al. (2012) argue that the current attention given to climate adaptation has the potential to go hand-in-hand with the long-term policy priority of increasing production and reducing vulnerability among poor farmers. Based on case study research in Kenya, Eriksen and O'Brien (2007) also claim that climate change adaptation can potentially reconcile objectives of poverty reduction and vulnerability reduction simultaneously. The paper argues that adaptation measures need to specifically target vulnerability-poverty linkages, address the societal processes generating vulnerability, and support local capacity to adapt.

CHAPTER 6

Dimensions of Governance

Dimensions of Governance

This chapter draws on a combination of the literature review and a series of interviews with national and some sub-national level stakeholders as a preliminary exploration of the governance dimensions of climate change adaptation and wider risk management in East Africa. Detailed governance analysis at multiple scales will be a key feature of the RRP phase.

6.1 Key governance dimensions

6.1.1 *Regional-level governance and adaptation policy*

East African countries have taken major steps towards developing regional and national institutional frameworks to address climate change.

The East African Community has devised high level medium term policies and strategies for both mitigation and adaptation among member states, highlighting the need for increased cooperation between them (EAC, 2011; IDRC, 2012; CCAFS, n/d). In 2011, the EAC produced a *Climate Change Policy* (CCP) to provide an overall framework in which to integrate national level policies (CCAFS, n/d). The CCP has three key pillars: adaptation, mitigation and climate change research (EAC, 2011). It sets out the following priorities: strengthening meteorological services and improving early warning systems; disaster risk management; efficient use of water and energy; irrigation, crop and livestock production; protection of wildlife and key fragile ecosystems; improvement of land use; climate proof social infrastructure; and reduction of climate sensitive diseases.

The EAC has established a regional Climate Change Coordination structure at the EAC Secretariat to support the successful implementation of the CCP. This will support needs related to capacity building, technology development and access to finance. Partner states are required to create an enabling environment through policy, legislative and institutional frameworks to operationalise the CCP, and establish a Climate Change Fund to mobilise financial resources for its implementation. States should also: (i) undertake detailed vulnerability and impact assessments; (ii) promote economic diversification; (iii) promote alternative livelihoods systems; (iv) enhance adaptive capacities of communities, ecosystems and economies; and (v) promote social protection.

Other EAC policies also consider the effects of and responses to climate change, such as the Agriculture and Rural Development Policy, which is designed to both streamline and develop the agricultural sector across countries (EAC, 2006a). This reflects a wider goal to pursue economic development, increase agricultural productivity, improve infrastructure and services, and deliver technological advancement (especially for agriculture and irrigation) (e.g. CCAFS, n/d). However, the extent to which the regional EAC frameworks have shaped national policies and plans in practice deserves further exploration.

In 2003, the Intergovernmental Authority on Development (IGAD) (Kenya, Uganda, Sudan, South Sudan, Ethiopia, Somalia, Eritrea, Djibouti) created the IGAD Climate Prediction and Applications Center created (formerly Drought Monitoring Centre). The functions of the Centre focus on meteorological data collection, analysis and forecasting.

The African Union (AU) (which covers all African countries except Morocco) has a Climate Change and Desertification Unit. The aim of the unit is to provide policy and political

guidance, and to enhance coordination and harmonization of Africa's activities in the field of climate change and desertification. It is organized within the overall framework of the Climate for Development in Africa (CLIMDEV), which is a joint initiative of African Development Bank (AfDB), the United Nations Economic Commission for Africa (UNECA) and the African Union Commission (AUC). The Unit also aims to ensure an effective engagement in climate change and desertification issues of Africa's political leadership at all levels, and to coordinate technical and financial support for mitigation and adaptation. The AU's 2010 policy framework for pastoralism also acknowledges the need to fully institutionalise livelihoods-based drought cycle management as part of a risk-based disaster management strategy (Haselio et al., 2013).

A number of major external agencies promote the needs for political commitment, high-level engagement, strong institutions, clear responsibilities both at central and local levels, and appropriate governance, transparency and accountability as part of this policy context in East Africa (ADB, 2013; UNISDR,2012).

Areas that merit further investigation in regard to regional level policies are: the nature of external drivers/institutions shaping these policy directions (especially the green growth paradigm pursued by Ethiopia (see below)), the ways in which the EAC policies have been translated into national policies by the member states, as well as how far and in what ways these policies have been implemented in practice in the member states.

6.1.2 *Global climate finance accessible to the region*

An ambition of several East African countries, is to better access climate finance, including through the Clean Development Mechanism, primarily through the development of institutions with the capacity to receive and manage it. This agenda is supported by some international financial institutions, which note that access to climate finance in East African countries to date has been limited by weak technical and institutional capacity. Furthermore, to date, much of this finance has been centred on mitigation activities, but African countries in general have pushed the adaptation agenda (e.g. at the 2014 COP in Lima) as crucial for their contexts at major international climate meetings, and have been developing specific adaptation plans alongside mitigation activities.

Some of the key funds available to the East African region for adaptation include the following:

i. The *Global Environment Fund* (ADB, 2013) grants funds to national governments, but the funds are currently allocated and managed by UNEP or UNDP until national agencies are accredited to process them (ADB, 2013). In Kenya, funding to the National Environmental Management Authority (NEMA) is routed through UNEP; while the National Drought Management Authority (NDMA) is seeking to gain legal status so that it can eventually access GEF finance coming in through the Treasury.

ii. The *Adaptation Fund* (2001) is for developing countries that are signatories to the Kyoto Protocol. There was an accreditation process for countries to become implementation agencies to receive these, until which no funds could be allocated. In Kenya, NEMA has been the implementing agency since 2002.

iii. The *Green Climate Fund* arises from UNFCCC and provides funding for mitigation and adaptation. It is much larger than the Adaptation Fund and encourages crosscutting projects and programmes (ADB, 2013). Countries need to have one or more National Implementation Agency(ies) approved. In Kenya, NEMA has sought approval to become one of these. In the interim, it is liaising with UNEP over access to this fund, which would be routed through the Treasury, and NEMA.

iv. The *Climate Investment Fund* (ADB, 2013) provides developing countries with grants, concessional loans and risk mitigation instruments (implementing agencies are the ADB, WB and IFC).

v. The *Sustainable Energy Fund for Africa* provided by the African Development Bank provides development capital for small and medium-size clean energy projects (ADB, 2013).

6.1.3 *National governance and adaptation policy*

All East African countries (and EAC member states) - Burundi, Djibouti, Eritrea, Ethiopia, Rwanda, Sudan, Tanzania and Uganda - have formulated medium term national policies and strategies for climate and/or adaptation (EAC, 2011) via National Adaptation Plans of Action (NAPAs), and, in the case of Kenya, a National Communication and later a National Climate Change Action Plan. NAPAs set out country-specific aims and activities for working towards adaptation. In the region, agricultural land-use and forestry play an important role (Alterra, 2010). Priority sectors for development include agriculture, water and energy.

Some countries have updated their NAPAs to produce National Adaptation Plans (NAPs), which reflect a more concrete commitment to specific adaptation initiatives. One example is Kenya, referred to below.

Ethiopia's NAPA primarily focuses on agricultural land-use: adaptation of water and other natural resource management; diversification of farm activities and off-farm extensions; promotion of a drought/crop insurance program; strengthening of drought and flood early warning systems; development of small scale irrigation and water harvesting schemes; improvement of rangeland resource management practices; community-based sustainable use of wetlands; capacity building; and improved food security through large-scale water development projects (Alterra, 2010).

Uganda's NAPA focuses on land and land use; farm forestry; water resources; health; weather and climate information; awareness creation; policy and legislation; and infrastructure. Proposed projects include community tree growing, water and sanitation, development planning, drought adaptation, indigenous knowledge, land degradation, meteorological services, pests and disease, water for production; research and knowledge, leadership and coordination, technical assistance (Hove et al., 2011b).

Kenya has several policy initiatives related to climate change mitigation and adaptation. Its National Climate Change Response Strategy 2013-17 (2009/10) is designed to ensure that adaptation and mitigation measures are integrated in all governmental planning processes, budgeting, and collaborative endeavours. It stresses the importance of integrating adaptation into wider development and sectoral planning efforts. It identifies priority adaptation actions by sector: agriculture, tourism, infrastructure, health and natural resources (CDKN, 2012).

The National Climate Change Response Strategy led to the production of the National Climate Change *Action* Plan 2013-17, which defined adaptation priorities and plans. It includes transitioning the transport sector to a low carbon development pathway. These priorities and plans are encapsulated within a Climate Change *Adaptation Action* Plan (led by the National Drought Management Authority under the Ministry of Devolution), which reflects the great importance of adaptation in Kenya, and holds that adaptation should be mainstreamed into development. The National Adaptation Action Plan prioritises environmental education, awareness and training.

Kenya's Vision 2030 Programme (2011) comprises a national development strategy that centres on developing agricultural production while also pursuing environmental protection. It also guides projects designed and implemented under the National Climate Change Action Plan.

Kenya is also developing a National Climate Change Policy, which was awaiting its third and final reading in parliament (due early 2015). It centres on adaptation and sets out to mainstream climate change throughout all government ministries and in budgetary planning (setting out clear roles and responsibilities with monitoring and evaluation). It will articulate the following priorities: innovative research and scale up (upscaling, intensity and focus); resilience; food security; development goals. The NCCP includes input from the local levels. It was devised by a Climate Change Working Group, a forum that convened from 2010-11 to bring together stakeholders from civil society, government, parliamentarians and NGO partners, to formulate a legislative framework for climate action in Kenya and national policies. The Working Group was a member of the Pan-African Climate Justice Alliance (civil society coalition) (UNISDR 2012). When passed, it will be implemented by the Climate Change Secretariat within the Ministry of Environment, Water and Natural Resources as a temporary arrangement; its final designation may be with the office of the President.

Other Kenyan policies and strategies also reflect climate priorities, including its Strategy for Revitalizing Agriculture (2004) (Hove et al., 2011d), and its National Policy for Disaster Management (2009).

Some external institutions advocate the wider integration of adaptation with development policy and planning, identifying the need to engage ministries that are responsible for economic development and finance, natural resources management, public health (Leary et al., 2007; IDRC, 2009), agricultural modernization (James, 2010), urban planning (Kithiia, 2011; Kithiia and Dowling, 2010), local planning (Heath et al., 2012), and even EIA processes (Kamau et al., 2013). This is the case in both Kenya and Ethiopia, which envisage dynamic economic growth based on their agricultural sectors. Several regional stakeholders articulated the difficulty of separating the adaptation agenda from the wider development agenda.

Through its Growth and Transformation Plan (FDRE, 2010) and the Climate Resilient Green Economy Development Strategy (FDRE, 2011), Ethiopia has integrated climate change concerns into a 'green growth' paradigm, which holds that low carbon economic development is the most promising route to effective adaptation (see box 11) (Bryan et al., 2009; Conway and Schipper, 2011; FDRE, 2011). Ethiopia's economic growth focuses on the development of the agricultural sector and the provision of associated infrastructure and technology, emphasizing the need for a greater role for the private sector (Kithiia and Lyth, 2011). Again, these ambitions may have merit in some ways, but their translation into

practice may be less smooth, not least because multi-stakeholder endeavours may become characterized by conflicting interests among the parties involved.

Box 11.

Climate Resilient Green Economy in Ethiopia

The aim of the Climate Resilient Green Economy (CRG) strategy is to pursue economic growth whilst guarding the country from the adverse effects of climate change, by promoting a new 'green' model of economic development that envisages progress towards the country's ambition of reaching middle-income status before 2025 without generating high greenhouse gas emissions. The 'Climate Resilient' dimension of the strategy centres on adaptation, while the 'Green Economy' dimension focuses on mitigation.

The strategy comprises four pillars:

- **Agriculture**: Improving crop and livestock production practices for higher food security and farmer income while reducing emissions
- **Forestry**: Protecting and re-establishing forests for their economic and ecosystem services, including as carbon stocks
- **Energy**: Expanding electricity generation form renewable energy for domestic and regional markets
- **Infrastructure**: Leapfrogging to modern and energy efficient technologies

Source: FDRE (2011).

In Kenya, government institutions and policies are also undergoing a process of decentralisation, which aims to strengthen the presence of key institutions and foci at the county level. For example, the Kenya Meteorological Service is establishing a climate information service at each county level: by early 2015, it had appointed county directors and was in the process of installing infrastructure (e.g. offices, meteorological equipment). Adaptation Plans have also been produced for each county. A reform of the Kenyan Constitution (2010) mandates participation of stakeholders from the inception of any project. Kenyan citizens are increasingly aware of their rights to participate in external initiatives, and are increasingly prepared to pursue them.

In some East African countries, climate change units have been established in relevant ministries to coordinate mitigation and adaptation policies and activities (e.g. Environment, Agriculture). There is widespread recognition that such units need to be cross-sectoral: government agencies and activities from different sectors – e.g. agriculture, livestock and pastoralism, water, energy, land use, forestry, transport, fisheries, health, urban development, tourism, planning - will either need to be integrated or better coordinated in order to improve communication and cooperation between them so as to ensure a coherent strategy on adaptation and to integrate climate concerns into other relevant policies (CCAFS, n/d; Kansiime, 2012).

Both Kenya and Uganda have established climate change units within government departments (Kenya, CDKN, 2012; Uganda, Hove et al., 2011b). As noted above, in Kenya, the National Climate Change Secretariat is located within the Ministry of Environment, Water and Natural Resources as an interim measure. In 2008 Uganda set up a Parliamentary Forum on Climate Change (Hove et al., 2011b). In 2015, Ethiopia set up a new directorate within the Ministry of Water, Irrigation and Energy, the Environmental Impact and Social Service, which focuses on climate change research and policy formulation. However, capacity is currently weak to carry out these functions.

How far and in what ways this cross-sectoral integration and coordination is occurring in practice is not clear, and could potentially be hampered by turf wars on the part of relevant government agencies. Kenya has undergone a deep reorganization of government structure in line with climate change policies. The sense among some stakeholders is certainly that there is a failure to coordinate plans and/or a duplication of efforts between different government agencies, including for mitigation and adaptation activities. This is an area to examine further.

In much of the institutional literature, the need for adaptation, especially among priority sectors and in particular agriculture and livestock, is taken as given, and becomes the focus of supposedly pragmatic policies and strategies for adaptation, such as the implementation of new technologies. Some more critical literature, however, questions the way in which climate change effects are framed and addressed. For instance, measures framed as urgent can justify immediate responses that may be ill-conceived for particular areas and social groups, thus leading to 'maladaptation' (Weisser et al., 2014). Others may focus narrowly on the management of particular problems and solutions, but in ways that neglect wider dynamics and processes (Brown, 2011), such as in the causes and effects of drought (Naumann et al., 2014). Such narrowly conceived interventions focusing on particular technologies or capacity building may be overly top-down and even instrumental (Brown, 2011; Munang and Nkem, 2014). Weisser et al. (2014) call for more critical attention to the ways in which such framings are shaping political debates and policy responses, and their implications for different places and people.

These issues are reflected in stakeholders' perspectives from the region. An important issue is the management of pastoralists' and agro-pastoralists' livelihoods in the face of increasing pressure on pasture land and water sources and increasing restrictions on large-scale movements (e.g. due to conflict). While some institutions and perspectives emphasise the need for adaptation in terms of the development of new technologies for 'climate smart agriculture' and livelihood diversification (e.g. the rearing of camels, which are more hardy than cattle), others highlight the roles of changing land ownership and land use in these groups' livelihoods (e.g. land grabbing for large scale commercial agriculture), as well as wider interests in reducing large numbers of cattle (to reduce CO_2 emissions).

In this regard, the division between mitigation and adaptation activities is far from clear cut. For example, REDD+ initiatives, being pursued in arid and semi-arid areas in some parts of East Africa to prevent forest degradation and deforestation, also have adaptation dimensions through forest conservation that can underpin livelihood diversification. Similarly, irrigation project can serve both mitigation and adaptation purposes by

encouraging a shift away from cattle (thereby reducing carbon emissions) as well as providing more secure livelihood opportunities.

According to some stakeholders from the region, some of the major international NGOs – such as ACT, the Red Cross, CARE and Oxfam - mostly funded by bilateral development assistance, have had a strong influence on government directions and decisions. For example, DFID funded support to Kenya's National Climate Change Secretariat and Oxfam's Africa Climate Change Resilience Alliance (ACCRA), which seconded staff members to the ministries of its target countries (Ethiopia, Mozambique, Uganda) to build capacity among policy makers. Indeed, policy influence is a major objective of some of these international NGOs.

6.1.4 *Local governance and institutions*

While much attention is paid to the reworking of national institutions and policies to accommodate mitigation and adaptation, considerable consideration is also given to local level institutions, both state and non-governmental, and including community-level and customary institutions.

Several authors stress the need to build on and/or strengthen institutions at all levels, including provincial or county institutions that provide goods and services including extension services, capacity building and training, technological development, improved infrastructure and services (e.g. water storage, public health), financial services and assistance, disaster relief, information services (weather forecasts, market forecasts) (Leary et al., 2007; Ifejika Speranza, 2013; Peterson, 2012). Some of these products are provided by non-state organisations (e.g. capacity building, infrastructure and technology), but the underlying emphasis seems to be that these should ultimately improve state capacity at different levels. The role of rural extension services is highlighted here, and is referred to by stakeholders in the region.

Other authors advocate the need to build on and/or strengthen existing local institutions, and/or promote the formation of new local associations, in order to improve resilience at the local level (Ruijs et al., 2011; Eriksen and Lind, 2009; Ifejika Speranza, 2013). Such institutions include: local government agencies (e.g. public rural extension agencies (Ruijs et al., 2011; Ifejika Speranza, 2013)), religious institutions (Ruijs et al., 2011), non-governmental organizations (e.g. microfinance), sectoral associations (e.g. farmer or grazing associations (ASARECA, 2009; Eriksen and Lind, 2009)), community-based organizations (e.g. water associations, savings schemes, women's groups), and traditional/customary institutions and kinship networks (Leary et al., 2007). A further consideration is the creation of new governance units, such as conservancies in Kenya. The thrust of most analyses is that it is important to both acknowledge and to engage such institutions in adaptation initiatives. That said, little mention is made in the literature of local and customary organizations.

Another important issue and concern here, relates to the diversity of local contexts and their institutional landscapes; for instance, pastoralist communities will have very distinct local institutions and networks, and social capital systems, than smallholder farmers or peri-urban residents, and institutions are likely to differ between pastoralist groups from different cultural backgrounds (e.g. Islamic, Masaai). It will be also important here to consider the extent to which these types of local institution are present in arid and semi-arid areas, and how they are configured in such places.

Several empirical studies that have explored the interaction between such local institutions – whether state, community or civil society – and adaptation initiatives at the local level support these recommendations. For example, Ruijs et al. (2011) provided survey-based evidence to show the supportive effects of state extension agencies and local organizations in community-based adaptation in Ethiopia and elsewhere. Similarly, drawing on field research in Kenya, Ifejika Speranza (2013) shows that extension services can build on local autonomous adaptation mechanisms, while Washington-Ottombre and Pijanowski (2012) show how collective action between local government and non-governmental organizations can help to form and drive effective adaptation initiatives. Gabrielsson and Ramasar (2013), again drawing on Kenya, also found that state support (organizational and financial) for farming associations was critical in fostering community organization for adaptation initiatives (e.g. water harvesting, drip irrigation). These associations were particularly important for integrating women and widows, and facilitating their access to resources.

Some authors, in particular within the academic literature, raise the issue of the extent to which national level policies and strategies are likely to effectively address very different ecological and social contexts (Biazin and Sterk, 2013) and inter-group differentials (based on, for example, income or gender) (Deressa et al., 2009; Gabrielsson and Ramasar, 2013). These perspectives enhance the need to involve and strengthen local institutions so that adaptation approaches can consider local practices, cultures and subjectivities. These observations also consider the merits of forms of 'indigenous' adaptation, in order to avoid the potential for top-down initiatives that are not appropriate to the local context and people and that could lead to unintended consequences including 'maladaptation' (Gabrielsson and Ramasar, 2013). However, the variability of local institutions in such different contexts is likely to be very large indeed, thereby requiring careful attention to the nature and dynamics of specific situations. For example, arid and semi-arid lands have a much lower presence of local state and non-state institutions than high rainfall areas in East Africa.

A further point raised is the degree of participation in designing and implementing adaptation initiatives, especially among the population groups living in the places where they are to be implemented (Adimo et al., 2012; Brown, 2011; Munang and Nkem, 2014). Adimo et al. (2012), drawing on Kenya, advocate a multi-scale participatory approach that considers the household and wider levels. Munang and Nkem (2014), referring to Kenya, Uganda and Ethiopia, assert that actions and solutions should be democratized, whereby citizens decide which actions and technologies are adopted and how, thus taking leadership and ownership over adaptation projects and creating their own knowledges and learning processes. This observation is rather at odds with the focus of many projects, which comprise interventions that are devised by non-local groups e.g. climate smart agriculture. An important aspect to explore further, therefore, is the scope that local communities may have in defining the focus and terms of interventions planned in their contexts. While participation is also now either common or mandatory in East African countries, the ways in which it is effected in practice is also likely to vary widely, and the scale and nature of participation in any given context needs to be interrogated. This said, some stakeholders from the region report difficulties in establishing trust with local communities in order to implement projects.

In addition to the spatial dimension covered above, Pringle and Conway (2012) pays attention to the temporal dimension of adaptation, observing that NGOs tend to frame

climate change in terms of long-term impacts, which may serve to disempower NGO staff and communities.

6.2 Adaptation planning and action

6.2.1 *Current adaptation initiatives*

In addition to the policy development and implementation initiatives covered in section 6.1, to date a very large number of adaptation activities have been implemented in East African countries, primarily by international organizations. These comprise in particular bilateral development assistance agencies and international NGOs, mostly in conjunction with local NGOs, government agencies and/or community groups. A set of country-specific reviews of adaptation initiatives undertaken by the International Institute of Sustainable Development found that in Uganda and Kenya, a large number of external initiatives formed part of multi-country African or East African initiatives, some of which are implemented specifically in these countries (Hove et al., 2011b, 2011d). In Ethiopia many ongoing projects were designed specifically for this country, especially ones focusing on pastoralism. Far fewer interventions were identified in Sudan and Somalia due to governance and security issues (Hove et al., 2011a; Zubrycki et al., 2011).

The majority of initiatives described as adaptation that are implemented on the ground in East Africa focus on capacity building, policy formation, technological development, information sharing and research, mainly in relation to agriculture and food security (livestock, crops and food), as well as disaster risk management and water security (see section 5.1). Many initiatives focus on strengthening state and local institutions. In contrast, NGOs are more prevalent in those regions not or only marginally covered by public extension services, although concerns about concentration of activities in certain areas have been expressed. It is important to note from the outset, however, that, while many of these are labelled as adaptation, there is a fine line between what is explicitly framed as adaptation and what is framed as environmental/livelihood improvement (see section 5.1). Moreover, this dynamic operates in both directions: some environmental/livelihood improvement initiatives may not be framed as adaptation but may be essentially implementing adaptation activities; while other initiatives may be framed as adaptation but may be actually undertaking more general environmental/livelihoods improvement activities. The frequent lack of coordination and/or overlap between these initiatives has been noted as a concern by many stakeholders from the region.

It would be useful to better understand how adaptation initiatives are conceived; that is, how changes are understood and responses constructed, and the roles of different stakeholders and sources of information in such processes. At present, many initiatives seem to take the effects of climate change and logical responses to them for granted. For instance, several stakeholder interviews in the region suggested that pastoralist livelihoods are simply assumed to be inviable in the face of climate change, which led pragmatic responses that were deemed to be suitable for these groups, but which may or may not have been effective or accepted in practice.

While some sources assert that many adaptation strategies are developed by local communities who perceive the effects of climate change and variability (Homann et al., 2005; Simane et al., 2012, 2013), according to Ruijs et al. (2011), based on a study of

Ethiopia and other countries, effective external organizations - whether governmental or non-governmental – have been needed to initiate adaptation activities, often serving to raise awareness, build capacity, and create commitment among community members. For example, in Ethiopia, public extension services have fulfilled this role in the many parts of the country where they have a strong and extensive network of agencies (for historical reasons), where they have fostered a very high degree of contact between households and external institutions, especially state extension services. Micro-finance institutions (formal banking or community institutions) and the media are other example of important external institutions that support adaptation initiatives (Ruijs et al., 2011; Kato et al., 2011; Peterson, 2012; Simane et al., 2013). Nevertheless, Ruijs et al. (2011) also found from their multi-country study that external support tends to result in elite capture, and this is an aspect to which we should be attentive.

6.2.2 *Aspects to be strengthened*

A large number of sources based on East Africa refer to weak governance in various respects, including lack of capacity building among government departments, lack of accountability among government institutions (FAO, 2013; Sharkey, 2011; ADB, 2013; Conway and Schipper, 2011), and lack of coordination between different government units (Olsen, 2006; FDRE, 2010). For example, Leary et al. (2007) highlight that key functions of risk management are inadequate or absent due to weaknesses in supporting institutions that are commonly poorly resourced, lacking in human capacity, overloaded with multiple responsibilities, and overwhelmed by the demands of their communities, while Doocy et al. (2013) highlight the weak levels of policy implementation and resource allocation for disaster preparedness and response in Uganda. FDRE (2010) advocates the development of regional and local institutional frameworks to strengthen the coordination, networking and information flow with different levels of government and civil society organizations. Other analyses note how the governance arrangements for adaptation focus on formal and top-down arrangements that are largely disconnected from the local level (Kato et al., 2011). Brown (2011) associates these with narrow technologically defined approaches to adaptation that give rise to a limited number of policy responses (e.g. climate smart agriculture).

A related issue is that climate change is often treated as an environmental rather than a development issue (Eriksen and O'Brien, 2007). This is reflected in the fact that climate change tends to be located within environmental departments of government – environment, agriculture, water – and are relatively weakly linked to wider economic development, planning and social policies. As mentioned in section 6.1, this does appear to be changing in countries like Ethiopia and Kenya, where attempts are being made to mainstream climate change across government and policy, and to link it with wider economic development and planning strategies.

In East Africa, adaptation initiatives are still very much towards directed towards *sectors* rather than specific types of *ecosystem* (Eriksen and Lind, 2009). This likely reflects the sectoral structure of government departments in East African countries as well as the specific foci of many non-governmental organizations working on adaptation. This pattern raises particular concerns in arid and semi-arid areas, which are often considered as homogenous yet vary greatly in terms of ecology, social organization and culture. While many adaptation projects are implemented in one place and then transferred or scaled up

to others, greater attention to the socio-ecological diversity of semi-arid areas may warrant approaches and interventions that are designed for particular *landscapes*, rather than specific *sectors*. For instance, pursuing livelihood diversification through smallholder agriculture or camel rearing may be effective in some places yet may encounter ecological and/or cultural barriers in others.

As mentioned in section 6.1, much literature and several stakeholder interviews refer to very limited stakeholder participation in formulating and implementing policy and practical initiatives. This contradicts the fact that most interventions state that participation is a crucial and integrated component of their activities. In addition, in Kenya, participation is mandatory under the Constitution and increasingly expected by local communities, although the degree to which they are aware of their rights varies across regions and sectors. Here, it is worth reflecting on the degree to which participation enables local people to be able to define the priorities and shape of interventions, rather than simply participate in interventions defined by others. In other words, the degree to which participation is meaningful and/or empowering, as opposed to instrumental, is a concern. Another relates to the ways in which the climate change and adaptation problematic is understood, framed and enacted, by different social actors, as opposed to merely examining how more varied – and especially poor – stakeholders can be integrated into and have their voices heard within adaptation initiatives. This point resonates with the observation that the degree of political representation (or marginalisation) of communities, as well as the degree of political organisation among them, is an important consideration (Berrang-Ford et al., 2012; Eriksen and Lind, 2009; Eriksen and O'Brien, 2007).

A further related issue is the role of local knowledge and 'indigenous' forms of adaptation (Simane et al., 2013), which are frequently referred to in the literature and by stakeholders in the region, yet little evidenced in practice. For instance, pastoralism is widely recognized as an indigenous form of adaptation, as people and cattle move large distances to access pasture and water. However, while there seems to be a general level of acknowledgement that local people living in arid and semi-arid areas have excellent knowledge and skills to inhabit these landscapes, a large number of interventions focus on modifying, rather than strengthening, these groups' livelihoods and practices.

6.3 What is motivating and supporting adaptation action?

6.3.1 *Drivers of adaptation policy*

In East Africa, adaptation action is driven at a *policy level* by government agencies, which are in turn stimulated by global climate negotiations (e.g. COP), regional organizations (e.g. EAC), international organizations (including UN institutions, multilateral financial institutions, bilateral development assistance agencies) and international NGOs. It is possible that current efforts to integrate and mainstream climate mitigation and adaptation into government policy and strategy respond as much to renewed opportunities to pursue economic growth and access climate finance as they do to safeguard existing economic sectors and livelihoods in the face of changing climatic conditions and their consequences. Nevertheless, the severe 2009 drought in the Horn of Africa, and the devastating effects on rural communities (especially pastoralists), is a situation that is at the forefronts of East African stakeholders' minds due to the severe impacts that it had on pastoralists and

livestock in particular. Little is written or discussed about these higher-level drivers, and they could be researched further.

As outlined in section 6.1, regional organizations are formulating wider frameworks for countries of the region. Interestingly, in the stakeholder interviews carried out, no mention was made of regional-level policies (from the EAC or AU) and any influence on national policies. Countries themselves are adopting climate policies (NAPAs and NAPs) and are integrating climate concerns into other areas of policy (e.g. agriculture). Both Kenya and Ethiopia are keen to access global climate finance, and are strengthening their local institutions in order to be able to receive funds directly rather than via UNEP and UNDP.

6.3.2 *Drivers of adaptation initiatives*

The reviews conducted by the International Institute for Sustainable Development established that the majority of adaptation initiatives present in East African countries are led by external development assistance agencies, mostly either as multi country programmes (within East Africa) or targeted at that country in particular (which is especially the case for Ethiopia) (Hove et al., 2011a, 2011b, 2011c, 2011d; Zubrycki et al., 2011) (see section 6.2).

In Ethiopia, according to Demeke et al. (2011) and Kato et al. (2011), most adaptation planning is developed by government stakeholders in a top-down fashion and simply implemented in communities, often in ways that is unfamiliar to them. However, other sources assert that many adaptation strategies are developed by local communities who perceive the effects of climate change and variability, for instance by shifting the cropping season according to the rains or temperatures (Homann et al., 2005; Simane et al., 2013). This apparent tension between top-down and bottom-up adaptation strategies may be an area to explore further in the case study locations, as well as the extent to which the latter may be shaped by local social factors, such as indigenous knowledge or lived experiences.

In Kenya, the National Environmental Management Authority has been the implementing agency for the country's Adaptation Fund (USD 9.9 million) since 2012. It formulated a programme of action for the Fund by inviting project applications and selecting 11 out of 101 applications on a competitive basis. The chosen implementers include a range of organisations (government bodies, NGOs, religious organizations, CBOs and a university; NEMA acts as the legal entity where organisations – such as CBOs – are not legal entities) to cover different sectors and regions. Moreover, once the implementers had been selected, a process of coordination ensured over approximately two months to combine the 11 projects into a coherent programme.

Analyses are mixed around the extent to which local initiatives are defined and driven by local groups. From the literature and stakeholder interviews, it appears that many are driven by national and local organisations according to their specific foci e.g. development of new infrastructure and technology. In this regard the extent to which such activities are framed as adaptation responses to climatic variation, rather than initiatives responding to wider drivers such as social mobility and livelihoods, is an important concern.

CHAPTER 7

Conclusions

Conclusion

In this concluding chapter we begin to trace out the key factors that may be at work in strengthening or impeding response to climate-related risks in the semi-arid lands of East Africa, paying particular attention to the wider linkages between adaptation and development. We also present our analysis of key gaps in literature, research and understanding relating to vulnerability and adaptation in semi-arid East Africa.

7.1 Towards identifying barriers and enablers

Here, we draw on the previous discussions in this report to suggest general barriers and enablers to vulnerability reduction and adaptation – in order to inform the overarching research question of ASSAR as we move into the RRP phase.

One central premise of ASSAR is that a narrow viewpoint on the analysis of vulnerability and adaptation is itself a fundamental barrier to progress (Simane et al., 2012). Research that is limited in scope to tracing the impacts and responses to climate signals will logically also lead to a limited scope of research-into-use. Eriksen and O'Brien (2007) point out that institutional responses are already often framed as a purely environmental concern, and fail to fully consider the wider political economy that so strongly shapes livelihoods and entitlements. But if, instead, there is a recognition that poverty reduction and adaptation objectives in development can be reconciled, then the converse outcome can emerge – the dual policy justification of vulnerability reduction as an enabling factor.

As a starting point toward the detailed elucidation of barriers and enablers, some contrasting examples drawn from the preceding discussions are presented in Table 5. This should, however, be seen as a simplified and preliminary list – there are many nuances that could be added to these simple statements, and the list is by no means intended to be exhaustive.

Table 5. Preliminary identification of key barriers and enablers to vulnerability reduction

COMMON BARRIERS	POTENTIAL ENABLERS
KNOWLEDGE AND CAPACITY - **Data gaps** - **Awareness and understanding** - **Absence of appropriate technology**	- Integration of traditional and modern knowledge - Accessible dissemination of information - Access to education - Increased support for knowledge generation and capacity building
LIVELIHOODS - **Insecure access to land and resources** - **Gendered differentiation in terms of resource access and adaptive roles** - **Dependency on climate-sensitive livelihoods** - **Undermining of traditional coping mechanisms/systems** - **Poor access to market and related infrastructure/services** - **Urban migration of economically active** - **Absence of social protection(reluctance to innovate)**	- Improved access to credit and markets for the rural poor - Enhanced reach of essential services and infrastructure - Gender-transformative approaches - Strengthening attention to environmental health - Effective skills training for livelihood strengthening and/or diversification - Reinforcement of pre-existing adaptability - Improved understanding of the push and pull factors for migration - Broad social development approach in adaptation
PLANNING & INNOVATION - **Inflexible cultural norms** - **Resistance to innovation/transformative change** - **Overly complex/bureaucratic structures** - **Scale constraints re intervention (not system/landscape level)**	- Holistic management and risk reduction - Readiness to consider innovative but sustainable measures - Readiness to promote transformative change Normalization of a planning culture - Understanding and promoting sustainable development pathways - Flexibility in approaches to farmland, rangeland and water management
GOVERNANCE - **Low capacity to prioritise and address climate risks** - **Distrust of institutions, including external intervention** - **Conflict and insecurity** - **Political marginalization**	- Strengthened governance capacity at all scales - Empowerment and participation of all stakeholders - Ability to form collective associations at grassroots level
FINANCIAL RESOURCES - **Dependence on external funding** - **Devolved responsibility without matching resources** - **Infrastructure constraints (e.g. roads, electricity) on investment**	- Change of mindset in funders toward longer-term funding - Decentralization of power and resources - Focus on sustainable adaptation intervention
PASTORALISM - **Carrying capacity (?): depending on rainfall characteristics** - **Ecological sensitivity of the rangelands (including disease potential)** - **Constraints on movement** - **Generational disengagement** - **Large-scale land acquisition, appropriation and marginalization**	- Holistic integrated management of rangeland to reduce water and pasture degradation/conflict - Increased livestock mobility - Improved rangeland governance and participation in decentralization - Empowerment of traditional governance structures - Facilitation of youth employment and pathways into pastoralism - Strengthened organization and empowerment of pastoral institutions (leading to a greater voice in macro-economic planning processes)

7.2 Key knowledge gaps

Despite a wealth of research and investigation reported in both academic and grey literatures for East Africa, we contend that deficiencies in knowledge on vulnerability and response to climate-related social-ecological risks remain wide and diverse. Many facets of these issues remain poorly explored. However, it is not just insufficient research across a wide thematic and geographical territory that is the problem. IDRC (2009) asserted that academic research to understand the implications of climate change has also generally failed to effectively link with local or national policy-making, such that it has not contributed to significantly enhancing the capacity of decision-makers, government personnel, resource managers, or vulnerable populations to understand climate change and act on that knowledge. An important consideration is that independent, critical *evidence* on the vulnerability of livelihoods in semi-arid areas, as well as the effectiveness of different adaptation measures is needed.

This section maps out some of the key knowledge gaps, as revealed both by the literature reviews and by the perspectives of stakeholders interviewed during the RDS phase.

- The production of good quality **climate data and its and effective dissemination** are concerns articulated by many analyses, as well as stakeholders from the region. Deficiencies include the lack of good quality and timely dissemination of data to the local level; the ineffective packaging, explanation and translation of climate information; and the lack of analysis of climate data to produce forecasts and scenarios, especially at the local level. Arguably, there is potential for these gaps to be filled by local people collecting data from community weather stations, and/or to pay more attention to local people's experiences and memories of weather patterns.
- Some stakeholders in the region reiterated that there is very little or no credible research on the **impacts of climatic and environmental change** in arid and semi-arid areas, implying that there is little knowledge about the impacts on livelihoods of pastoralist groups in particular (see also the ASSAR RDS report on communication in this regard). Particular gaps surround, for example, the impacts on land use of the spread of invasive plants (IAS, and their potential management), the impact of climate variability and change on crop and livestock diseases, and the changes in environmental health conditions under situations of drought.
- Substantial research gaps exist around how to effectively **link climate change to development** that aims to reduce poverty and improve well-being. In particular, there is a greater information gap on vulnerability of and impacts on women, children, elderly and disabled people. There are also key gaps in terms of what shapes differential vulnerability, such as the influence of socially differentiated access to land and water resources, and how that helps define both relative vulnerability and adaptive capacity.
- Research focusing on future response in semi-arid lands in East Africa particularly has to try to understand the current **dynamics in the strategies and actions of pastoralists**, including changes in mobility patterns. This is a key part of a wider endeavor to understand the conditions for developing sustainable and equitable rangeland management and resolution of resource and land use conflicts.

- Important gaps relate to the ways in which risk response and adaption activities are **implemented and assessed**: how they are planned, measured, reported and verified. While many policies and initiatives refer to building resilience among communities in climate-sensitive areas, mechanisms to measure this in practice, both in terms of process and outcome, are underdeveloped. More attention to this area may shed light on which interventions are really improving resilience among communities, but also what the enablers and barriers are to doing so. There is a need to critically assess, for example, the potential for ecosystem based adaptation or the effectiveness of gender-focussed approaches.
- A further gap relates to the **appropriateness of blueprint response strategies** and technologies for particular ecological and cultural contexts. Many adaptation gaps surround the development of new climate-resilience crops, livestock breeds and infrastructure. Further areas for exploration here include the shelf life of adaptation options in the face of constantly changing climatic conditions, the potential for maladaptation (e.g. new irrigation schemes leading to new diseases, new livestock breeds requiring more fodder), and the potential for elite capture of projects designed to assist poor groups.
- Knowledge gaps exist in relation to the role and limitations of livelihood-based adaptations. This includes how strategies for livelihood diversification can be better integrated into market opportunities, and how access to crop or livestock insurance can be fostered.
- Documenting the potential of **local and 'indigenous' knowledge** to enhance capacity is frequently mentioned, yet appears to be under-researched in practice. While many developments around new technologies exist, there is also greater potential for pre-existing adaptive practices to be documented and tested in new contexts.
- Equally important is research on the **governance context of risk response and adaptation**, from local to international scales. That includes understanding the diversity and roles of local institutions, and the extent with which they can shape practices and decision-making. The degree to which national policies have been implemented in practice, and have been scaled down to local levels – such as in conjunction with processes of decentralisation - is also an area for further exploration. This additionally relates to the concern about how adaptation planning is pursued in very different ecological and cultural contexts (e.g. pastoralist areas), and how the different needs of these areas are framed and thus addressed.
- The key **drivers behind policy developments** and the shapes that they have taken are also worth fleshing out in greater depth. In particular, much of the institutional literature focuses on the nature of policies and (new or reworked) institutional arrangements in place, but pays less attention to the strategies and practices through which the policies are to be implemented in practice.
- Some literature and stakeholders acknowledge the role of **wider environmental and political economic changes** in climate-related risk and adaptation, such as the drive towards commercial agriculture, land privatization and transfers, social mobility and rural-urban migration and regional conflicts, yet institutional responses to adaptation rarely consider the social and gendered implications of these. Specific wider processes that are of particular relevance to the East African region are the

implications of major developments such as the LAPSSET Corridor Project, the decentralization of governance systems, and the land use and settlement changes in pastoral populations.

- Underlying much of this identification of knowledge gaps is the fundamental need to approach the social dimensions of vulnerability and adaptation research in a critical manner. That means seeking to understand the likely **social trade-offs** that exist in responses to risk, whether endogenous or exogenous.

CHAPTER 8

References

References

Abbink, J., K. Askew, D. Feyissa Dori, E. Fratkin, E. Christina Gabbert, J. Galaty, S. LaTosky, J. Lydall, H. A. Mahmoud, J. Markakis, G. Schlee, I. Strecker and D. Turton (2014) 'Lands of the future: Transforming pastoral lands and livelihoods in eastern Afria', *Working Paper No. 154*, Max Planck Institute for Social Anthropology.

Abdo et al (2009) 'Assessment of climate change impacts on the hydrology of Gilgel Abay catchment in Lake Tana basin, Ethiopia', *Hydrological Processes* 23(26), 3661–3669.

Abebe, M.A. (2014) 'Climate change, gender inequality and migration in East Africa', *Washington Journal of Environmental Law and Policy* 4(1): 104-140.

Aberra, Y. (2012) 'Perceptions of climate change among members of the house of peoples' representatives, Ethiopia', *Journal of Risk Research* 15 (7): 771–785.

Abila, R.O. (2003) 'Fish trade and food security: Are they reconcilable in Lake Victoria?' Report of the Expert Consultation on International Fish Trade and Food Security, FAO Report No. 708, Food and Agriculture Organization, Rome. Available at: http://www.fao.org/docrep/006/y4961e/y4961e0d.htm

Adams, W. M. (1989). Dam construction and the degradation of floodplain forest on the Turkwel River, Kenya. *Land Degradation and Development*, *1*(3), 189-198.

Adams, W. M., and Hughes, F. M. (1986). The environmental effects of dam construction in tropical Africa: impacts and planning procedures. *Geoforum*, *17*(3), 403-410.

ADB (2013) At the Center of Africa's Transformation: Strategy for 2013-2022, African Development Bank Group, Abidjan.

Adimo, A., Njoroge, J., Claessens, L. and L. Wamocho (2012) 'Land use and climate change adaptation strategies in Kenya', *Mitigation and Adaptation Strategies for Global Change*, 17(2): 153-171.

AEA Group (2008) *Final report - Kenya: Climate screening and information exchange* (ED 05603, Issue 2). Available online: http://www.dewpoint.org.uk/Asset%20Library/DFID/Climate%20Risk%20Assessment%20Report%20-%20Kenya.pd

Ali, A. and Hobson, M. (2009) Social protection in pastoral areas, Overseas Development Institute, Humanitarian Policy Group, London.

Alila, P.O., Atieno, R. (2006) Agricultural Policy in Kenya: Issues and Processes, A paper for the Future Agricultures Consortium workshop, Institute of Development Studies, 20-22 March 2006, Available at: http://www.fao.org/fileadmin/user_upload/fsn/docs/Ag_policy_Kenya.pdf

Allison, E.H., A. L. Perry, M.C. Badjeck, W. Neil Adger, K. Brown, D. Conway, A. S. Halls, G. M. Pilling, J. D. Reynolds, N. L. Andrew and N. K. Dulvy (2009) 'Vulnerability of national economies to the impacts of climate change on fisheries', *Fish and Fisheries*, 10(2): 173-196.

Alterra (2010) Climate change in East Africa: Towards a methodological framework on adaptation and mitigation strategies of natural resources, Alterra. Wageningen.

Amsalu, A. and Adem, A. 2009. Assessment of climate change-induced hazards, impacts and responses in the Southern Lowlands of Ethiopia. Addis Ababa: Forum for Social Studies.

Aredo, D. (2010) 'The Iddir: An informal insurance arrangement in Ethiopia', *Savings and Development*, 1(XXXIV): 53-72.

ASARECA (2009) *Capacity Needs for Strengthening and Empowering Farmer Organisations in East and Central Africa*, Association for Strengthening Agricultural Research in Eastern and Central Africa, Entebbe, Uganda.

Awlachew, S.B., Erkossa, T. and Namara, R.E. (2010) Irrigation potential in Ethiopia: Constraints and opportunities for enhancing the system, Research Report, International Water Management Institute, Addis Ababa.

Awlachew, SB., Erkossa, T. and Namara, RE. 2010. Irrigation potential in Ethiopia: Constraints and opportunities for enhancing the system. Research Report, International Water Management Institute, Addis Ababa.

Awuor, C. (2009) 'Increasing drought in arid and semi-arid Kenya'. In: Ensor, J. and Berger, R. (eds.) *Understanding climate change adaptation: Lessons from community-based approaches*, Practical Action Publishing, Rugby, 101–114 pp.

Baguma, D., J. H. Hashim, S. M. Aljunid and W. Loiskandl (2013) 'Safe-water shortages, gender perspectives, and related challenges in developing countries: The case of Uganda', *Social Science & Medicine* 75(6): 1067-1077.

Barrett, CB., Reardon, T. and Webb, P. (2001) 'Nonfarm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications', *Food Policy* 26: 315–331.

Bernard, M., Ochieng Andrew Adwera, Kariuki Joan Kungu, Tonui Charles and Judi W. Wakhungu (2012) Case Study on Climate Compatible Development (CCD) in Agriculture for Food Security in Kenya, Climate and Development Knowledge Network. Available online: http://germanwatch.org/en/download/8349.pdf.

Berrang-Ford, L., K. Dingle, J. D. Ford, C. Lee, S. Lwasa, D. B. Namanya, J. Henderson, A. Llanos, C. Carcamo and V. Edge (2012) 'Vulnerability of indigenous health to climate change: A case study of Uganda's Batwa Pygmies', *Social Science & Medicine,* 75(6): 1067-1077.

Bewket, W. and Conway, D. (2007) 'A note on the temporal and spatial variability of rainfall in the drought-prone Amhara Region of Ethiopia', *International Journal of Climatology* 27: 1467–1477.

Bewket, W. and Sterk, G. (2005) 'Dynamics in land cover and its effect on stream flow in the Chemoga watershed, Blue Nile basin, Ethiopia, *Hydrological Processes* 19: 445-458.

Bezabih, M. and S. Di Falco (2012) 'Rainfall variability and food crop portfolio choice: evidence from Ethiopia', *Food Security* 4(4): 557-567.

Biazin, B. and Sterk, G. (2013) 'Drought vulnerability drives land-use and land cover changes in the Rift Valley dry lands of Ethiopia', *Agriculture, Ecosystems and Environment*, 164: 100–113.

Blench, R.M. (1998c) *Resource conflict in semi-arid Africa: An essay and an annotated bibliography*, ODI Research Study, Overseas Development Institute, London.

Block, P. and Strzepek, K. (2012) 'Power ahead: Meeting Ethiopia's energy needs under a changing climate', *Review of Development Economics*, 16(3): 476–488.

Boelee, E., Yohannes, M., Poda,. J., McCartney, M,. Cecchi, P., Kibret, S., Hagos, F. and Laamrani, H. (2013) 'Options for water storage and rainwater harvesting to improve health and resilience against climate change in Africa', *Regional Environmental Change*, 13: 509–519.

Bossio, D., Erkossa, T., Dile, Y., McCartney, M, Killiches, F. and and Hoff, H. (2012) 'Water implications of foreign direct investment in Ethiopia's agricultural sector', Water Alternatives 5(2): 223-242.

Broad K, Agrawala S. (2000) The Ethiopia food crisis-uses and limits of climate forecasts. *Science*, 289:1693–1694.

Brooks, S, Thompson J, Odame H, Kibaara B, Nderitu S, Karin F, Millstone E (2009) Environmental change and maize Innovation in Kenya: exploring pathways in and out of maize. STEPS Working Paper 36. STEPS Centre, Brighton

Brooks, S. (2014) 'Enabling adaptation? Lessons from the new Green Revolution in Malawi and Kenya', *Climate Change* 122(1-2): 15-26.

Brown, D.R., Dettmann, P., Rinaudo, T., Tefera, H. and Tofu, A. (2011) 'Poverty alleviation and environmental restoration using the clean development mechanism: A case study from Humbo, Ethiopia', *Environmental Management*, 48:322–333.

Brown, S. (2011) 'Sustainable adaptation: An oxymoron?', *Climate and Development* 3(1): 21-31.

Bryan, E., C. Ringler, B. Okoba, C. Roncoli, S. Silvestri and M. Herrero (2013) 'Adapting agriculture to climate change in Kenya: Household strategies and determinants', *Journal of Environmental Management* 114(0): 26-35.

Bryan, E., Deressa, T. T., Gbetibouo, G. A., Ringler, C. (2009) 'Adaptation to climate change in Ethiopia and South Africa: options and constraints', *Environmental Science & Policy* 12(4): 413-426.

Buontempo, C., Mathison, C., Jones, R., Williams, K., Wang, C. and McSweeney, C. 2014. An ensemble climate projection for Africa. *Climate dynamics*.

Butt, B. and Turner, M. (2012) "Clarifying Competition: The Case of Wildlife and Pastoral Livestock in East Africa." *Pastoralism: Research, Policy, Practice* **2**(9).

CARE ALP (2013) Climate change Vulnerability and Adaptive Capacityin Garissa County, Kenya, CARE Adaptation Learning Programme, Care International. Available online: http://www.careclimatechange.org/files/CVCA_Kenya_Report__Final.pdf

Caretta, M.A. (2014) 'Credit plus' microcredit schemes: a key to women's adaptive capacity, *Climate and Development* 6(2): 179-184.

Carius, A (2009) Climate Change and Security in Africa: Challenges and International Policy Context. UN Office of the Special Adviser on Africa, Berlin, December.

Catley, A, Lind J, and Scoones I, eds. (2013) *Pastoralism and Development in Africa: Dynamic Change at the Margins*, Routledge and Earthscan. London, 295 pp.

CCAFS (n/d) Developing a Climate Change, Agriculture and Food security Research Agenda for East Africa: Identifying Research Needs and Priorities: Emerging Issues from Regional Engagements and Studies in East Africa, Climate Change, Agriculture and Food Security (CCAFS) East Africa regional programme.

CDKN (2012) Agriculture, Food Security and Climate Compatible Development – Case Studies: Synthesis Paper, Climate and Development Knowledge Network, London.

Chaudhury M, Vervoort J, Kristjanson P, Ericksen P, Ainslie A (2013) Participatory scenarios as a tool to link science and policy on food security under climate change in East Africa. *Reg Environ Change* 13(2):389–398.

Cherotich, KV., Saidu, O. and Bebe, BO. 2012. Access to climate change information and Support services by the vulnerable groups in semi-arid Kenya for adaptive capacity. African Crop Science Journal 20: 169 – 180.

Christensen, J.H., Hewitson, B. et al, 2007, Regional climate projections, in: Climate Change: The physical science basis, contribution of working group I to the fourth assessment report of the IPCC, edited by Solomon S. et al, Cambridge University Press, Cambridge, UK and New York, NY, USA.

Christy, JR., Norries, WB. And McNider, RT. 2009. Surface temperature variation in East Africa and possible causes. *Journal of Climate* 22: 3342-3356.

Claessens, L., J. M. Antle, J. J. Stoorvogel, R. O. Valdivia, P. K. Thornton and M. Herrero (2012) 'A method for evaluating climate change adaptation strategies for small-scale farmers using survey, experimental and modeled data', *Agricultural Systems* 111(0): 85-95.

Clemens, M.A. and Ogden, T. (2014) 'Migration as a strategy for household finance: A research agenda on remittances, payment and development, Centre for Global Development Working Paper No. 354, NYU Wagner Research Paper No. 2457148, Social Science Research Network.

COBRA (2014) Disaster risk reduction action plan – Karamoja, CoBRA (Community Based Resilience Assessment) Report, UNDP Drylands Development Centre.

Conway, D. (2005) From headwater tributaries to international river: Observing and adapting to climate variability and change in the Nile basin. *Global Environmental Change* 15: 99–114.

Conway, D. (2011) 'Adapting climate research for development in Africa', *Wiley Interdisciplinary Reviews: Climate Change* 2(3): 428-450.

Conway, D., E. Allison, R. Felstead and M. Goulden (2005) 'Rainfall variability in East Africa: implications for natural resources management and livelihoods', *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 363(1826): 49-54.

Conway, D., Schipper ELF (2011) 'Adaptation to climate change in Africa: Challenges and opportunities identified from Ethiopia', *Global Environmental Change* 21: 227-237.

Cross, K., Rossing, T., and Oliver, S. (2011) Assessing Climate Change Vulnerability in East Africa: A case study on the use of CARE's Climate Change Vulnerability and Capacity Assessment (CVCA) Methodology within the Global Water Initiative East Africa Program, CARE International Adaptation Learning Programme.

CSA (2011) *Ethiopia Demographic and Household Survey*, Central Statistics Agency, Available at: http://dhsprogram.com/pubs/pdf/FR255/FR255.pdf

Daron, J.D. (2014) “Regional Climate Messages: East Africa”. Scientific Report from the CARIAA- Adaptation at Scale in Semi-Arid Regions (ASSAR) Project, December 2014.

Davidson O., Halsnaes K., Huq S., Kok M., Metz B., Sokona Y. and Verhagen, J. (2003) ‘The development and climate nexus: the case of sub-Saharan Africa’, *Climate Policy* 3(1): 97-113.

Degefu, M. A., Asfaw, B. (2006) Flood hazard assessment in the Ghibe-Omo basin: The case of 2006. Climate Change and Environmental Degradation, Report on the 2006 Flood Disaster in Ethiopia. Forum for Environment, Ethiopia between the Sharp Scissors: Ensermu Kelbesa (Ed.).

Degefu, M.A. and Bewket, W. (2014) ‘Trends and spatial patterns of drought incidence in the Omo-Ghibe river basin, Ethiopia’ *Geografiska Annaler: Series A*, *Physical Geography.*

Demeke, A.B., Keil, A. and Zeller, M. (2011) ‘Using panel data to estimate the effect of rainfall shocks on smallholders food security and vulnerability in rural Ethiopia’, *Climate Change*, 108: 185–206.

Deressa, T.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: 248–255.

Desta, S. (2006) ‘Pastoralism and development in Ethiopia’, *Economic Focus*. 9(3): 12-20.

Devereux, S. (2009) ‘Why does famine persist in Africa?’ *Food Security* 1:25-35.

Devereux, S., and Scoones, I. (2008). The crisis of pastoralism? A response Discussion Paper 003. Brighton, UK: Future Agricultures Consortium.

DFID (2009) *Climate Change Facts – Ethiopia*, Department for International Development, London.

Di Falco, S., Yesuf, M., Kohlin, G. and Ringler, C. (2012) ‘Estimating the impact of climate change on agriculture in low-income countries: Household level evidence from the Nile Basin, Ethiopia’, *Environmental Resource and Economics*, 52: 457–478.

Dile et al (2013) Hydrological Response to Climate Change for Gilgel Abay River, in the Lake Tana Basin - Upper Blue Nile Basin of Ethiopia. *Plos One* **8**(10), e7929.

Dinku, T. 2011. Climate Risk Management and Data Needs for Agriculture in Ethiopia. In the Proceedings of Strengthening Capacity for Climate Change Adaptation in the Agriculture Sector in Ethiopia. National Workshop held in Nazreth, Ethiopia 5-6 July 2010.

Dinku, T., Block, P., Sharoff, J., Hailemariam, K., Osgood, D., del Corral, J., Cousin, R. and M.C. Thomason (2014) ‘Bridging critical gaps in climate services and applications in Africa’ *Earth Perspectives* 2014, **1**:15.

Dinku, T., Connor, S.J., Ceccato, P. and Ropelewski, C.F. (2008) ‘Intercomparison of global gridded rainfall products over complex terrain in Africa’, *International Journal of Climatology*, 28: 1627–1638.

Doocy, S., Russell, E., Gorokhovich, Y., Kirsch, T. (2013) ‘Disaster preparedness and humanitarian response in flood and landslide-affected communities in Eastern Uganda’, *Disaster Prevention and Management* 22(4): 326-339.

Droogers, P. (2009) Climate Change and Hydropower, Impact and Adaptation Costs: Case Study Kenya, Future Water Report 87. Available online: http://www.futurewater.nl/downloads/2009_Droogers_FW85.pdf

EAC (2006a) Agriculture and rural development policy for the East African Community, Arusha, Tanzania.

EAC (2006b) Agriculture and rural development strategy for the East African Community 2005-2030, East Africa Community Secretariat, Arusha, Tanzania.

EAC (2011) *EAC Development Strategy 2011/12-2015/16*, East African Community, Arusha, Tanzania.

Eaton, D. (2010) 'The rise of the 'traider': the commercialization of raiding in Karamoja', *Nomadic Peoples*, 14(2): 106-122.

Edossa, DC., Awulachew, SB., Namara, RE., Babel, MS. and Gupta, AD. 2007. Indigenous systems of conflict resolution in Oromia, Ethiopia. Community-based Water Law and Water Resource Management Reform in Developing Countries (eds B. van Koppen, M. Giordano and J. Butterworth). CAB International 2007.

Egeru, A. (2012) 'Role of indigenous knowledge in climate change adaptation: a case study of the Teso sub-region, Eastern Uganda', *Indian Journal of Traditional Knowledge* 11(2): 217-224.

Elmi, M., and Birch, I. (2013) Creating policy space for pastoralism in Kenya, IDS Working Paper No. 68, Future Agricultures.

Endris, HS., Omondi, P., Jain, S., Lennard, C., Hewitson, B., Chang'a, L., Awange, JL., Dosio, Patrick Ketiem, A., Nikulin, G., Panitz, H., Büchner, M., Stordal, F, and Tazalika, L. 2013: Assessment of the performance of CORDEX regional climate models in simulating East African rainfall. *Journal of Climate* 26: 8453–8475.

Eriksen, S. and J. Lind (2009) 'Adaptation as a Political Process: Adjusting to Drought and Conflict in Kenya's Drylands', *Environmental Management* 43(5): 817-835.

Eriksen, S. H. and K. O'Brien (2007) 'Vulnerability, poverty and the need for sustainable adaptation measures', *Climate Policy* 7(4): 337-352.

Eriksen, S. H., K. Brown and P. M. Kelly (2005) 'The Dynamics of Vulnerability: Locating Coping Strategies in Kenya and Tanzania', *The Geographical Journal* 171(4): 287-305.

FAO (2003) *TERRASTAT – Land resource potential and constraints statistics at country and regional level*, FAO Land Water Division (FAO/AGL), Rome, Italy. Available at: http://www.fao.org/ag/agl/agll/terrastat)

FAO (2006) *State of food insecurity in the world*, Food and Agriculture Organisation, Rome, Italy.

FAO (2013) Resilient Livelihoods: Disaster Risk Reduction for Food and Nutrition Security, Food and Agriculture Organisation, Rome, Italy.

Farley, C. and Farmer, A. (2013) Uganda Climate Change vulnerability assessment report, USAID, African and Latin American Resilience to Climate Change Project. Available online: http://community.eldis.org/.5b9bfce3/ARCC-Uganda%20VA-Report.pdf

Farrow, A., Musoni, D., Cook, S., Buruchara, R. (2011) 'Assessing the risk of root rots in common beans in East Africa using simulated estimated and observed daily rainfall data', *Expl Agric.* 47(2): 357-373.

FDRE (2010) *Growth and Transformation Plan (GTP) 2010/11-2014/15 (Draft)*, Federal Democratic Republic of Ethiopia, Addis Ababa.

FDRE (2011) *Ethiopia's climate-resilient green economy: Green economy strategy*, Federal Democratic Republic of Ethiopia, Addis Ababa.

FDRE (Federal Democratic Republic of Ethiopia). 2004. *Productive Safety Net Programme: Programme Implementation Manual*. Addis Ababa: Ministry of Agriculture and Rural Development.

Few, R. (2007) Health and climatic hazards: framing social research on vulnerability, response and adaptation. *Global Environmental Change* 17, 281-295.

Figueiredo, P. and Perkins, P.E. (2013) 'Women and water management in times of climate change: participatory and inclusive processes', *Journal of Cleaner Production* 60(0): 188-194.

Fleuret, P. (1985). The social organization of water control in the Taita Hills, Kenya. *American Ethnologist*, *12*(1), 103-118.

Fraser, E.D.G. (2007) 'Travelling in antique lands: using past famines to develop an adaptability/resilience framework to identify food systems vulnerable to climate change', *Climatic Change*, 83 (4): 495–514.

Fratkin (2014) Ethiopia's pastoralist policies: development, displacement and resettlement, *Nomadic Peoples*, 18:94-114.

Funk, C, Eilerts, G., Davenport, F., and Michaelsen, J. (2010) A climate trend analysis of Kenya – August 2010, United States Geological Survey. Available online: http://www.fews.net/docs/Publications/FEWS%20Kenya%20Climate%20Trend%20Analysis.pdf

Funk, C., Dettinger, M.D., Michaelsen, J.C., Verdin, J.P, Brown, M.E., Barlow, M. and Hoell, A. (2008) 'Warming of the Indian Ocean threatens eastern and southern African food security but could be mitigated by agricultural development', *PNAS – Proceedings of the National Academy of Science*, 105(32): 11081-11086.

Gabriellson, S. and Ramasar, V. (2013) 'Widows: agents of change in a climate of water uncertainty', *Journal of Cleaner Production* 60(0): 34-42.

Gachathi, F. N. and S. Eriksen (2011) 'Gums and resins: The potential for supporting sustainable adaptation in Kenya's drylands', *Climate and Development* 3(1): 59-70.

Gallopin, G.C. (2006) Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change* 16, 293-303.

Galvin, K.A. (2009) 'Transitions: Pastoralists Living with Change', *Annual Review of Anthropology* 38(1): 185-198.

Gathenya, M., H. Mwangi, R. Coe and J. Sang (2011) 'Climate- and land use- induced risks to watershed services in the Nyando River Basin, Kenya, *Experimental Agriculture* 47(Special Issue 02): 339-356.

Gebrehiwot, T. and van der Veen, A. (2013) 'Farm Level Adaptation to Climate Change: The Case of Farmer's in the Ethiopian Highlands', *Environmental Management* 52: 29–44.

Gebremichael, Y., Hadgu, K. and Ambaye, Z. (2005) Addressing pastoralist conflict in Ethiopia: The case of the Kuraz and Hamer sub-districts of South Omo zone. Research report to Great Lakes Regions and the Horn of Africa, pp. 1-46.

Gebresenbet, F. and Kefale, A. 2012. Traditional coping mechanisms for climate change of pastoralists in South Omo, Ethiopia. Indian Journal of Traditional Knowledge 11: 573-579.

GoK (2010) *Kenya: Millennium Development Goals Report*, Government of Kenya, Nairobi.

GOU (2010), National Development Plan (2010/11 – 2014/15), Government of Uganda. Available online: http://opm.go.ug/assets/media/resources/30/National%20Development%20Plan%202010:11%20-%202014:15.pdf

GoU (2012) Uganda Climate Change Vulnerability Assessment Report, Government of Uganda Ministerial policy statement for water 2012/13, Kampala.

Goulden, M. C., W. N. Adger, E. H. Allison and D. Conway (2013) 'Limits to Resilience from Livelihood Diversification and Social Capital in Lake Social-Ecological Systems', *Annals of the Association of American Geographers* 103(4): 906-924.

Goulden, M., Few, R., Abebe, L., Brooks, N., Daoud, M., Konaté, M.K., Sarney, E., Smith, D., Umoh, B.,Vernon, P., Weiner, J. and Yamba,B. (2011) 'Climate change, water and conflict in the Niger River Basin', International Alert, London and University of East Anglia, Norwich, UK.

Gray, C. and Mueller, V. (2012) 'Drought and population mobility in rural Ethiopia', *World Development*, 40 (1): 134–145.

Gunasekara, N. K., S. Kazama, D. Yamazaki and T. Oki (2013) 'The effects of country-level population policy for enhancing adaptation to climate change', *Hydrol. Earth Syst. Sci.* 17(11): 4429-4440.

Haile, AT., Kusters, K. and Wagesho, N. 2013. Loss and damage from flooding in the Gambela region, Ethiopia. International Journal of Global Warming 5 (4): 483–497.

Hansen, J.W., Mason, S.J., Sun, L. and Tall, A. (2011) 'Review of seasonal climate forecasting for agriculture in sub-Saharan Africa, *Experimental Agriculture* 47(2): 205-240.

Hansen, JW and Indeje, M. (2004) Linking dynamic seasonal climate forecasts with crop simulation for maize yield prediction in semi-arid Kenya, *Agricultural and Forest Meteorology*, 2004.

Haselio, J, Mugabe, J, Baudoin, A. (2013) Africa-EU Research Collaboration on Climate Change, Food Security and Water Linkages: An Overview of Emerging Issues and Potential Research Priorities, CASST-NET Plus.

Headey, D., Taffesse, AS, You, L, 2014, Diversification and Development in Pastoralist Ethiopia. World Development, 56: 200–213.

Heath, T. T., A. H. Parker and E. K. Weatherhead (2012) 'Testing a rapid climate change adaptation assessment for water and sanitation providers in informal settlements in three cities in sub-Saharan Africa', *Environment and Urbanization* 24(2): 619-637.

Hepworth, N. and Goulden, M. (2008) Climate Change in Uganda: Understanding the implications and appraising the response, LTS International, Edinburgh.

Hess, C and Pattison J, 2013, Ensuring devolution supports adaptation and climate resilient growth in Kenya, IIED Briefing June 2013, Accessed Online http://pubs.iied.org/pdfs/17161IIED.pdf

Hisali, E., P. Birungi and F. Buyinza (2011) 'Adaptation to climate change in Uganda: Evidence from micro level data', *Global Environmental Change* 21(4): 1245-1261.

Homann, S., Rischkowsky, B., Steinbach, J. and Kirk, M. (2005) 'Towards endogenous development: Borana pastoralists' response to environmental and institutional changes', Conference on International Agricultural Research for Development, Stuttgart-Hohenheim, October 11-13, 2005.

Homewood, K., Kristjanson, P. and Trench, P.C. (2009) Staying Maasai? Livelihoods, Conservation and Development in East African Rangelands, Springer, New York.

Hove, H., Ecevarria, D., Parry, J. (2011a) *Review of Current and Planned Adaptation Action: East Africa – Somalia*, International Institute for Sustainable Development, Ottawa.

Hove, H., Ecevarria, D., Parry, J. (2011b) Review of Current and Planned Adaptation Action: East Africa – Uganda, IISD, Ottawa.

Hove, H., Ecevarria, D., Parry, J. (2011c) Review of Current and Planned Adaptation Action: East Africa – Ethiopia, ISSD, Ottawa.

Hove, H., Ecevarria, D., Parry, J. (2011d) Review of Current and Planned Adaptation Action: East Africa – Kenya, IISD, Ottawa.

Huq, S., F. Yamin, A. Rahman, A. Chatterjee, X. Yang, S. Wade, V. Orindi and J. Chigwada (2005) 'Linking Climate Adaptation and Development: A Synthesis of Six Case Studies from Asia and Africa', *IDS Bulletin* 36(4): 117-122.

IBRD/WB (2010) Economics of Adaptation to Climate Change: Synthesis report, IBRD/ World Bank, Washington DC.

IDRC (2009) Innovating for Development: Strategic Framework 2010-2015, IDRC, Canada.

IDRC (2012) AfricaInteract - Enabling Research to Policy Dialogue for Adaptation to Climate Change in Africa: East Africa Region Sensitization Workshop Report, IDRC, Canada.

Ifejika Speranza, C. (2013) 'Buffer capacity: capturing a dimension of resilience to climate change in African smallholder agriculture', *Regional Environmental Change* 13(3): 521-535.

IPCC (2007) *Climate Change 2007 Fourth Assessment Report*, Intergovernmental Panel on Climate Change.

IPCC (2014) Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IUCN/SSC/ISSG (2000). IUCN Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive Species. IUCN – the World Conservation Union Species Survival Commission, Invasive Species Specialist Group. http://www.iucn.org/themes/ssc/publications/policy/invasivesEng.htm

Jack, W. and Suri, T. (2014) 'Risk sharing and transacation costs: Evidence from Kenya's mobile money revolution', *American Economic Review*, 104(1): 183-223.

James, P.A.S. (2010) 'Using Farmers' Preferences to Assess Development Policy: A Case Study of Uganda', *Development Policy Review* 28(3): 359-378.

Jeuland, M. and Whittington, D. 2014. Water resources planning under climate change: Assessing the robustness of real options for the Blue Nile. Water Resource Research 50: 2086–2107.

Joto Afrika 14 (2014) Joto Afrika: Adapting to Climate Change in Africa, Issue 14 (special issue), July 2014.

Kabubo-Mariara, J. (2008) 'Climate change adaptation and livestock activity choices in Kenya: An economic analysis', *Natural Resources Forum* 32(2): 131-141.

Kabubo-Mariara, J. (2009) 'Global warming and livestock husbandry in Kenya: Impacts and adaptations', *Ecological Economics* 68(7): 1915-1924.

Kaimba, G.K. Bernard, K.N. and Guliye, A.Y. (2011) Effects of cattle rustling and household characteristics on migration decisions and herd size amongst pastoralists in Baringo District, Kenya, *Pastoralism: Research, Policy and Practice*, 1:18.

Kamau, J.W. and Mwaura, F. (2013) 'Climate change adaptation and EIA studies in Kenya', *International Journal of Climate Change Strategies and Management* 5(2): 152-165.

Kansiime, M.K. (2012) 'Community-based adaptation for improved rural livelihoods: a case in eastern Uganda', *Climate and Development* 4(4): 275-287.

Kato, E., Ringler, C., Yesuf, M. and Bryan, E. (2011) Soil and water conservation technologies: a buffer againstproduction risk in the face of climate change? Insights from the Nile basin in Ethiopia. *Agricultural Economics* 42: 593–604.

Kirui, V., Oseni, S. and Bebe, O. 2010. Evaluating accessibility and usability of dissemination pathways for delivering climate information and services to vulnerable groups in semi-arid Kenya. Research Application Summary. Second RUFORUM Biennial Meeting 20 - 24 September 2010, Entebbe, Uganda.

Kitha, J. and A. Lyth (2011) 'Urban wildscapes and green spaces in Mombasa and their potential contribution to climate change adaptation and mitigation', *Environment and Urbanization* 23(1): 251-265.

Kithiia, J. (2011) 'Climate change risk responses in East African cities: need, barriers and opportunities', *Current Opinion in Environmental Sustainability* 3(3): 176-180.

Kithiia, J. and R. Dowling (2010) 'An integrated city-level planning process to address the impacts of climate change in Kenya: The case of Mombasa', *Cities* 27(6): 466-475.

KNBS (2009) *The 2009 Kenya Population and Housing Census*, Kenya National Bureau of Statistics, Nairobi.

Kostandini, G., R. La Rovere and T. Abdoulaye (2013) 'Potential impacts of increasing average yields and reducing maize yield variability in Africa', *Food Policy* 43(0): 213-226.

Kristjanson, P., Neufeldt, H., Gassner, A., Mango, J., Kyazze, F., Desta, S., Sayula, G., Thiede, B., Forch, W., Thornton, P., Coe, R. (2012) 'Are food insecure smallholder households making changes in their farming practices? Evidence from East Africa', *Food Security* 4(3): 381-397.

Kruska, R.L., Reid, R.S., Thornton, P.K., Henninger, N., Kristjanson, P.M. (2003) 'Mapping livestock-orientated agricultural production systems for the developing world', *Agricultural Systems*, 77: 39–63.

Kumamoto, M. and Mills, A. (2012) 'What African countries perceive to be adaptation priorities: results from 20 countries in the Africa Adaptation Programme', *Climate and Development* 4(4): 265-274.

Lasage, R., Aerts, J. C. J. H., Mutiso, G. C., and De Vries, A. (2008). Potential for community based adaptation to droughts: Sand dams in Kitui, Kenya.*Physics and Chemistry of the Earth, Parts A/B/C*, *33*(1), 67-73.

Leach, M., Mearns, R. and Scoones, I. (1999) Environmental entitlements: dynamics and institutions in community-based natural resource management. World Development 27(2), 225-247.

Leary, N., Kulkarni, J., Seipt, C. (2007) *Assessment of Impacts and Adaptation to Climate Change*, International START Secretariat, Washington DC.

Leclerc, C., C. Mwongera, P. Camberlin and V. Moron (2014) 'Cropping System Dynamics, Climate Variability, and Seed Losses among East African Smallholder Farmers: A Retrospective Survey', *Weather, Climate, and Society* 6(3): 354-370.

Little, P. (2012). Reflections on the future of pastoralism in the Horn of Africa. In A. Catley, J. Lind, and I. Scoones (Eds.), Pastoralism and development in Africa: Dynamic change at the margins. London, UK: Routledge.

Liu, J., S. Fritz, C. F. A. van Wesenbeeck, M. Fuchs, L. You, M. Obersteiner and H. Yang (2008) 'A spatially explicit assessment of current and future hotspots of hunger in Sub-Saharan Africa in the context of global change', *Global and Planetary Change* 64(3-4): 222-235.

Lopez-Marrero, T. and Tschakert, P. (2011) From theory to practice: building more resilient communities in flood-prone areas. Environment and Urbanization 23, 229-249.

Luseno, W. K., McPeak, J. G., Barret, C., Little, P. D. and Gebru, G. (2003). Assessing the value of climate forecast information for pastoralists: evidence from southern Ethiopia and northern Kenya. *World Development* 31: 1477–1494.

Lutz, W., Muttarak, R., Striessnig, E. (2014) 'Universal education is key to enhanced climate change adaptation', *Science* 346(6213): 1061-1062.

Lybbert, T. J., Barrett, C.,McPeak, J. G. and Luseno,W. K. (2007). Bayesian herders: asymmetric updating of rainfall beliefs in response to external forecasts. *World Development* 35: 480–497.

MA (2006). *Ecosystems and Human Well-being: Current State and Trends*.Volume 1. Millennium Ecosystem Assessment. Island Press, Washington http://www.millenniumassessment.org//en/products. global.condition.aspx

Maingi, J. K., and Marsh, S. E. (2002). Quantifying hydrologic impacts following dam construction along the Tana River, Kenya. *Journal of Arid Environments*,*50*(1), 53-79.

Mango, L. M., A. M. Melesse, M. E. McClain, D. Gann and S. G. Setegn (2011) 'Land use and climate change impacts on the hydrology of the upper Mara River Basin, Kenya: results of a modeling study to support better resource management', *Hydrol. Earth Syst. Sci.* 15(7): 2245-2258.

Manzano, P. (2014). Community Based Adaptation to climate change strengthens pastoralists' resilience. Editorial. Joto Afrika 14, p1.

Markakis, J. (1998) Resource Conflict in the Horn of Africa, Sage, London.

McCartney, MP. and Girma, MM (2012) 'Evaluating the downstream implications of planned water resource development in the Ethiopian portion of the Blue Nile River', *Water International* 37 (4): 362-379.

McGahey, D., Davies, J., Hagelberg, N. and Ouedraogo, R. (2014) Pastoralism and the green economy – a natural nexus? IUCN/UNEP, Nairobi.

McMichael, A., Campbell-Lendrum, D., Corvalan, C., Ebi, K., Githeko, A., Scheraga, J. and Woodward, A. (eds) (2003) Climate change and human health: risks and response. World Health Organization, Geneva.

McPeak, J., Little, P. D., and Doss, C. R. (2011). Risk and social change in an African rural economy: Livelihoods in pastoralist communities. New York: Routledge.

McSweeney, C., New, M. and Lizcano, G. (2009) *UNDP climate change country profile: Kenya*. Available online: http://ncsp.undp.org/sites/default/files/Kenya.oxford.report.pdf

Meikle, A, 2010, Africa Climate Change Resilience Alliance (ACCRA) Ethiopia Country Level Literature Review.

Mekasha, A., Tesfaye, K. and Duncan, A.J. (2014) 'Trends in daily observed temperature and precipitation extremes over three Ethiopian eco-environments', *International Journal of Climatology*, 34(6): 1990-1999.

Mengistu, D., Bewket, W. and Rattan, L. 2013. Recent spatio-temporal temperature and rainfall variability and trends over the upper Blue Nile River Basin, Ethiopia. *International Journal of Climatology.*

MENR (2002) First national communication of Kenya to the Conference of the Parties of the United Nations Framework Convention on Climate Change. National Environment Secretariat, Ministry of Environment and Natural Resources, Nairobi. Available online: http://unfccc.int/resource/docs/natc/kennc1.pdf

Merttens, F., Hurrell, A., Marzi, M., Attah, R., Farhat, M., Kardan, A. and MacAuslan, I. (2013) Kenya Hunger Safety Net Programme Monitoring and Evaluation Component: Impact Evaluation Final Report 2009-2012, Oxford Policy Management, Oxford.

Meze-Hausken E. Contrasting climate variability and meteorological drought with perceived drought and climate change in Northern Ethiopia. *Clim Res* 2004, 27:19–31.

Middleton, N., Stringer, L., Goudie, A. and Thomas, D. (2011) *The forgotten billion: Millennium Development Goals achievement in the drylands*, United Nations Development Programme, New York.

Mideksa, T. K. (2010) 'Economic and distributional impacts of climate change: The case of Ethiopia', *Global Environmental Change* 20(2): 278-286.

Mitchell, T. and Tanner, T. (2006) *Adapting to climate change: challenges and opportunities for the development community*, Institute of Development Studies and Tearfund, Sussex.

MoFED (2010) *Ethiopia: Millennium Development Goals Report - Trends and prospects for meeting MDGs by 2015*, Ministry of Finance and Economic Development, Federal Democratic Republic of Ethiopia, Addis Ababa.

MoFED (2012) Ethiopia's Progress Towards Eradicating Poverty: An Interim Report on Poverty Analysis Study (2010/11), Ministry of Finance and Economic Development, Government of Ethiopia, Addis Ababa.

Morton, J and Barton, D., 2002, Destocking as a drought mitigation measure: clarifying rationales and answering critiques, *Disasters,* 26, 3, 213-228.

Morton, J. and Kerven, C. (2013) *Livelihoods and basic service support in the drylands of the Horn of Africa* (Brief prepared by a Technical Consortium hosted by CGIAR in partnership with the FAO Investment Centre), Technical Consortium Brief 3, International Livestock Research Institute, Nairobi. https://cgspace.cgiar.org/bitstream/handle/10568/27615/tc_brief3.pdf?sequence=2

Mubiru, D. N., E. Komutunga, A. Agona, A. Apok and T. Ngara (2012) 'Characterising agrometeorological climate risks and uncertainties: Crop production in Uganda', *South African Journal of Science* 108(3/4): 108-118.

Munang, R. and J. N. Nkem (2014) 'Using Small-Scale Adaptation Actions to Address the Food Crisis in the Horn of Africa: Going beyond Food Aid and Cash Transfers', *Sustainability* 3(9): 1510-1516.

Mwongera, C., J. Boyard-Micheau, C. Baron and C. Leclerc (2014) 'Social Process of Adaptation to Environmental Changes: How Eastern African Societies Intervene between Crops and Climate', *Weather, Climate, and Society* 6(3): 341-353.

Nahamya, K.W. (2012) Social protection and the vulnerable poor: the role of social safety nets in poverty reduction in Uganda, PhD Thesis, Makerere University, Kampala.

Naimir-Fuller, M. (1999) *Managing mobility in African rangelands*, Intermediate Technology publications, London.

Naumann, G., P. Barbosa, L. Garrote, A. Iglesias and J. Vogt (2014) 'Exploring drought vulnerability in Africa: an indicator based analysis to be used in early warning systems', *Hydrol. Earth Syst. Sci.* 18(5): 1591-1604.

Ndiku, K. (2014) A corridor of opportunity? The LAPSSET project in local context. Available online: http://www.insightonconflict.org/2014/12/kenya-lapsset-conflict/

Ngugi, R. K. (2002). Climate forecast information: the status, needs and expectations among smallholder agropastoralists in Machakos District, Kenya, *IRI Technical Report 31*. Palisades, NY: IRI, Columbia Earth Institute, Columbia University.

Nikulin, G., Jones, C., Giorgi, F., Asrar, A., Büchner, M., Cerezo-Mota, R., Christensen, OB., Déqué, M., Fernandez, J., Hänsler, A., Meijgaard, EV., Samuelsson, P., Sylla, MB. and Sushama, L. 2012. Precipitation climatology in an ensemble of CORDEX-Africa regional climate simulations. *Journal of Climate* 25: 6057–6078.

NMA (2007) *Climate change national adaptation program of action (NAPA) of Ethiopia*, National Meteorological Agency, Ministry of Water Resources, Addis Ababa.

Norrington-Davies. G. and Thornton, N. (2011) Climate Change Financing and aid Effectiveness: Tanzanian Case Study, Agulhas. Available online: http://www.oecd.org/dac/environment-development/48458474.pdf

Notter, B., L. MacMillan, D. Viviroli, R. Weingartner and H.P. Liniger (2007) 'Impacts of environmental change on water resources in the Mt. Kenya region', *Journal of Hydrology* 343(3-4): 266-278.

Nyasimi, M, Radeny, M, Kinyangi, J. (2013) Climate Change Adaptation and Mitigation Initiatives for Agriculture in East Africa, CCAFS Working Paper N. 60, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Copenhagen, Denmark. Available online at: www.ccafs.cgiar.org

Odame, H. and Muange, E. (2011) Agro-dealers and the political economy of agricultural biotechnology policy in Kenya, Future Agriculture Consortium Working Paper 33. Available online: http://r4d.dfid.gov.uk/Output/190214/

ODI (2010) *Pastoralism demographics, settlement and service provision in the Horn and East Africa: Transformation and opportunities*, Regional Pastoral Livelihoods Advocacy Project (REGLAP), Humanitarian Policy Group, Overseas Development Institute, London.

Ogalleh, S., C. Vogl, J. Eitzinger and M. Hauser (2012) 'Local Perceptions and Responses to Climate Change and Variability: The Case of Laikipia District, Kenya', *Sustainability* 4(12): 3302-3325.

Okoba, B., A. A. Dejene and M. Mallo (2011) 'Climate Shocks, Perceptions and Coping Options in Semi-Arid Kenya', In: *Experiences of Climate Change Adaptation in Africa*. W. Leal Filho, Springer Berlin Heidelberg: 167-181.

Olago, D., M. Marshall, S. O. Wandiga, M. Opondo, P. Z. Yanda, R. Kanalawe, A. K. Githeko, T. Downs, A. Opere, R. Kavumvuli, E. Kirumira, L. Ogallo, P. Mugambi, E. Apindi, F. Githui, J. Kathuri, L. Olaka, R. Sigalla, R. Nanyunja, T. Baguma and P. Achola (2007) 'Climatic, socio-economic, and health factors affecting human vulnerability to cholera in the Lake Victoria basin, East Africa', *Ambio* 36(4): 350-358.

Olsen, K.H. (2006) 'National ownership in the implementation of global climate policy in Uganda', *Climate Policy* 5(6): 599-612.

Olsson, L. and A. Jerneck (2010) 'Farmers fighting climate change: from victims to agents in subsistence livelihoods', *Wiley Interdisciplinary Reviews: Climate Change* 1(3): 363-373.

Omolo, N.A. (2010) 'Gender and climate change-induced conflict in pastoral communities: case study of Turkana in northwestern Kenya', *African Journal on Conflict Resolution*, 10(2): 81-102.

Omondi, P.A. et al. (2014) 'Change in temperature and precipitation extremes over the greater Horn of Africa region from 1961 to 2010', *International Journal of Climatology,* 34: 1262-1277.

Omumbo, J.A., Lyon, B., Waweru, S.M., Connor, S.J. and Thomson, M.C. (2011) 'Raised temperatures over the Kericho tea estates: revisiting the climate in the East African highlands malaria debate', *Malaria Journal* **10**:12.

Opondo, D.O. (2013) 'Erosive coping after the 2011 floods in Kenya', *International Journal of Global Warming* 5(4): 452-466.

Orindi, V. A. and A. Ochieng (2005) 'Case Study 5: Kenya Seed Fairs as a Drought Recovery Strategy in Kenya', *IDS Bulletin* 36(4): 87-102.

Osano, P.M., Said, M.Y., de Leeuw, J., Moiko, S.S., Kaelo, D.O., Schomers, S., Birner, R. and Oguntu, J.O. (2013) 'Pastoralism and ecosystem-based adaptation in Kenya Masailand', *International Journal of Climate Change Strategies and Management* 5(2): 198-214.

Osbahr, H., P. Dorward, R. Stern and S. Cooper (2011) 'Supporting agricultural innovation in Uganda to respond to climate risk: linking climate change and variability with farmer perceptions', *Experimental Agriculture* 47(Special Issue 02): 293-316.

Owuor, B., S. Eriksen and W. Mauta (2005) 'Adapting to Climate Change in a Dryland Mountain Environment in Kenya', *Mountain Research and Development* 25(4): 310-315.

Owuor, B., W. Mauta and S. Eriksen (2011) 'Sustainable adaptation and human security: Interactions between pastoral and agropastoral groups in dryland Kenya', *Climate and Development* 3(1): 42-58.

Oxfam (2012) "A Dangerous Delay: The cost of late response to early warnings in the 2011 drought in the horn of Africa". Joint agency Briefing Paper. Oxfam and Save the Children. 18 January 2012. https://www.oxfam.org/sites/www.oxfam.org/files/file_attachments/story/bp-dangerous-delay-horn-africa-drought-180112-en_4.pdf)

Pacey, A., and Cullis, A. (1986). Rainwater harvesting: the collection of rainfall and runoff in rural areas. Intermediate technology publications.

Peterson, ND. 2012. Developing Climate Adaptation: The Intersection of Climate Research and Development Programmes in Index Insurance. *Development and Change* 43(2): 557–584.

Pretty, J. N., Thompson, J., and Kiara, J. K. (1995). Agricultural regeneration in Kenya: the catchment approach to soil and water conservation. *Ambio. Stockholm*, *24*(1), 7-15.

Pringle, P. and D. Conway (2012) 'Voices from the frontline: the role of community-generated information in delivering climate adaptation and development objectives at project level', *Climate and Development* 4(2): 104-113.

Raleigh, C. and Kniveton, D. (2012) 'Come rain or shine: An analysis of conflict and climate variability in East Africa', *Journal* of *Peace Research,* 49(1): 51-64.

RAO, K. P. C., W. G. NDEGWA, K. KIZITO and A. OYOO (2011) 'CLIMATE VARIABILITY AND CHANGE: FARMER PERCEPTIONS AND UNDERSTANDING OF INTRA-SEASONAL VARIABILITY IN RAINFALL AND ASSOCIATED RISK IN SEMI-ARID KENYA', *Experimental Agriculture* 47(Special Issue 02): 267-291.

Reardon, T. 1997. Using Evidence of Household Income Diversification to Inform Study of the Rural Nonfarm Labor Market in Africa. World Development 25: 135-741.

Roba, G., 2014, Strengthening communal governance of rangeland in Northern Kenya, In Herrera, P.M., Davies, J and Manzano Baena, P. (eds) The governance of rangelands: collective action for sustainable pastoralism, Earthscan 298pp.

Robinson, S., D. Willenbockel and K. Strzepek (2012) 'A Dynamic General Equilibrium Analysis of Adaptation to Climate Change in Ethiopia', *Review of Development Economics* 16(3): 489-502.

RoK (2012) *Vision 2030*, Government of Republic of Kenya, Nairobi.

RoK (2013) *National Climate Change Action Plan*, Government of Republic of Kenya, Nairobi.

Roncoli, C., Barrack Okoba, Violet Gathaara, Jane Ngugi, and Teresiah Nganga (2010) Adaptation to Climate Change for Smallholder Agriculture in Kenya: Community-Based Perspectives from Five Districts. Available online: http://www.africa-adapt.net/media/resources/410/Roncoli_report_FINAL.pdf

Rovin, K., K. Hardee and A. Kidanu (2013) 'Linking population, fertility, and family planning with adaptation to climate change: perspectives from Ethiopia', *African Journal Of Reproductive Health* 17(3): 15-29.

Ruijs, A., de Bel, M., Kononen, M., Linderhof, V., Polman, N. (2011) Adapting to Climate Variability:Learning from past experience and the role of institutions, *World Bank Social Development Working Papers no. 124*, World Bank, Washington DC.

Salami, A., Kamara, A.B., Brixiora, Z. (2010) Smallholder agriculture in East Africa: Trends, constraints and opportunities, African Development Bank Group Working Paper Series No. 105, African Development Bank, Abidjan.

Schilderinck, G. (2009) Drought cycle management in arid and semi-arid Kenya: a relevant disaster risk reduction model? An empirical study of Garissa, Marsabit, Samburu and Wajir. Catholic Organisation for Relief and Development Aid.

Schilling, J., Opiyo, F.E.O. and Scheffran, J. (2012) 'Raiding pastoral livelihoods: motives and effects of violent conflict in north-western Kenya, *Pastoralism: Research, Policy and Practice*, 2:25.

Scoones I, Thompson J (2011) The politics of seed in Africa's green revolution: alternative narratives and competing pathways. *IDS Bulletin*, 42:1–23.

SEI (2009) Economics of climate change in Kenya, Stockholm Environment Institute. Available online: http://www.sei-international.org/mediamanager/documents/Publications/Climate-mitigation-adaptation/kenya-climatechange.pdf

Seitz, J. and Nyangena, W. (2009) Economic Impact of Climate Change in the East African Community, Global 21 Consulting and GIZ. Available online: http://www.global21.eu/download/Economic_Impact_Climate_Change_EAC.pdf

Seleshi, Y. and Camberlin, P. 2006. Recent changes in dry spell and extreme rainfall events in Ethiopia. *Theoretical and Applied Climatology* 83: 181–192.

Seleshi, Y. and Zanke, U. 2004. Recent changes in rainfall and rainy days in Ethiopia. *International Journal of Climatology* 24: 973–983.

Seré, C., and Steinfeld, H. (1996) World Livestock Production Systems: Current Status, Issues and Trends, FAO Animal Production and Health Paper No. 127, Food and Agriculture Organization of the United Nations, Rome, Italy.

Settele, J., R. Scholes, R. Betts, S. Bunn, P. Leadley, D. Nepstad, J.T. Overpeck, and M.A. Taboada, 2014: 'Terrestrial and inland water systems'. In Field et al (eds) Climate Change 2014: Impacts,Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 271-359.

Shames, S. (2012) National policy for climate smart agriculture, *Policy Focus*, November 2012.

Sharkey, C. (2011) Climate Change, Climate Action, Climate Justice, Trocaire.

SID (2012) State of East Africa Report - Deepening integration, intensifying challenges, Society for International Development, Washington DC.

Silvestri, S., E. Bryan, C. Ringler, M. Herrero and B. Okoba (2012) 'Climate change perception and adaptation of agro-pastoral communities in Kenya', *Regional Environmental Change* 12(4): 791-802.

Simane, B., B. F. Zaitchik and D. Mesfin (2012) 'Building climate resilience in the Blue Nile/Abay Highlands: a framework for action', *International Journal Of Environmental Research And Public Health* 9(2): 610-631.

Simane, B., B. Zaitchik and M. Ozdogan (2013) 'Agroecosystem Analysis of the Choke Mountain Watersheds, Ethiopia', Sustainability 5(2): 592-616.

Slegers, M.F.W. and Stroosnijder, L. (2008) 'Beyond the Desertification Narrative: A Framework for Agricultural Drought in Semi-arid East Africa', *Ambio,* 37(5): 372-380.

Smith, K.R., A.Woodward, D. Campbell-Lendrum, D.D. Chadee, Y. Honda, Q. Liu, J.M. Olwoch, B. Revich, and R. Sauerborn, 2014: Human health: impacts, adaptation, and co-benefits. In Field et al (eds) Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 709-754.

Smucker, T.A. and Wisner, B. (2008) Changing household responses to drought in Tharaka, Kenya: vulnerability, persistence and challenge. *Disasters* 32 (2), pp. 190-215.

Speranza, C. I. (2010) 'Drought coping and adaptation strategies: Understanding adaptations to climate change in agro-pastoral livestock production in Makueni district, Kenya, *European Journal of Development Research* 22: 623-642.

Speranza, C.I. (2013) 'Buffer capacity: capturing a dimension of resilience to climate change in African smallholder agriculture, *Reg Environ Change* 13:521-535.

Stathers, T., R. Lamboll and B. Mvumi, 2013, Postharvest agriculture in changing climates: its importance to African smallholder farmers, Food Security, 5 (3), 361-392.

Suarez, P. and Patt, A. (2004). Caution, cognition, and credibility: the risks of climate forecast application. *Risk, Decision and Policy* 9: 75–89.

Suri (2003) 'Spillovers in village consumption: Testing the extent of partial insurance', Working Paper, Department of Economics, Yale University.

Tesfay, Y. and Tafere, K. (2004) Indigenous Rangeland resources and Conflict Management by the North Afar Pastoral Groups in Ethiopia A Pastoral Forum Organized by the Drylands Coordination Group (DCG) in Ethiopia, June 27-28, 2003, Mekelle, Ethiopia. Available online: http://www.eldis.org/vfile/upload/1/document/0708/DOC17969.pdf

Tessema, W., P. M. Ingenbleek and H. M. van Trijp (2014) 'Pastoralism, sustainability, and marketing. A review', *Agronomy for Sustainable Development* 34(1): 75-92.

Tessema, Y. (2012) 'Ecological and Economic Dimensions of the Paradoxical Invasive Species-Prosopis juliflora and Policy Challenges in Ethiopia'. *Journal of Economics and Sustainable Development* 3(8): 62-70.

Thornton, P. K., P. G. Jones, G. Alagarswamy, J. Andresen and M. Herrero (2010) 'Adapting to climate change: Agricultural system and household impacts in East Africa', *Agricultural Systems* 103(2): 73-82.

Thornton, P., R. Boone, K. Galvin, S. BurnSilver, M. Waithaka, J. Kuyiah, S. Karanja, E. Gonzalez-Estrada and M. Herrero (2007) 'Coping Strategies in Livestock-dependent Households in East and Southern Africa: A Synthesis of Four Case Studies', *Human Ecology* 35(4): 461-476.

Tonia, A. et al (n.d.) Monitoring mechanisms of the social safety net programmes in Uganda. Available online: http://www.comcec.org/UserFiles/File/WorkingGroups/Poverty3/Presentations/4-4-Uganda.pdf

UBS (2002) *Uganda Population and Housing Census – Main Report*, Uganda Bureau of Statistics, Kampala.

UNDP (2011) Drought and potential conflict scenarios in northern Kenya and other arid lands: a situational report, UNDP, Nairobi.

UNDP (2014) Disaster risk reduction action plan – Karamoja, CoBRA (Community Based Resilience Assessment) Report, UNDP Drylands Development Centre.

UNDP (2014) *Ethiopia: Country Economic Brief*, United Nations Development Programme, Washington DC.

UNEP (2006) *Africa Environmental Outlook 2: Our Environment, our wealth*, United Nations Environment Programme, Nairobi.

UNEP (2011) Food security in the horn of Africa: the implications of a drier, hotter and more crowded future. Available online: http://na.unep.net/geas/getUNEPPageWithArticleIDScript.php?article_id=72

UNEP (2013) Africa Environment outlook 3: Our environment, our health - summary for policy makers, United Nations Environment Programme, Nairobi.

UNEP (2015). Building Resilience of Ecosystems for Adaptation. http://www.unep.org/climatechange/adaptation/EcosystemBasedAdaptation/tabid/29583/Default.aspx

UNISDR (2012) *Disaster Risk Reduction in Africa: Africa Informs Special Issue on Drought 2012*, United Nations International Strategy for Drought Reduction (UNISDR) Africa Office.

USAID (2012) *East Africa Regional Conflict and Instability Assessment – Final Report*, United States Agency for International Development, Washington DC. Available at: http://conflict.care2share.wikispaces.net/file/view/USAID+East+Africa+Conflict+Assessment+March2012.pdf

USAID (2013) *Uganda Climate Change Vulnerability Assessment Report*, United States Agency for International Development, Washington DC.

Varghese, S. (2007) *Water Crisis and Food Sovereignty from a Gender Perspective*. Institute for Agriculture and Trade Policy, Minneapolis. Available at: http://www.tradeobservatory.org/library.cfm?refID=97668

Vermeulen, S.J., Challinor, A.J., Thornton, P.K., Campbell, B.M., Eriyagama, N., Vervoort, J.M., Kinyangi, J., Jarvis, A., Laderach, P., Ramirez-Villegas, J., Nicklin, K.J., Hawkins, E. and Smith, D.R. (2013) 'Addressing uncertainty in adaptation planning for agriculture, PNAS, 110(21): 8357-8362.

Vervoort, J.M., A. Palazzo, D. Mason-D'Croz, P.J. Ericksen, P.K. Thornton, P. Kristjanson, W. Förch,M. Herrero, P. Havlik, C. Jost, and H. Rowlands (2013) The future of food security, environments and livelihoods in Eastern Africa: four socio-economic scenarios, CCAFS Working Paper no. 63, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Copenhagen, Denmark. Available online at: www.ccafs.cgiar.org

Wanyama, M., Mose, LO., Odendo, M., Okuro, JO., Owuor, G. and Mohammed, L. 2010. Determinants of income diversification strategies amongst rural households in maize based farming systems of Kenya. African Journal of Food Science 4(12): 754-763.

Washington-Ottombre, C. and Pijanowski, B.C. (2012) 'Rural organisations and adaptation to climate change and variability in rural Kenya, *Regional Environmental Change*, 13(3): 537-550.

Webber, H., T. Gaiser and F. Ewert (2014) 'What role can crop models play in supporting climate change adaptation decisions to enhance food security in Sub-Saharan Africa', *Agricultural Systems* 127(0): 161-177.

Weisser, F., M. Bollig, M. Doevenspeck and D. Muller-Mahn (2014) 'Translating the 'adaptation to climate change' paradigm: the politics of a travelling idea in Africa', *The Geographical Journal* 180(2): 111-119.

Weldegebriel, ZB. and Prowse M. (2013) Climate change adaptation in Ethiopia: To what extent does social protection influence livelihood diversification? *Development Policy Review* 31: 35-56.

Wisner, B., Blaikie, P., Cannon, T. and Davis, I. (2004) At risk: natural hazards, people's vulnerability and disasters. Routledge, London.

Witsenberg, K.M. and Adano, W.R. (2009) 'On rain and raids: Violent livestock raiding in Northern Kenya', *Civil Wars* 11(4): 514–538.

Worku F. F. Werner M. Wright N. van der Zaag P. and Demissie S. S. (2014) 'Flow regime change in an endorheic basin in southern Ethiopia', *Hydrol. Earth Syst. Sci.* 18: 3837-3853.

World Bank (2003) Land Policies for Growth and Poverty Reduction: A World Bank Policy Research Report, The World Bank, Washington DC.

World Bank (2006) Ethiopia: Managing water resources to maximize sustainable growth, World Bank, Washington DC.

World Bank (2013) Country profiles of Kenya, Uganda and Ethiopia. Available at: http://data.worldbank.org/

Zubrycki, K., Crawford, A., Hove, H., Parry, J. (2011) *Review of Current and Planned Adaptation Action: East Africa – Sudan*, IISD, Ottawa, Canada.