ANNUAL PROGRESS REPORT FROM THE INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE 2012

Project on "Climate-induced Vulnerability and Pastoralist Livestock Marketing Chains in Southern Ethiopia and Northestern Kenya (CHAINS)"

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Nairobi, Kenya and Atlanta, GA, USA

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Preface

This is the first year technical progress report from the new “Climate-Induced Vulnerability and Pastoralist Livestock Marketing Chains in southern Ethiopia and northeastern Kenya (CHAINS)” project, which is part of the Adapting Livestock Systems to Climate Change (LCC), Collaborative Research Support Program based at Colorado State University and supported by AID Grant No. EEM-A-00-10-0001. It represents the first twelve months of research activities of the International Livestock Research Institute (ILRI), one of the key partners of the CHAINS project. Other partners in Ethiopia include the Institute of Development Studies and Addis Ababa University, and in Kenya, include Pwani College/Kenyatta University. The CHAINS’ project objectives are to: (1) understand the ways in which climate variability and change affect livestock marketing chains in southern Ethiopia and northeastern Kenya; (2) assess which social groups (for example, low-income pastoralists and small- and large-scale traders) benefit the most from different market chains and climate risk scenarios; (3) examine the effects of increased market commercialization and climate variability on pastoral livelihoods and land use; and (4) recommend policy-based solutions to improve livestock markets and the benefits that low-income pastoralists and traders derive from them.

As part of the CHAINS project, IRLI focuses on the spatial and environmental parameters of pastoral livestock production systems. This technical progress reports on the initial contributions of IRLI in assessing how climate and land use information relates to market and movement decisions. This technical progress report details activities that IRLI took on in Ethiopia and Kenya during the first year of the CHAINS project. Rather than wait several months or even years until these materials are published in a formal format or journal, we are making the materials available in a field research report series with only light editing.

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Introduction

This is a technical progress report from the International Livestock Research Institute (ILRI) for the first year of the CHAIN project (1 November 2011 to 30th October 2012). It reports on the activities led by ILRI during this year. The five livestock markets towns of Dubuluk, Dida Hara, Haro Bakke and Dilo in Ethiopia and Moyale in Kenya/Ethiopia were chosen to conduct livestock market chain analysis and how these market chains relate to climate variability. ILRI is a participating institution in the above-mentioned project and a sub-awardee under the Emory University-led project. The project focuses on the role of livestock markets in pastoralists' climate risk management strategies. ILRI's contributions focus on the spatial and environmental parameters of pastoral livestock production systems. Pastoralists manage the considerable climatic variability inherent to dryland environments through moving their cattle to different grazing areas and water points. They also move their animals to and from markets. There is a fundamental challenge in balancing the movement of animals for water and forage with the need to be close to markets at key times in order to sell animals for good prices. Multiple factors are changing both pastoralist mobility patterns and engagement with markets. Animal diseases are also affected directly by climate variability as well as location and conditions of animals. This project seeks to better understand these changing dynamics and thus foster both better climate risk management and pastoralist engagement with markets, given that uncertainty over extreme climate events is likely to increase in the next couple of decades.

Project objectives:
1. Assess how climate information is used to make market and movement decisions.
2. Assess how livestock markets can benefit poor livestock keepers, including women
3. Demonstrate the importance of certain market chains
4. Build the capacity of CRD, AAU to train Ethiopian researchers and practitioners on pastoralist development

The principal research site is the Borana Zone in southern Ethiopia. A complementary site across the border was to be Garissa District, Kenya, but security considerations have required a switch to Marsabit and Moyale.

ILRI's contribution is largely to the first objective. The main activities for ILRI during the first year were to be as follows:

- Participate in research design for a household study to be started during August-October, 2012 via meetings and e-mail correspondences related to this study.
- Undertake field trips to the project's research sites.
- Administer a sub-contract with Pwani College (Kenya) research team. Dr. Hussein Mahmoud of Pwani is leading the trader survey in the Kenya locations.
- In collaboration with other members of the research team, help in designing appropriate questionnaires and participate in focus group and key informant interviews in Borana, Ethiopia.
- Collect meteorological and mapping data for Ethiopia and Kenyan sites and house them at ILRI/Addis campus.

- Gather and analyze secondary data and reports on land use, settlement, and vegetation using remote sensed sources (NDVI), products produced under the LEWS project, and other sources.

Progress to date:

The following activities have been accomplished in the first year:

- In 2012, ILRI recruited a research technician who provides support in data collection and literature reviews for the project.
- In June through September, consultations were held between team members in ILRI Nairobi and Addis Ababa. The contact person in ILRI Addis Ababa (Waktole) has been supportive in providing information from various sources in Ethiopia and also advising the research based on his personal experience. The team has shared and reviewed survey tools (Questionnaires) too. Similarly the ILRI Nairobi team has advised upon available data for Kenya.
- In October 2012, a consultative meeting was held between ILRI team and Dr. Little. A project review was done, taking into account the actual conditions on the ground in both Kenya and Ethiopia. This included a review of the project sites and objectives. Field visits for data collection in the proposed Kenyan sites were halted due to security concerns. Field visits for Ethiopia were required proper coordination with local people. Scheduling conflicts prevented Dr. Ericksen from joining field visits to Borana in the first year. However, plans are in place for the team from Nairobi to join Ethiopian counterparts to conduct surveys, participatory mapping and focus group discussions in the first part of 2013.
- The ILRI team has been running a separate project in the Borana Zone. Information collected from the field for this project has been shared with the LCC-CRSP project team and has proved very important. The data includes anthropogenic developments in the area which have modified and altered land use and land cover in the area.
- ILRI has conducted some preliminary analyses of land use and land cover around the study sites.
- Literature on previous research and reports on settlements, land degradation, rainfall, land use and land cover changes and population trends in the study sites has been conducted.
- In October 2012 the Kenya trader survey work was initiated by Dr. Mahmoud from Pwani University. Key markets for the surveys were identified and the questionnaire was tested.

Background

The Borana rangelands are located in southern Ethiopia and occupy about 95,000 km^2 of land area (Kamara et al. 2004) and are home to about 350,000 people and one million head of cattle, small ruminants, and camels (Coppock et al. 2007). The semi-arid rangeland annual rainfall ranges from 300 to 900 mm, with high spatial and temporal variability. Borana are the main ethnic group who depend on extensive livestock production – predominately keeping cattle and small numbers of small ruminants, camels and donkeys (Kamara et al. 2004). Livestock trading is a very important economic activity for the region. Livestock traders engage in different types of social networks to better confront the risks and uncertainties imposed by poor dissemination of market information, a weak market infrastructure, insecurity, and highly volatile livestock prices. The trade is conducted based on social networks that are highly personalized and individualized. In this study the five livestock markets towns of Dubuluk, Dida Hara, Haro Bakke and Dilo in Ethiopia and Moyale in Kenya were chosen to conduct livestock market chain analysis and how these market chains relate to climate variability.

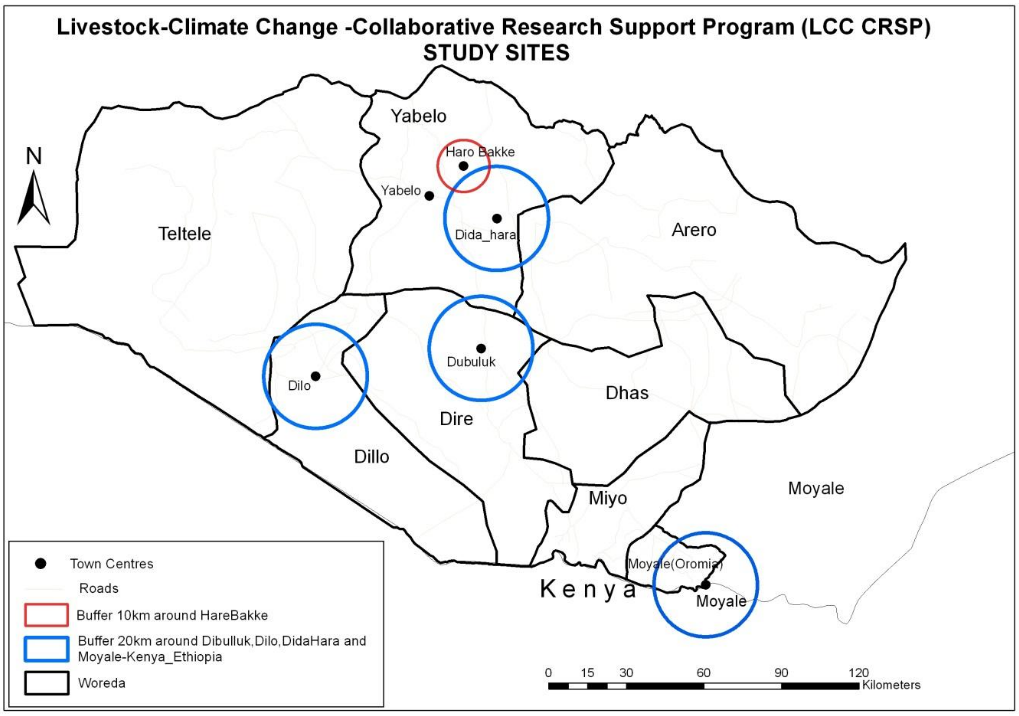


Figure 1a. Map showing project sites

The major factors that appear to have significant roles in cattle trading networks in the study area include socio-economic (wealth) status, age, and ethnicity of traders. Ethnic resources play a major role in entrepreneurial processes particularly where formal market structures are underdeveloped. Ethnic clusters, language capabilities and high cattle values facilitate elaborate networks, reducing transaction costs and creating a situation of market distortions and exclusions (Mahmoud 2001). In this report market centres are characterised by biophysical parameters such as rainfall, temperature, soil, land cover, population and social characteristics such as agricultural activities and management of enclosures. Further, detailed analysis on land cover was conducted that included description of land cover for each of the sites, trends in vegetation cover as measured by satellite over the last 3 decades, analysis of rainfall and temperature patterns of the sites in Kenya and Ethiopia. Included in this report is a discussion on livestock stocking rates, settlement patterns and fire use in managing the lands.

Characteristics of the project sites

Six variables were used to characterise the 5 main sites and ranged from altitude, rainfall, temperature, population density, soil and land cover (Table 1). Dida Hara, Dubuluk and Haro Bakke are located in high altitude areas of more than 1500 meters, both Dilo and Moyale are on low altitudes of less than 1000 meters and places were characterised by high maximum temperatures of over 30^{o}C.

In terms of rainfall Dilo and Moyale have the lowest rainfall at less than 600 mm of annual rainfall . Haro Bakke had the highest annual rainfall of about 900mm. Both Dida Hara and Dubuluk had annual rainfall exceeding 800 mm. Moyale has the largest area under agriculture compared to the other 4 sites and most of the agriculture is based on irrigation and also high population density. The population density in Moyale, Kenya is about 70 people per km^2 while the population densities in the 4 Ethiopian sites are between 9 to 12 people per km^2. The dominant soils in the study sites are mainly composed of chromic cambisols and luvisols. Luvisols are well-to-imperfectly drained mineral soils that have developed under deciduous forest, mixed deciduous-coniferous boreal forests, or under mixed forest in the forest-grassland transition zone. Cambisols in the arid (sub) tropics are found in young deposition areas but also in erosion areas where they form after genetically mature soils such as luvisols have eroded away. In terms of land cover Dida Hara is dominated by open shrubland, Dilo bushed shrubbed grassland, Dubuluk bushed shrubbed grassland, Haro Bakke wooded grassland and open shrubland, and Moyale open shrubland and cultivation.

Table 1: Characteristics of the sites based on biophysical and social indicators

Site	Altitude (m)	Rainfall (mm)	Temp (^{0}C)	Population Density (per km^2)	Soils	Land cover
Dida Hara	1560	800	26	11	Chromic cambisols and Chromic luvisols	Open shrubland
Dilo	970	570	30	9	Chromic cambisols and Lithic leptosols	Bushed shrubbed grassland
Dibuluk	1520	840	25	9	Chromic cambisols	Bushed shrubbed grassland
Haro Bakke	1610	900	26	12	Chromic Luvisols	Wooded grassland and open shrubland
Moyale	960	580	32	70	Gneiss, mignatite and Chromic luvisols	Open shrubland and cultivation

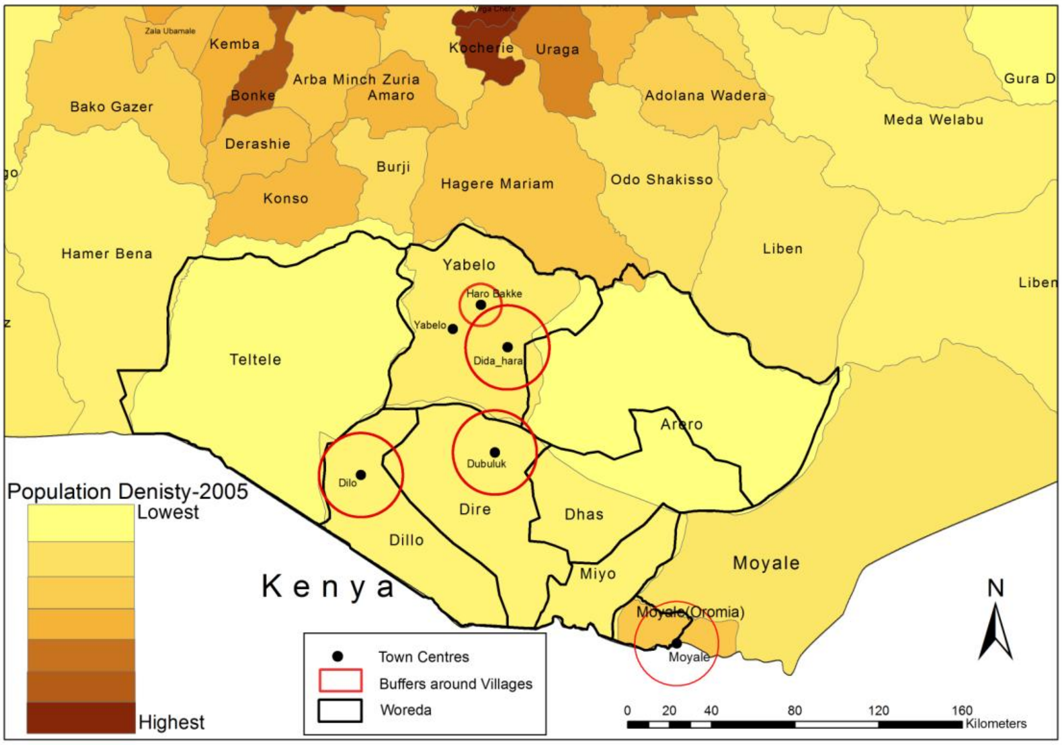


Figure 1b. Human population distribution

Detailed land cover description for the sites

The land cover description for the 5 market sites was based on interpretation of remotely sensed images (Figure 2). The data for Ethiopia sites was based on Farming in Tsetse Controlled Areas (FITCA) and for Moyale Kenya on Africover (FAO 2000). To generate the land cover for each site we clipped the vegetation based on the 20 and 10 km buffers. The vegetation was classified using 2 levels. The goal of vegetation classification is to facilitate consistent field description of vegetation communities and to convey an impression of the site in simple terms (Grunblatt et al. 1989). The 2 levels of the classification use cover area (open, dense and closed) to indicate the canopy cover and the second descriptor indicates the vegetation of secondary importance. The canopy category of open indicates a canopy cover of between 20% – 49%, dense 50% – 79% and closed > 80%.

Most of the sites have dense vegetation with a few having open grassland fields (Figure 3). Dida Hara vegetation is mainly composed of open shrubland (77%), dense shrubland (13%), open bushland (7%) and moderate cultivated fields (2.3%). Dilo has the largest area under bushed shrubbed grassland (54%), with significant areas under open bushland (27%), open grassland (10%) and exposed rock surface (9%). Dubuluk also has large areas occupied by bushed shrubbed grassland (45%), open bushland (35%) and the largest tracts of open grassland (35%). Haro Bakke is composed of mainly wooded grassland (50%), open shrubland (43%) and significant cultivated area (7%). Moyale, Kenya has the highest area under cultivation (23%), and other natural vegetation includes open shrubland (24%), open grassland (20%), dense bushland (18%), wooded grassland (7) and exposed rock surface (1%).

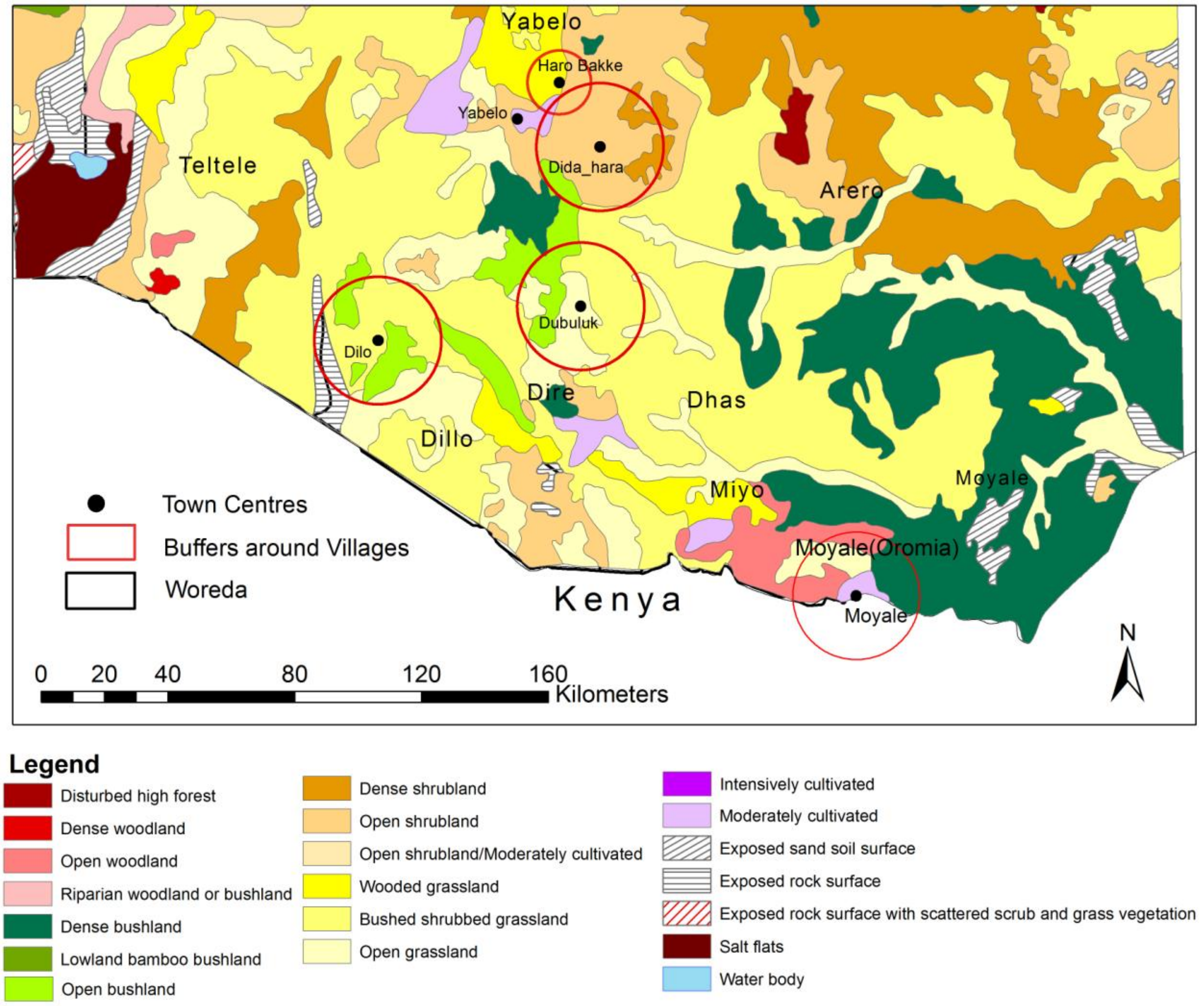
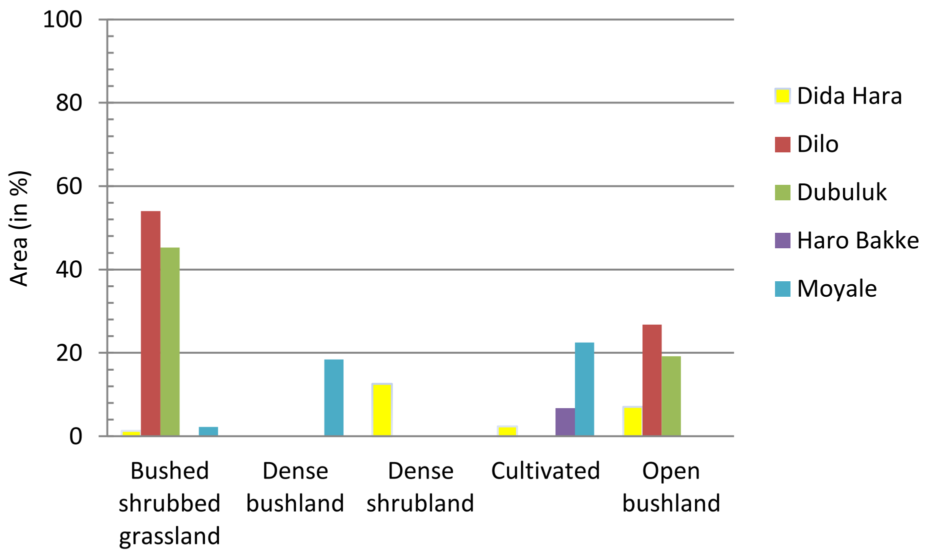


Figure 2: Land cover map



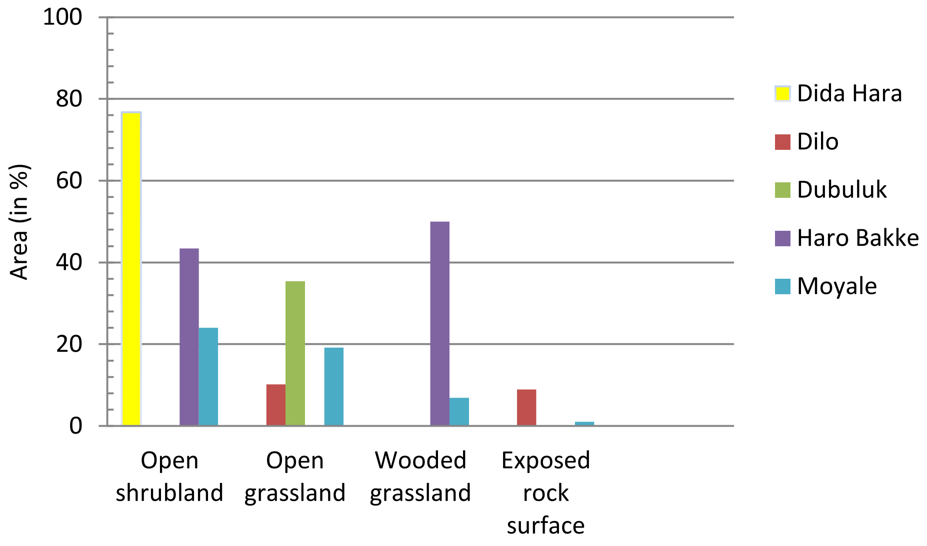


Figure 3. Summary of land cover for the 5 sites

Land cover dynamics – vegetation trends

Normalized Difference Vegetation Index (NDVI) measures the amount of vegetation vigour at the land surface. Various satellites provide information on the status of vegetation at various spatial and temporal scales. We used data generated by NOAA satellites. The primary sensor on board the NOAA polar-orbiting satellites is the Advanced Very High Resolution Radiometer (AVHRR). In this study we derived the NDVI from AVHRR images downloaded from FEWS NET data portal (http://earlywarning.usgs.gov/fews) at a spatial resolution of 8 km.

The trend analysis of the NDVI was based on the 5 sites: Dida Hara, Haro Bakke, Dilo and Dibuluk in Ethiopia and Moyale, Kenya. The analysis was based on 20km buffers for all the sites except for Haro Bakke. The monthly NDVI for the 5 sites were spatially averaged and interannual variations in vegetation conditions were analysed based on standardized anomalies. Monthly NDVI anomalies were calculated for the entire time series from 1982 to 2009 using the *z*-transform ((x_i – m)/std), with x_i being the NDVI value for each given month in year *i*, *m* the mean NDVI, and std the standard deviation of the NDVI.

The results of the long-term trends shows there was synchrony of vegetation condition for the four sites between 1982 and 1996 except for the years 1984-85 where the vegetation coverage in Haro Bakke was above average; in Dubuluk, Dida Hara and Dilo the NDVI was very low indicating drought conditions (Figure 4). In the 1980s, the period 1983-84 was a period of severe droughts and the only site that seems to be unaffected was Haro Bakke. There were also some mild droughts in the 1980s, especially in late 1985 and early 1988 as indicated in the low values of the NDVI.

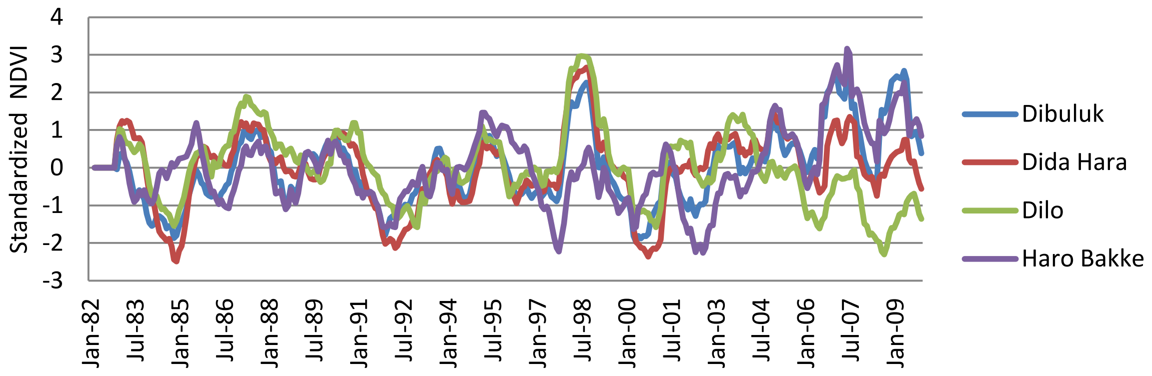


Figure 4: NDVI trends in Dibuluk, Dida Hara, Dilo and Haro Bakke 1982 - 2009

In the 1990s, from 1991 to 1993 all four sites had below normal NDVI, which was followed by short spells of mild droughts between August 1993 to July 1994 and January 1996 to March 1998. In 1997 there were moderate declines in vegetation in Dida Hara, Dibuluk, and Dilo while the analysis indicates that Haro Bakke had a severe shortage of vegetation. The year 1998 registered the highest peak for NDVI for Dilo, Dida Hara and Dibuluk, while the recovery of Haro Bakke was limited.

The period 2000 – 2009 shows two major vegetation patterns. The period 2000-2003 shows most of the sites had below average NDVI, the lowest from May 2000 to January 2001 and January 2002 to October 2002. The period from 2004 to 2009 indicates above normal NDVI in Haro Bakke, Dibuluk and Dida Hara with slight declines in the months of January 2006 and January 2008. However, there has been a general decline in the vegetation index in Dilo from 2004 to 2009; however, a slight increase in NDVI was registered in January 2007 and June 2009. Peak NDVI values were registered in December 2006 and January 2009. The high rainfall peak in 1998 is associated with the El Niño–Southern Oscillation.

In Ethiopia, warm phases of ENSO (El Niño) have been associated with reduced rainfall in the main wet season, JAS, in north and central Ethiopia causing severe drought and famine, and enhanced rainfalls in the February to April rainfall season which mainly affects southern Ethiopia (McSweeney et al. 2008). Kamara et al. (2004) examined policies, interventions and drought events in Borana between 1974 and 1998 and reported there were droughts in 1974-75, 1979-80, 1984-85, 1991-92 and 1995-96 in Borana. The 2 excessive rains during this period were recorded in 1980-81 and 1997-98. Until the 1997-98 El was the strongest in recorded history and was not detected until the onset of its most devastating impacts (Kamara et al. 2004).

Trends and spatial distribution of rainfall

The timing, variability, and quantity of seasonal and annual rainfall are important factors for both livestock and crop cultivation in the Borana area. In Ethiopia there are three seasons namely Kiremt, Belg, and Bega. The Belg season is the light rainy season and usually lasts from March to May; it is the main source of rainfall for the water-deficient southern and southeastern parts of Ethiopia. The Kiremt season is the main rainy season and usually lasts from June to September, covering all of Ethiopia except the southern and southeastern area (Seleshi and Zanke, 2004). The Bega season is the dry season and usually lasts from October to February, during which the entire country is dry, with the exception of occasional rainfall in the central sections.

In Kenya there are four seasons with the short dry spell from January to February. The main long rainy period is from March to June, and the long dry period is from July to September. The short rainy season is from October to December. The rainfall pattern of the Borana rangelands, however resembles those of Kenya over the pattern typically experienced in Ethiopia, Cheung et al. (2008) reported in their analysis on rainfall patterns and trends that out of 12 of the 13 watersheds in Ethiopia, the Kiremt rainfall constituted a majority of the study area's annual rainfall The only exception was the watershed in Borana, which reported that 48.8% of its annual rainfall came during the Belg, and only 20.5% during the Kiremt season (Cheung et al. 2008). Figure 5 shows the spatial distribution of the rainfall in Borana zone showing the spatial variations across the 5 sites (source of information is International Food Policy Research Institute [IFPRI]).

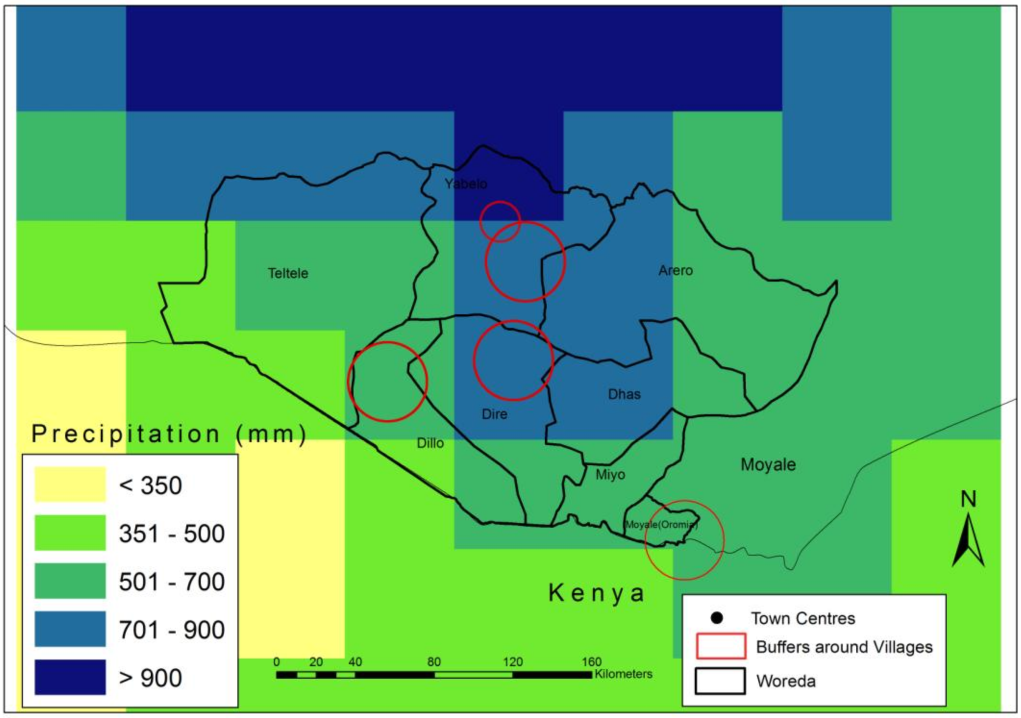


Figure 5: Distribution of annual rainfall in Borena zone

Cheung et al. (2008) conducted trend analyses on seasonal and annual rainfall at national, regional, and watershed scale. Regression of annual watershed rainfall against time showed no significant changes in rainfall for any of the watersheds examined. However, in the regressions of seasonal rainfall averages against time Cheung et al. found a significant decline in June to September rainfall for a number of watersheds including the Borana watershed. The decline of rainfall in Borana was about 1.2 mm/year ($p = 0.0933$). A similar analysis was conducted for northern Marsabit and data used was from 1935 to 2007. The rainfall trend was based on the long rain season running from March to June (MAMJ). The decline in the Kenyan side was about 0.7 mm/year. Figure 6 shows rainfall trends for northern Marsabit that includes Marsabit, North Horr and Moyale.

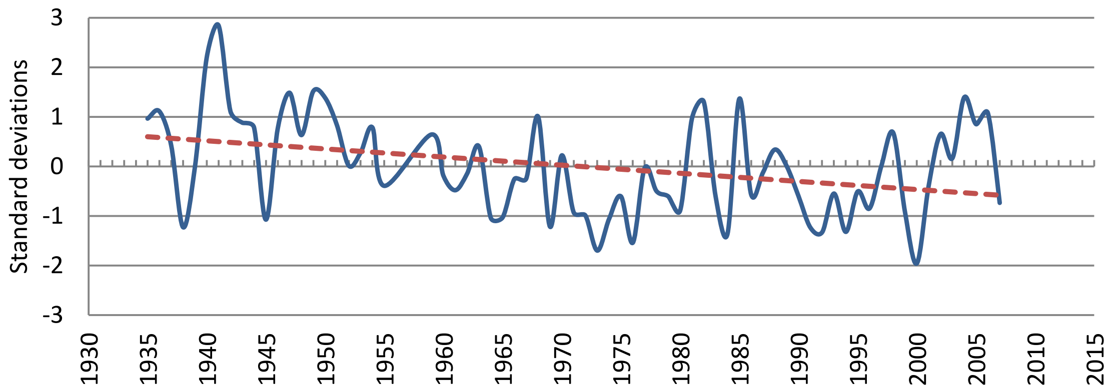


Figure 6: Trend in rainfall MAMJ (long rain season) for Northern Marsabit (1935-2007)

Degradation

Land degradation can be defined as the loss of land productivity, quantitatively or qualitatively through various processes such as wind and soil erosion, salinization, waterlogging, and depletion of soil nutrients and soil contaminants. Land degradation is a serious problem for much of Ethiopia. Rapid population growth, limited arable land and a shortage of alternative employment opportunities have increased pressure on the forest and grazing land resources in Ethiopia, thus increasing land degradation through exploitation and misuse (Hurni 1988). Cultivation on steep slopes and clearing vegetation on the highlands for agricultural purposes has also accelerated soil erosion (Bhan 1988). The amount of topsoil lost annually from Ethiopia's highlands is notably above the tolerable soil loss levels (1 to16 t/ha/yr compared to soil formation rate of less than 2 t/ha/yr). The 1.5 billion tons of soil lost annually would add about 1-1.5 billion tons of grain to the country (Girma 2001).

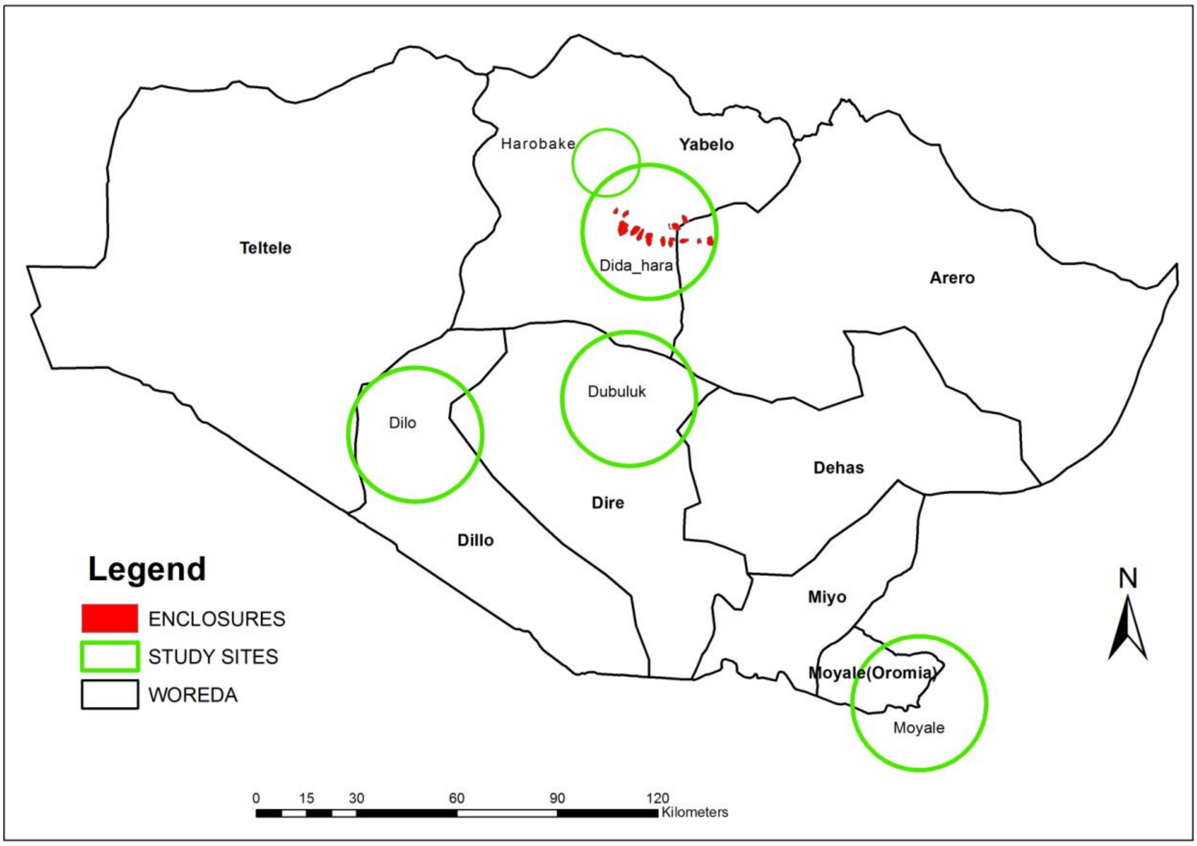
Although the Borana pastoral production systems were historically the most sustainable systems in land use, after 1980 the region started experiencing greater cattle population die-offs during periodic droughts. This is associated with deterioration of the ecosystem as evidenced by the proliferation of bush encroachment and reduction in pastures (Angasa and Oba 2007). Rapid population growth led to an increased demand for wood products and also led to the changing use of land for agricultural purposes. Destruction of the land has made it more susceptible to wind and water erosion (Girma 2001). The country and particularly the southern region experience severe climatic variations. Livestock production has also been blamed for land degradation in Ethiopia. Overgrazing due to overstocking and mechanical pulverization of soils (by hooves) often increases erodibility. Controlled grazing, often encouraged by water points or markets, concentrate animal traffic and these sites become areas of initial wind erosion (Girma 2001).

Several studies have documented observed changes in land use driven by socio-economic and biophysical factors. The advent of cultivation in communities coincides with the formation of peasant associations and the endorsement of private rights to cropland. Bush encroachment and habitat change is a direct result of policy intervention in the early 1970s which banned the use of local fire burning. Development of road networks and market centres have increased interactions between pastoralists and neighbouring agro-pastoral ethnic groups hence individuals acquire private land (Kamara et al.2004) Traditional land use used to be pastoral farming but recently there have been crop farming and semi-private ranch enclosures which have transformed the traditional system of land use. Similarly, the Borana traditional setting has been affected by various policies and development interventions over the past decades (Kamara et al.2004).

Settlement and Enclosures

Most parts of southern Ethiopia have had increased human settlements while forests, shrub lands and riverine vegetation have reduced considerably (Kebrom and Hedlund 2000). Rural settlements increased by 2.6 square kilometres (57%) in 28 years while urban settlements increased by 192% over the same period. If the deterioration of forests and shrubland continues in the same manner as this period, it will result in erosion of the highlands, flooding in the lowlands and inundation of the food producing areas. Pastoral communities have established enclosures to manage their livestock and resources The establishment of range enclosures is the communities' way of responding to the scarcity of feed for vulnerable herd classes, such as calves. The traditional calf-grazing reserves (laaf seera yaabi) were a communal resource managed collectively (Oba 1998), "fenced by rules and regulations" (Travis et al. 2000).

The use of range enclosures was adopted from the sedentary Guji agro-pastoralists (Travis et al. 2000). Coppock (1994) previously estimated that 90% of the Borana settlements in the Yabello district have access to range enclosures. Range enclosures are less developed in the arid lowlands, where conditions are too dry, and in the Liban district in the east, where the population is more nomadic (Travis et al. 2000). Specific rules and regulations exist for the communities' use of range enclosures and traditional calf-grazing reserves; for example, the age of calves is specified as 6–24 months. In most areas, the stocking of the enclosures with calves is not regulated, the assumption being that since the pastures were grazed during the dry season and rested during the growth season, there was no threat of overgrazing. ILRI has started to map the enclosures and the movements of livestock (through collared cattle with GPS) in the Borena zone. Thus far, the mapping has been done for the project (ILRI-BMZ) project sites that are located in the four Ethiopian sites of this study.



This project will link with these activities. The enclosures in Dilo, Dubuluk and Oromia will require the team to get mapping data from the ground to complete the mapping.

Mapping and monitoring fires

The Moderate-resolution Imaging Spectroradiometer (MODIS) fire product is an interdisciplinary product designed to meet the needs of the global change research and the fire applications community (Justice et al. 2006). Fire is an important component in climate modelling, atmospheric transport and chemistry models, ecosystem dynamic models and models of land use change (Justice et al., 2006, Roy et al. 2005).

The MODIS 1 km fire products use 2 channels of wave bands to distinguish fires. Fire observations are made four times a day from the Terra AM (10:30 and 22:30) Aqua and PM (13:30 and 01:30) platforms. The data on fires was acquired from Fire Information for Resource Management System (FIRMS; http://maps.geog.umd.edu/firms/). MODIS provides information on the location of a fire, its emitted energy, the flaming and smoldering ratio, and an estimate of area burned. The geospatial data variables include acquisition date and time, satellite type, brightness and confidence level of the fires detected. The fire map in this study was a combination of all the fires archived from 2001 to 2012 (Figure 7). There is less use of fires to manage land in the drylands as compared to wetter areas in Ethiopia.

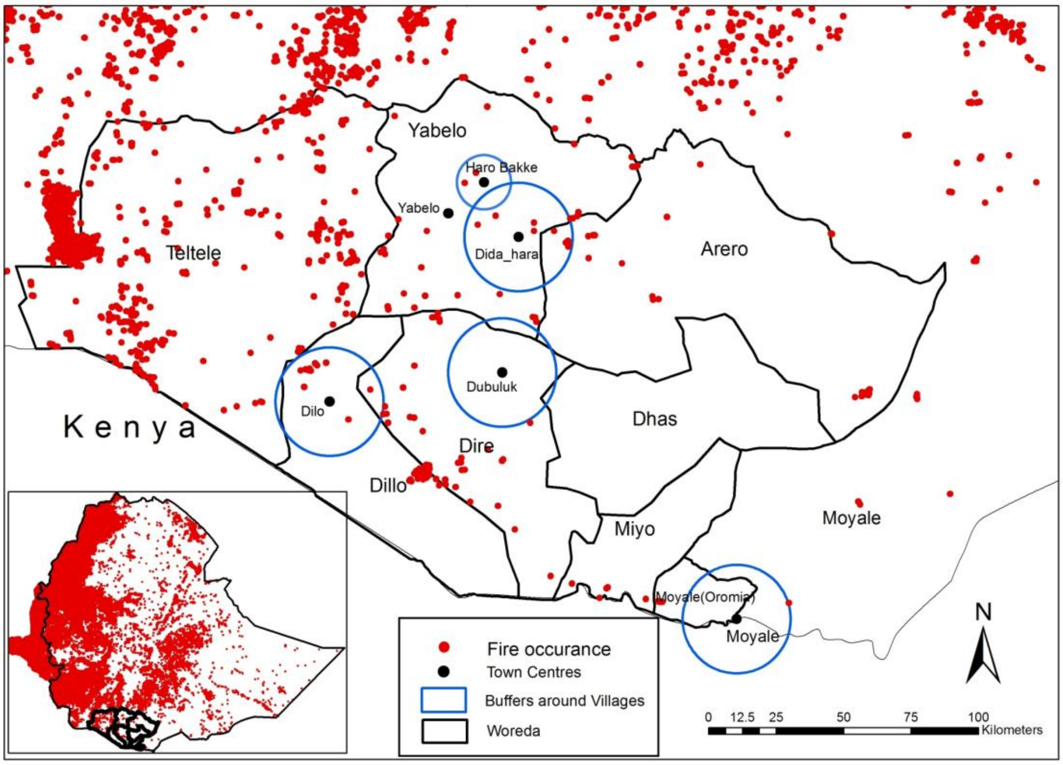


Figure 7: Distribution of fires as mapped by MODIS from 2001 to 2012.

In the study sites there was a ban on the use of fire that compelled the pastoralists to stop this traditional practice in the 1970s (Coppock, 2007). This lack of fire has contributed to the conversion of open, mixed savanna communities to dense woodlands and bushlands as indicated in the land cover of area [Figure 2]. In 2005, prescribed fires were conducted in certain areas. The results following the fires indicated improvement to the overall forage species composition in the fire site and the amount of bare ground decreased (Coppock, 2007). Coppock et al. (2007) further report doubling of vegetation cover for the highly valued *Themeda* forage grass from 18% of cover to 40% in sites where fires were prescribed.

Challenges

It was technically impossible to visit the Garissa site in Kenya due to political instability that has been affecting the area. The project team has agreed to focus on Marsabit and Moyale. This is anticipated to give similar outcomes as those anticipated from the earlier proposed Garissa area market chain.

Data on Ethiopian sites, particularly meteorological data, has not been easy to find as the systems works differently from those in Kenya. Data on population trends and settlements has also proved difficult to acquire as the Ethiopia Central Bureau of Statistics publishes population data aggregated at much higher political divisions than the project sites. The partners in Ethiopia, particularly the PhD students, have agreed to contact relevant authorities in Ethiopia and request the specific data. This should be available in the first few months of the second year of the project. The project team will use technology to apportion population (based on regional figures and density) to the project sites. This will be verified during focus group discussions planned for the second year of the project.

Unusual events/Opportunities:

The project benefited from ILRI having an on-going presence on the project sites. The team has collected information on all the livestock enclosures in the region. This information is going to be very important in assessing the impact of the enclosures on the marketing of livestock and also on the land degradation.

There are more development partners and researchers who have started programs in the study site including the climate change, agriculture and food security (CCAFS) program of the CGIAR. Their presence may provide opportunities for synergistic working and information sharing.

Pwani University Sub-Contract:

This contract has been delayed owing to the insecurity in the Garissa region that has made travel and field work impossible. After discussions, it was decided to undertake field work in Moyale and Marsabit. The trader survey has been tested in Nairobi and will be implemented in Northern Kenya in early 2013.

References

Angasa, A., Oba, G. (2007). "Relating long-term rainfall variability to cattle population dynamics in communal rangelands and a government ranch in Southern Ethiopia." Agricultural systems **94**: 715-725.

Asnakew, W.-A. B. (1989). "The Role of Soil Fertility Management in Crop production." Natural resources conservation conference.

Bhan, C. (1988). "Spatial analyses of Potential Soil Erosion risks in Welo region, Ethiopia: A geomorphologic evaluation." *mountain Research and Development* **8**: 139-144.

Cheung, W.H., Senayb, G.B., and Singh, A (2008) "Trends and spatial distribution of annual and seasonal rainfall in Ethiopia". Int. J. Climatol. DOI: 10.1002/joc.1623

Coppock, D. L. (1994). "The Borana plateau of southern Ethiopia." Synthesis of Pastoral Research Development and Changes 1980 -1990. International Livestock Centre for Arica, Addis Ababa, Ethiopia.

Desta, S., Coppock, D.L. (2004). "Pastoralism under pressure: Tracking system change in southern Ethiopia." Human Ecology **32**: 465-486.

Coppock, D. L.,Gebru,G.,Desta, S., Gizachew, L., Amosha, D.,Taffa, F, "Stakeholder Alliance Facilitates Re-Introduction of Prescribed Fire on the Borana Plateau of Southern Ethiopia" (2007). *ENVS Faculty Publications.* Paper 209.

DiMaggio, P., Louch, H. (1998). "Socially Embedded Consumer Transactions: For What Kinds of Purchases Do People Most Often use Networks?" American Sociological Review **63**: 619-637.

FAO (2000) Africover Multipurpose Land Cover Database for Kenya. Rome: FAO. Online at: www.africover.org

Girma, T. (2001). "Land Degradation: A Challenge to Ethiopia." Environment Management **27**: 815-824.

Grunblatt, J., Ottichilo, W. K., Sinange, R. K. (1989). "A hierarchical approach to vegetation classification in Kenya". African Journal of Ecology **27**: 45-51.

Heath, B. (2001). The possibility of establishing Cow-Calf camps on private ranches as a drought mitigation measure. N. R. Institute, Stock Watch.

Hurni, H. (1988). "Degradation and conservation of land resources in the Ethiopia Highlands." mountain Research and Development **8**: 123-130.

Hussein, M. (2001). Livestock trading and trader Networks in Northern Kenya and Southern Ethiopia. Parima, University of Kentucky.

Justice, C., Giglio, L., Boschetti, L., Roy, D., Csiszar, I., Morisette, J., Kaufman, Y. (2006) MODIS Fire Products Algorithm Theoretical Background Document, Version 2.3 ed.

Kamara A. B, Swallow, B., Kirk, M (2004). "Policies, interventions and institutional change in pastoral resource management in Borana, southern Ethiopia." Development policy review **22**: 381-403.

Kebrom, T. and L. Hedlund (2000). "Land cover changes between 1958 and 1986 in Kalu district, Southern Wello, Ethiopia." International Mountain Society **20**(1): 45-51.

Little. P. D., Mahmoud, H., Coppock, D. L. (2001). "When deserts flood: Risk Management and climatic processes among pastoralists in East Africa." Climate Research **19**: 149-159.

McSweeney, C., New, M., and Lizcano, G. (2008) UNDP Climate Change Country Profiles Ethiopia School of Geography and Environment, University of Oxford, Tyndall Centre for Climate Change Research. http://country-profiles.geog.ox.ac.uk

Oba, G., 1998. Assessment of indigenous range management knowledge of the Borana pastoralists of southern Ethiopia. Commissioned by GTZ Borana Lowland Pastoral Development Program in Collaboration with the Oromiya Regional Bureau for Agricultural Development, Negelle/Borana, Ethiopia.

Paulos, D. (1996). "Availability of phosphorus in the coffee soils of south west Ethiopia." proceedings of the third conference of the Ethiopian society of soil science: 28-29.

Rakitoarisoa, M., Massawe, S., Mude, A., Ouma, R., Freeman, A., Bahigwa, G., Karugua, J. (2008). Investment opportunities for livestock in North Eastern Province of Kenya: A synthesis of existing Knowledge. ReSaKSS. Nairobi, ILRI.

Richie B, Hachieka, E., Awour, C.B., Hammill, A. (2009). "Climate related vulnerability and adaptive capacity in Ethiopia's Borana and Somali communities." Save the Children, Care, IISD and IUCN. pp 83.

Roy, D.P., Jin, Y., Lewis, P.E., Justice, C.O. (2005) Prototyping a global algorithm for systematic fire-affected area mapping using MODIS time series data. Remote Sensing of Environment **97**, 137-162.

Seleshi Y, Zanke U. (2004). "Recent changes in rainfall and rainy days in Ethiopia". International Journal of Climatology **24**: 973–983, DOI: 10.1002/joc.1052.

Stower, D. (2011). National Land reclamation Policy. Ministry of Water, Government of Kenya.

Travis, J., Lybbert., et al. (2000). "Pastoral Risk and Wealth-Differentiated Herd Accumulation Patterns in Southern Ethiopia." 2000

Annex 1

Gathered GIS/Remote sensing data sets:

(a) SPOTVGT Normalizes Differential Vegetation Index (NDVI). The data is decadal (10 day's interval) from 1998 to 2012. The ground resolution is 1km by 1km. The data has been averaged to monthly NDVI's.

(b) NOAA – Normalized Differential Vegetation Index (NDVI), The data is decadal (10 day's interval) from 1982 to 2009

(c) Human Population (Demography) 2005. The data has the following variable: total populations, males, female and densities

(d) Water point: Only location *Source: IBLI*

(e) Roads:

(f) Towns

(g) Agro ecological zones

(h) Landcover 1970 ILCA System Study in a Synthesis of pastoral Research, development and Change. 1986_ FITCA 2005_FAO: Landcover classes

(i) Dry season grazing land: *source* : IBLI

(j) Digital Elevation Model (DEM) 90 meter resolution

(k) Woreda: Administrative units

(l) Geology: contains geology classes, landform and major soils

(m) Fire data from MODIS based and have 1km by 1km ground resolution from 2001 up to 2012

(n) Rainfall Global dataset

(o) Min Max temperature global datasets

(p) Livestock production systems Global dataset

(q) IFPRI datasets