AN EX-ANTE ASSESSMENT OF THE SOCIO-ECOLOGICAL IMPLICATIONS OF COMMUNAL LAND CERTIFICATION IN PASTORAL AREAS OF THE BORANA ZONE IN SOUTHERN ETHIOPIA

TRINITY SANDRA SENDA

A THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY IN MANAGEMENT OF AGROECOSYSTEMS AND THE ENVIRONMENT

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FACULTY OF AGRICULTURE

UNIVERISTY OF NAIROBI

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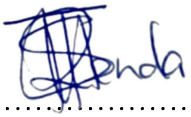

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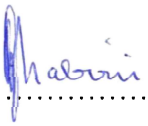


Signature ……Date…15th August 2022……

Prof. Charles K. K Gachene

Department of Land Resource Management and Agricultural Technology

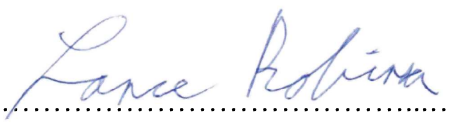
University of Nairobi

Signature ……Date……23rd August 2022……

Prof. Geoffrey Kironchi

Department of Land Resource Management and Agricultural Technology

University of Nairobi



Signature……. Date…15th August 2022……....

Dr. Lance W. Robinson

Sustainable Livestock Systems

International Livestock Research Institute

DECLARATION OF ORIGINALITY

Name of Student: Trinity Sandra Senda

Registration number A80/51543/2017

College: Agricultural and Veterinary Sciences

Faculty/School/Institute: Agriculture

Department: LARMAT

Course name: Management of Agroecosystems and the Environment

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To my mother: Veronica ‘Qakeza’ Dube, I am a product of the “power of a praying mum” you are such an inspiration, you are my rock!

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LIST OF ABBREVIATIONS AND ACRONYMS

ADLI	Agricultural Development Led Industrialization
AE	Adult equivalents
AFDM	Africa Flood and Drought Monitor
AHP	Analytical Hierarchical Process
ALDEV	African Land Development Organization
AU	African Union
AU-ECA-AfDB	Africa Union-EU Commission for Africa and African Development bank
CBRM	Community Based Rangeland Management
CHANS	Coupled Human-Natural Systems
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station
CI	Condition Index
CSA	Central Statistical Agency
DECUMA	Decisions Under Conditions of Uncertainty by Modelled Agents
DEM	Digital Elevation Model
DRLUA	Department of Rural Land Use and Administration
ESA	European Space Agency
FAO	Food and Agriculture Organisation
FGD	Focus Group Discussion
FRLR	Fast Track Land Reform

GDP	Gross Domestic Product
GIS	Geographic Information System
IBLI	Index Based Livestock Insurance
IFAD	International Fund for Agricultural Development
ILC	International Land Coalition
ILRI	International Livestock Research Institute
ISRIC	International Soil Reference and Information Centre
KII	Key Informant Interviews
LAND	Land Administration to Nurture Development
LGAF	Land governance and assessment framework
LPI	Land Policy Initiative
LSD	Least Significant Difference
MCDA	Multi Criteria Decision Analysis
NDVI	Normalised Difference Vegetation Index
ODK	Open Data Kit
PDO	Pastoralist Development Office
POM	Pattern Oriented Modelling
SDG	Sustainable Development goals
SRTM	Shuttle Radar Topography Mission
TLU	Tropical Livestock Units
UN	United Nations

USAID	United States Agency for International Development
USDA	United States Department of Agriculture**.**
USGS	United States Geological Survey
VGGT	Voluntary guidelines for the Governance of Tenure
VLA	Village Land Act
VLUP	Village Land Use Planning
WLUP	Woreda Land Use Planning

ABSTRACT

Land is the main platform for livelihood sourcing for many communities in Sub Saharan Africa. It is however becoming scarce owing to many factors that include the growing human population, land degradation and climate change. Pastoralism is an important livelihood source for many, but land scarcity and tenure insecurity are threatening its viability as a livelihood source. Pastoral communities' resource use and governance display unique characteristics that complicate tenure formalization. Policy makers are thus faced with a huge task of drafting policies that take this uniqueness into consideration.

This study was conducted in Dirre grazing unit of the Borana zone in southern Ethiopia. The objectives were to assess the implications of securing land tenure by formalizing land rights at different scales and how this interacts with socio economic drivers that shape land use in pastoral systems. It also assessed the implications of communal land rights formalization on such issues and rangeland ecology, livestock and livelihoods. The methodology applied a scenario development approach with key informant interviews and focus group discussions. It also employed a household survey with 187 households and coupled human-ecosystem simulation modelling approach was used with SAVANNA an ecosystem model and DECUMA an agent-based model. The data was analysed using multiple analysis techniques that includes the Analytical Hierarchal Analysis (AHP) of the multi criteria decision analysis tool and a two-tailed t-test was used to compare means at 95% confidence level.

The findings show that smaller scale certification would have more advantages, but pastoralists preferred larger scale which despite its challenges, is the best for maintaining flexible mobility and for allowing implementation of seasonal grazing management. Pastoralists response showed that land certification will secure land rights, enable better management of rangelands, and improve livestock-based livelihoods. However, the findings also suggest that certification will not necessarily reverse individualization and the ongoing shift in livelihoods toward agropastoralism. From the simulation modelling, vegetation layers respond differently to the grazing management scenarios. The unpalatable grass levels rise regardless of grazing

management, which is potentially a sign of increased degradation. When it is a very low rainfall year, grazing management does not have as many benefits, as everything becomes dry and stressed. Both grazing scenarios had marginal effects on woody biomass and population for palatable species for about half the simulation time for palatable woody species.

The study suggests the need for multi-pronged approaches and various support mechanisms when implementing a formal land tenure system in these areas as the scale of operation matters. Secondly, it is concluded that, while strengthening communal tenure for pastoralists is key, the drivers toward individualization and adoption of crop agriculture are such that implementing a formal communal land tenure system will not always in itself be sufficient to stem individualization. The reasons for livelihood transition go beyond land tenure security. Thirdly, as the land certification program in pastoral areas moves forward, it should aim at enhancing pastoralist livelihoods and their capacity to manage rangelands, halt degradation and allow the rangelands to recover to be able to sustain livestock production for longer. There is need to couple planned grazing with intensive rangeland reclamation, and management efforts, intensify livestock production through, cattle fattening, or diversify into other livelihood activities.

Key words: land rights, tenure security, agropastoralism, modelling, grazing access, scale, pastoralists. livelihoods, rangelands

CHAPTER 1 INTRODUCTION

1.1 Background

For most rural communities in the developing world, land is the main platform for livelihood sourcing and access to it is an important driver for poverty alleviation and economic emancipation but is increasingly becoming scarce (Holden & Ghebru, 2016; Kuusaana & Bukari, 2015; Teklu, 2004). The increasing land scarcity is driven by many factors that include the growing human population, land degradation and climate change. According to the UN, Department of Economic and Social Affairs, Population Division (2017), the world population is expected to increase by 2050 with an associated increase in world food demand. This will put pressure on the environment and more so on rangelands especially for livestock-based systems. The bulk of the world population growth is expected to take place in nine countries of the world- India, Nigeria, the Democratic Republic of the Congo, Pakistan, Ethiopia, the United Republic of Tanzania, the United States of America, Uganda and Indonesia, (UN, Department of Economic and Social Affairs, Population Division, 2017). There is therefore a need to start rethinking land policies and align them in such a way that ensures sustainability of land-livestock-based livelihoods such as pastoralism.

Pastoralism is an important livelihood source for many across the world and more so, in East, Central and West Africa. Land fragmentation and scarcity in pastoral areas is increasingly becoming a cause for concern and threatening the viability of pastoralism as a livelihood source. The importance of livestock is not only critical for these systems, but also in the global space where it accounts for up to 40% of the value of the world's agricultural output and provide approximately one third of the protein intake by humans (Adriansen, 2008; Ayantunde et al., 2011; Thornton, 2010). In Ethiopia, pastoralism is practiced mainly in the lowland arid and semi-arid parts and accounts for about 62% of the national land, employing close to 27% of the population (Tefera et al., 2016). Pastoralists also play an important role in the conservation of biodiversity and use of marginal areas as they exploit spatial heterogeneity of rangelands (Brak et al., 2004). They are, however faced with different kinds of challenges that include loss of natural resources especially water and grazing land. Other challenges include inappropriate settlements, expansion of cropping into the rangelands, lack of markets, drought and bush

encroachment (Greiner et al., 2013). This has direct negative effect son productivity, thus limiting the human habitants of these areas from realizing the full benefits of livestock consequently making them vulnerable to poverty.

These land scarcity problems are causing a lot of insecurity of tenure, which in some instances has fueled unnecessary land grabbing and a shift to a more sedentary way of life (Greiner et al., 2013). This is likely to contribute to increased poverty rates and land degradation if not carefully planned for. Increasing tenure insecurity in Southern Ethiopia has seen pastoralists call for the government to improve their land tenure security by formalizing their land rights through certification as has been done in the Ethiopian highlands (Deininger et al., 2007). There is also an increasing demand for land by multinationals for various development and agrobusiness projects, which has been termed the "land rush" by some scholars (Anseeuw et al., 2011). While these projects have good intentions for local economic development and the country's economic growth, there is a high risk that such land concessions will dispossess rural communities of their land especially considering that they do not have legal entitlement to it. Most of the land in rural communities is under State ownership and the communities have usufruct rights and not empowered to contest land reallocations. Rural land is often governed under both the formal and customary laws where decisions by the former often supersedes the latter.

Some international organizations like the World Bank and Food and Agriculture organization (FAO) have begun to invest resources and efforts in developing the frameworks for the governance of tenure in the Africa and the world at large (Deininger, Selod, and Burns 2012, Herrera et al 2016). In many African countries, Ethiopia included, communal tenure is the most prevalent and pastoralists in these areas make significant contribution to the country's GDP and food security (Samuel, 2006). Over recent years some African government have made some efforts to adjust the land policies in such a way that strengthens the land rights of its citizens particularly the rural poor. Recognizing and protecting customary land rights is one of the first steps in trying to protect and secure the land rights of the rural communities. Land governance and tenure systems thus have broad implications as they do not only affect the household capacity to produce food but also their social status, economic wellbeing and investments on land care. Improved tenure security is important for optimal land use and reconciling differences among land users (Tefera et al., 2016).

Some of the challenges with tenure systems in Africa is that often land is subjected to two or more governing entities, which is the formal and customary administration, often termed legal pluralism (Clover and Eriksen, 2009). The two systems are not entirely mutually exclusive but are often intertwined in complex mosaics of resource tenure structures. The other challenge is that often the customary tenure is not recognized as a legal entity and that makes the land under such tenure to be prone to grabbing and reallocation with no compensation (Tura, 2018; Alden-Wily, 2011). This is among the issues that have been the impetus for land rights formalization for the rural communities. These new policy initiatives need to be informed by local perspectives, reflect and recognize local realities. This is important in that it will not weaken the local governance structures but compliment them.

Policy makers are thus faced with a huge task of drafting policies that will facilitate processes that provide the greatest benefits and promote the transition to a sustainable and integrated management of the land. Pastoral systems have some unique characteristics which are often misunderstood by those drafting the land policies. Often social needs are not matched with ecological needs and one of these suffers at the end. There is need to assess the tradeoff between these two and come up with win-win decisions about land use and tenure. There remain some very critical questions on how land rights formalization should thus be implemented in these areas.

This study therefore sought to get an understanding of the implications thereof and provide guidance on how best to recognize and protect the land rights and communal tenure for pastoral areas. It assesses the implications of communal land rights formalization on such issues as rangeland management, livestock and livelihoods, seeks to gain an understanding on how the land users and managers perceive the socio-ecological implications of communal land certification. The study captures local realities and combines sociological analyses with scenario based ecological and agent-based simulation modelling approaches to get answers of what the direction and magnitude of change. It is framed in a forward-looking methodology, where the implications are being assessed based on what might be, rather than on what could have been, or was. This is done through an in-depth analysis of the social, livelihood and ecological implications of putting up a communal land rights formalization program.

1.2 Problem statement

To begin with, implementing a formal land tenure system in communal areas has its complexities. In Ethiopia it is further complicated by the fact that, the legal framework for land certification was designed with the farmlands in mind and not pastoralism out of which livestock mobility and rangeland management take place (Samuel, 2006). There are different propositions on how the land certification can be implemented in the pastoral settings where land is communally owned. There are ideas to use the government administrative boundaries versus the Borana traditional boundaries for certifying the rangelands. According to the government administration in the Borana, the smallest administrative unit is the k*ebele* (village) which falls under is *woreda* (district) whereas the traditional governance structure divides the Borana into *dheedas* (grazing unit) and *reeras* as the next management level and then the *arda* (group of households) (Degen, 2011; Homann, 2004; Hussein Wario, 2015). There however remains the biggest challenge of how pastoral communities should be delineated for strengthened property rights in such a way that the tradeoffs between livelihoods, pastoralists expectations and the needs for environmental care are taken into consideration

Scholarly work on pastoral systems, argues that pastoral systems often do not conform to the principles of mainstream commons theories (Robinson, 2019, Behnke et al 2011, Moritz, 2016). Resource use in these systems is driven by the temporal and spatial variability of forage and water across the landscape thereby necessitating the need for free and flexible mobility (Behnke et al., 2011; Brottem et al., 2014; Molnar, 2014). Pastoralists move with livestock between seasons in search for feed and water to sustain livestock throughout the year (Wario et al., 2016; Xiao et al., 2015). This is strategically done by assessing the condition of both their livestock and different pastures. Mobility is a key livestock drought survival strategy to minimize drought related livestock losses. Traditional pastoralist institutions, management practices and social fabric are adapted to the spatio-temporal variability in rainfall and forage and to this mobile livelihood pattern. For instance, the boundaries of rangeland and community territories are often flexible and porous. Some pastoral resource governance systems are “open property regimes” with rules made in such a way that allows free and flexible mobility (Moritz, 2016). In such systems, *open access* does not mean the absence of rules, as usually understood in the literature on commons but, instead refers to the pastoralists’ right of open access to common pool grazing

resources (Moritz, 2016). One of the characteristics of open property regimes is that there are no territorial boundaries, and the areas are usually large. Robinson, (2019) argues that some pastoral systems are neither conventional commons nor open property regimes but are systems in which there is a gradation in clarity and strength of boundaries and property rights over different resources, and in which social processes and governance mechanisms other than conventional land tenure institutions play a stronger role in governance.

Secondly, the relationships between land, livestock, and people in pastoral societies are often poorly understood, which complicates the provision of secure tenure (Herrera;et al, 2016; Moritz, et al., 2013a). Experiences with the implementation of policies in drylands are complicated by the limited understanding by policy makers of either the biophysical spatio-temporal heterogeneity, or institutional and social dynamics in these areas. Arguments for strengthening communal tenure in pastoral systems is often formulated with some inbuilt assumptions about land use, livelihoods and governance in these areas. The tenure reform policies often take a top-down approach informed by these preconceived ideologies and without careful engagement with the relevant stakeholders. Manzano (2018) refers to such policies as "misguided investments on pastoralism" as they may negatively impact pastoral systems. At times policy interventions can interfere with the local institutions and way of life, as seen with the Borana in Ethiopia how the establishment of additional water sources unintentionally disturbed grazing rules and other indigenous knowledge based natural resource management systems (Bambio & Agha, 2018; Homann et al., 2008). This raises a question of how much more can these systems absorb the pressure of external policies that do not adequately capture local perceptions and account for local dynamics.

Considering the observed downward trends in pastoral livelihoods over the past years, the study sought to get an understanding of how pastoralists perceive the land certification in contributing to bettering their lives and thereby halting this downward trend. Formalization of communal land rights aims to secure the rights of pastoralists and indigenous communities, but with many uncertainties on livelihoods outcomes. It is therefore important to get an understanding of the likely outcomes of the land certification by capturing pastoral perceptions on the biophysical and socio-economic facets of pastoralism.

Thirdly, the biggest question for decision makers is, when certifying communal land at what scale are pastoralist expectations met, to ensure secure tenure and sustainable ecological implications and livelihoods (and how pastoralists respond to the changes in the rangeland). Such an analysis is important in the sense that it gives both land users and decision makers an opportunity to make informed decisions about tenure, the complexities and the likely implications will be demonstrated.

For reasons as these, the implementation of a formal tenure system in a pastoral rangeland setting becomes both conceptually and practically difficult to implement. Various proposals have been put forward on how to best implement this, based on different stakeholders' perspective, with the scale of implementation being the biggest bone of contention, but the central question that remains is, what does it mean for the pastoralists in the future, despite the scale?

1.3 Justification

Governing of natural resources is a mammoth task for many governments as the competition for use is increasing at an alarming rate. Critical resources management like the rangelands require planning to be done on a large scale especially considering the livestock mobility involved in pastoral systems (Flintan, 2011). This creates a complex situation for communities, land use and policy planners as planning ought to take place where there is an overlap in resources across boundaries. At the same time, coming up with sound decisions on land use and policy may be both costly and time consuming. More often than not, pastoralist perceptions are overlooked, and pastoralism is considered by many as ecologically unfriendly and unsustainable (Kassahun et al., 2008). There are different pros and cons of certifying rangelands hence the need to explore them through an *ex-ante* analysis.

Having answers to the questions raised above will give an indication of the direction and magnitude of change in the rangelands, livestock and pastoral livelihoods. Knowledge of this is important for crafting land rights policies in pastoral systems. Perhaps having an idea of how things are going to look like will give an indication of what policies need to put in place to ensure sustainable livelihoods. How to implement a policy that resonates with the aspirations and norms of the pastoralists at the same time meeting the objectives of the securing tenure for them and enhancing livelihoods. The tradeoff analysis gives an indication of what the gaps and

opportunities for growth and sustainability lie. This study thus endeavored to unpack these by individually identifying and weighing the different criteria (based on the social, livelihood and ecological facets of pastoralism) that matters when crafting a land certification policy for pastoral communities. Such studies can help to ensure that the land certification policy is rolled out in a way which mitigates against the challenges that the system is currently facing and enhance livelihoods rather than limiting them.

The results of this research will be useful for policy makers and analysts, development practitioners and all other land managers and users, in such a way that they will be able to both craft policies, support mechanisms that not only protect the rights of pastoralist but also enhance livelihoods and protect the environment. It will also provide responses to the question of what scale to use when implementing a land rights formalization program for communal set ups and more so pastoral communities. It is expected to give guidance on the development of a pastoralist-oriented policy and serves as basis for monitoring the achievements of the goals of the certification, which include improved rangeland management, better livelihoods and secure tenure.

This study is also important for serving as a basis for decision making about land tenure policies in large landscape livestock systems where land is communally owned. It demonstrates the implications of changes in land use and access through changing policies and shows the dynamics of complex systems by applying a scenario development approach. There are also a lot of interactions among socio-ecological processes which need to be understood to inform decision making and development of tools for such. It is critical that land tenure implementation in pastoral areas involve the land users and understand how they make decisions about land resource use as well as other governance issues in their areas. In a nutshell, the impact of changes in communal land tenure on rangeland access, productivity, management and ultimately on pastoralism as a viable livelihood source are seldom considered in planning and policy formulation. There is therefore a need to assess the implications of the different proposed tenure regimes to meaningfully contribute to the intended outcomes of the Sustainable Development Goals (SDGs), number one-No poverty and number two- Zero hunger as well as number fifteen-Protecting, restoring and promoting sustainable use of terrestrial ecosystems.

Through coupled human-ecosystem simulation modelling in the context of land tenure scenarios it is possible to disentangle the likely implications of grazing management alterations thereby supporting decision making that ensures environmental and livelihood sustainability (Boone et al., 2011). Modelling at a large landscape scale incorporates both social and ecological land use features and will help to communicate to policymakers the impact of tenure and other land uses on livestock production, social and environmental sustainability in rangelands (Baskent & Keles, 2005; Weisberg et al., 2006). This is expected to inform the future of pastoralism in East African countries by providing a basket of options for guiding land tenure policy direction.

At sub-national and regional levels this research will contribute to the different efforts by many projects supporting partners in the piloting of land management initiatives. Examples of such projects include the LAND project funded by USAID, the Woreda Land use planning both in Ethiopia, the Village Based Land Use planning in Tanzania and the County Spatial planning in Kenya. On a broader scale the research will help contribute to the achievement of the intended outcome of designing and implementing policies that will improve the environmental management of livestock systems by national government agencies. From a research and development point of view it will also contribute to science by informing the current scholarly debate and advancing the scientific inquiries about the future of pastoralism in the face of land policy reforms.

1.4 Objectives

1.4.1 Broad Objective

To assess the implications of communal land certification on pastoralism by applying a mixed methods approach to guide decision making about communal tenure recognition pastoral systems.

1.4.2 Specific objectives

i. To analyse the implications of alternative scales of communal land tenure formalization in pastoral systems in Ethiopia
ii. To assess how formalization of communal land tenure in pastoral settings may interact with livelihood, socio-economic and demographic drivers that shape land use
iii. To explore the effects of tenure reform induced grazing management alterations on rangeland productivity, livestock population dynamics and livelihoods

1.5 Research questions

There is a lot of uncertainty about the future of pastoralism in the face of global environmental change. The land certification policy is an external factor in pastoral systems that adds on to the complexity and uncertainty in these areas. The study thus pursues these questions:

i. How should pastoral "communities" be delineated for strengthened property rights and what are the implications of scale on pastoralism facets?
ii. How does formalization of communal land tenure in pastoral settings interact with socio-economic drivers that shape land use?
iii. How do grazing regime alterations in the face of land rights formalization affect rangeland ecology, livestock productivity and livelihoods?

CHAPTER 2 LITERATURE REVIEW

2.1 Land, land rights and policies around the globe

Land policies are key in agrarian development but differ from country to country because land use issues are closely embedded onto the sociocultural and geographical variables. The World Bank paper of 1975 cited by Samuel, (2006) suggested three basic principles to inform land policies; (i) owner operated family farms were efficient and desirable, (ii) free land markets to allow land transfers to more efficient users and (iii) the need for more equitable distribution of assets (Samuel, 2006; USAID, 2004). Land governance is at the center of the 2030 global agenda as mentioned by the World Bank Land Governance and Assessment Framework (LGAF) (Deininger, Selod, and Burns 2012). This was set up to develop an analytical framework for assessing the state of the land governance at both national and sub national levels and to serve as a basis for dialogue for policy issues with respect to land governance. Rapid changes taking place on the global space, including population growth, climate change and the increased demand for food and raw materials are putting pressure on the land resources. This is happening at a time when there are no clear land rights for some communities hence fueling high levels of tenure insecurity and conflicts (Deininger & Binswanger, 1999). The LGAF thus seeks to give guidance for countries on a much coarser scale on how to identify and implement priority reforms in the land sector.

Secure tenure is a cornerstone for agriculture and food security and contributes to improvements in investment in better farming methods such as mechanization of agriculture and intensification (Deininger et al., 2008). The world bank continues to make efforts to engage with partners of the "Land 2030 Global Initiative" to enhance the commitment of countries to mobilize resources to achieve the set targets of securing land rights by 2030 (UN 2013). Most of these efforts are to bring countries in Africa, Asia, Eastern Europe and Central Asia, Latin America, and the Middle East up to speed with the issue of improving land tenure security (Deininger & Binswanger, 1999). To support this global initiative there has been several other support structures such as the International Land coalition, Voluntary Guidelines on the Responsible governance of tenure by FAO. The Africa land governance framework is one such structure that feeds into the goals of

the Land 2030 Initiative (Herrera et al, 2016). In 2012, FAO developed the guidelines for the governance of tenure to serve as reference to guide the governance of tenure in a way that ensures food security for all. The guidelines also acknowledge the importance of land as the main livelihood stage for the rural poor and that their livelihoods are based on secure and equitable access to resources (Herrera et al, 2016., FAO, 2016). It advises governments to include these guidelines as they implement the governance of tenure and natural resources (Herrera et al, 2016). There has of late been a greater push by many other international organizations for strengthening land rights. Some examples include the International Land coalition (ILC) a global alliance of over 200 member organizations, working together to put people at the center of land governance. As part of their strategy, they seek to ensure that indigenous communities such as pastoralists have secure tenure rights and are included in decision making about tenure to prevent and remedy land grabbing (UN-Habitat, 2018)

2.2 Land, land rights and policies- African context

The land issue in most developing countries is a cause for strife and unrest as it is very much intertwined with the people's culture and identity. For most rural dwellers land is the primary means of generating a livelihood and is a critical asset which can be passed on to the future generations. Most governments in developing countries find themselves having to address the land acquisition and tenure issues as a way of fostering investment and economic growth (Little & Behnke, 2010). Land size and availability has a huge influence on household income and food security in African agriculture (Kideghesho et al., 2013; Teklu, 2004). The African Union (AU) developed the framework and guidelines on land policy in Africa to strengthen land rights, enhance productivity and secure livelihoods. The rate of implementing the land policy in African States has however remained slow.

Some of the challenges owing to this slow progress have been assessed by the Land Policy Initiative (LPI) that has also put up a framework to enhance and speed up the implementation process (United Nations. Economic Commission for Africa., 2011). The context of the land policy in Africa as presented by the consultative workshops for the five regions of Africa held by the Africa Union-EU Commission for Africa and African Development bank (AU-ECA-AfDB) consortium in 2011 highlighted common problems regarding land, governance and access. Most

of the land was shown to be under communal ownership and governed by customary institutions and management programs. Levels of insecurity of tenure was also shown to be very high. The tenure insecurity was said to exacerbated by increasing human population, reallocations and expropriation for mining, irrigation and public works (Tura, 2018). Methods of securing tenure and people's rights in the context of legal pluralism was also said to be an issue and there are increases in land related conflicts (Deininger et al., 2008). In East Africa for example, land fragmentation was said to be responsible for the reduction in carrying capacities and the decline in both domestic and wild animal populations (Desta & Coppock, 2004; Galvin et al., 2004). Some of the African countries (for example, Ghana, Rwanda, Tanzania and Kenya), have made some strides in trying to curb these land administration and rights for different user groups, and to contribute to sustainable natural resource management (Ghebru & Lambrecht 2017. ILC. 2013, Kibugi, 2011, Mwangi and Ostrom, 2009). There are various efforts to protect the commons, integrate the customary systems into the new institutional framework, harmonize gender and community based natural resources management policies.

In East Africa for example, are some of the countries that are working on land rights formalisation policies for pastoral areas. Kenya started the working on land rights policies for pastoralists by introducing the group ranch concept in the 1960s (Dixit et al., 2013, Veit, 2011). In Tanzania similar processes are underway with a joint Village Land Use Plan (ILC, 2013). In Ethiopia this began with the securing of land rights for the farming community in the Ethiopian highlands is now being expanded to the pastoral areas as enshrined in the constitution (Gebremeskel et al., 2016, Ambaye 2012). These threee countries have the highest number of pastoralists in the East African region with many animals and they play a ctrical role in the countries economies (Desta and Coppock 2002, ILC, 2013, Kibugi 2011). In Ethiopia current tenure insecurities are high and pastoralists are faced with many challenges that threaten their liveliohoods, but the communal and right formalisation is for pastoralists is in infancy, albeit with many questions on how it could be implemented and the implications thereof (Deininger et al., 2007).

In Tanzania, according to the Village Land Act (VLA) of 1999 (section 11 and Regulation 2002 No 26-35) communities are empowered to enter into joint land use agreements with other

villages for the purposes of planning, managing and using resources jointly. The Land Use Planning Act (section18) provides formation of a joint Village Land Use Plan (VLUP) and (in section 33(1) (b) (ILC, 2013) provides for the preparation of joint resource management sector plan for the shared resources. These policy initiatives provide a means for reasonably sharing the rangeland resources and provide a mechanism in which local communities play a fundamental role in decision making about their land. When the joint VLUP process has been carried out, a group of land users can be formed to whom a certificate of customary rights of occupancy can be issued in order to secure their rights to use the shared land/resource (ILC, 2013). The VLUP process in rangeland settings is a challenging activity. This is because the pastoralists often require movement across the village boundaries to access key resources like water and grazing (Flintan, 2012; Roe et al., 2013)

In Kenya the African Land Development Organization (ALDEV) was established in 1945 to deal with issues of overgrazing and livestock diseases (Veit, 2011). This established the private enclosure land tenure system and set to replace nomadic pastoralism. In 1960 there were further policy reforms to sedentarise pastoralists, and this started with the introduction of group ranches where pastoralists were given joint ownership and management of a land parcel (Dixit et al., 2013). The government's objectives were to increase land productivity in these areas through increased offtake, reduced land degradation and improve the incomes of pastoralists. This was meant to re-order the rangelands and ensure formal land holding (Kibugi, 2011) The group ranch concept was an alteration to the land tenure system which meant to prevent the so called "tragedy of the commons", but policy makers overlooked the socio ecological interactions in the pastoral set up (Mwangi, 2007; Mwangi & Ostrom, 2009). The ownership of the ranch was by the registered members in that ranch, and it gave them exclusive rights.

Many group ranches however did not function as expected, for example, the pastoralists were not willing to increase offtake, and this caused a lot of animals to be confined on the limited land area thereby causing the rangeland to deteriorate. As a result, the pastoralist started dividing the land amongst themselves moving from group tenure to individual tenure (Veit, 2011). This saw the transition to crop cultivation becoming more common. In 1968 the government through the Land (Group Representatives) Act provided for the subdivision of group ranches despite being previously opposed to this. In 2010 Kenyans approved the new constitution where Article 63 (4)

specifies that “Community land shall not be disposed or otherwise used except in terms of legislation specifying the nature and extent of the rights of member of each community individually and collectively” (Veit 2011). Section 5 of Article 63 the same Act requires Parliament to pass legislation to implement requirements of groups ranches (Veit 2011). Now Kenyan pastoralists are in a lot of conflicts over grazing issues and are in a predicament of being found in between new tenure rules associated with the dissolving of group ranches and subdivision of communal lands (Thornton et al., 2006).

In Ethiopia land is a public property and has been administered by the government since the 1975 land reform (Samuel, 2006). Before this reform took place the kinship and private tenure systems were the most common. The kinship system allowed access to land by all descendants of a common ancestor. This system reduced landlessness but encouraged land fragmentation. Private tenure was the most dominant system during the last days of the Imperial regime, largely created by means of land granting by the Crown to the members of the army who were loyal to the regime (Ambaye, 2012). Under this system land was sold and exchanged but still land holders had no absolute rights. This fueled land concentration and exploitative tenancy as well as insecurity (Samuel, 2006; USAID, 2004). Between 1974 and 1991 (the Derge period), there were radical changes in the policies that saw the end of the tenant-landlord relationships (Ambaye, 2012; Bruce et al., 1994). This reform was set to alter agrarian relations, increase agricultural production, distribute land and increase rural incomes and allow growth in the agriculture sector. Since that time the right to own land was vested on the state, allowing farmers to access land through state mandated associations (Deininger et al., 2007). Land was allocated according to the number of household members.

The Ethiopian government came up with the rural land policy and Ethiopia's Agricultural Development Led Industrialization (ADLI) policy in 1994-95 focusing on increasing productivity in the smallholder sector through provision of key cropping inputs, access to credit and growth in infrastructure (Little & Behnke, 2010; Tsegaye et al., 2010). This strategy viewed agriculture as the key driver for economic growth. There were some assumptions that this strategy builds on, for example that there will be no changes in product prices despite increased

production, and that institutional arrangements would remain the same. The issue of land tenure however remained unresolved.

The poverty reduction strategy paper in Ethiopia in relation to land policy was developed to assess the poverty levels in the country and what the possible causes were. Significant increases in poverty levels were noted with the unavailability of land and declining soil fertility being cited as the major causes (Deininger et al., 2007). The issue of land tenure was however not considered at great length as the focus of that time was achieving the objectives of the ADLI. Some authors argued that strengthening agricultural production alone would not solve the problems of poverty in Ethiopia if there is still a lot of tenure insecurity which is related to the land policy (Little & Behnke, 2010; Teklu, 2004).

In the current system, the federal constitution of 1995 favored the public ownership of land. Control of land administration has been taken away from regional governments and is now directly under the responsibility of political bodies rather than technical ministries. In some areas land re-distributions are still expected (Samuel, 2006). The problem with the land tenure system in Ethiopia was that most people were landless as the means of gaining land was through rentals, inheritance and disguised sales. That system did not guarantee security of tenure and because of that there were no incentives in investing in good land management (Oba, 2012). This caused environmental degradation, reduced productivity and increased poverty. The debate on the land policy emphasized that since the ownership of land remains with the State, there is limited investment in land care by the users unlike when land is privately owned. Others argued that, if that was to be the case, the poor would become poorer as they cannot afford to purchase land, and their livelihoods are solely from the land (Deininger et al., 2007). This would in turn accelerate rural urban migration as people seek alternative livelihood options. Arguments for those who supported private land ownership tenure type are that land disputes will be reduced, investment in land management would increase, and land markets emerge (Wario et al., 2015).

Ethiopia has a central government overlooking a population of close to 100million found in nine regional states and two independent cities (Tesfahunegn, 2018) The economy is faced with challenges like expansion of cropping into rangelands and invasive species that are lowering their productivity (Gebremeskel et al., 2016). In the past, little land use planning was done in rural areas, and the country's natural resources were getting depleted and livelihoods of those

depending on them affected. Most of the land use planning that has been done before was mainly focused on the river basin development, forest planning and regional land use, with very little integration among these (Gebremeskel et al., 2016). The government envisages the land use policy will be ready for use in its third Growth and Transformation Plan for the period 2020-2025 (Deininger et al., 2007). For these reasons the government has taken major steps in issuing a national land use policy and a national integrated land use policy. Inasmuch as land is legally owned by the state in Ethiopia, grazing lands are communal property which clan members can access within their boundaries. Land under cultivation is however considered private. The constitution in 1994, declares in Article 40 that "Ethiopian pastoralists have a right to free land for grazing and cultivation as well as the right not to be displaced from their own lands (Ambaye, 2012). The Ethiopian government has over the years seen a great need to give attention to pastoralism as it is of economic importance to the nation. It has started the process of land certification to improve tenure security in the farmlands and continues to seek ways of how this certification can be implemented in pastoral settings (Beyene, 2016).

Land use planning in rangeland settings of Ethiopia is often difficult because of the overlapping uses over a large scale. In the past few years, pastoralists have been faced new challenges which call for land use planning in these areas. The government piloted a participatory district level land use planning in some of these pastoral areas (Woreda Land Use Planning-WLUP) as a way of implementing the land use policy (Gebremeskel et al., 2016). The nature and complexity of the lowland pastoral areas however need a different approach from the usual land use planning in sedentary systems. Land use planning needs time and resources for decision making processes to make sound decision and the best land use options with equitable benefits and minimum harm to the environment. There is however need for detailed information on the land resource in question and how it is positioned on the larger landscape (Ridgewell et al., 2007). When done in a participatory manner, all stakeholders are represented, and chances of future conflicts are minimized. It also allows for long term planning and environmental protection concerns are brought up for discussion. The limitations of land use planning are that at times it is limited within village boundaries and may limit the best use of the land on a large scale (Roe et al., 2013). The process can also be costly and time consuming especially where it takes long for stakeholders to reach a consensus. Livestock is an important player in the economy of Ethiopia

as seen in the Livestock Master Plan of 2015, which requires livestock intensification and more efficient use of resources (Little. et al., 2010).

2.3 Livestock production and livelihoods in pastoral systems

It is reported by Boone & Coughenour, (2001), that two thirds of Africa is in the arid to semi-arid areas where livestock farming, and wildlife are the most common land uses. The semi-arid rangelands support livestock production which is a valuable cash income source as well as for direct consumption (Abebe et al., 2012). Pastoralists have for a long time been surviving from this kind of life, but their wellbeing is declining with a reduction in livestock numbers and ecosystem diversity (Abebe et al., 2012; Brottem et al., 2014; Tessema et al., 2014). However, in recent years, new threats have emerged for this livelihood option and have seen a growing number of formerly nomadic pastoralists beginning to sedentarise and cultivate crops (Greiner et al., 2013). The pastoralists are under pressure as rangelands and other natural resources are under frequent droughts, invasion by alien species and changing policies (Schmidt & Pearson, 2016). There are numerous complexities that are found in these systems ranging from governance to climate and management of social change (Robinson, 2009). Traditional mechanisms of coping with drought and other complexities in these areas are becoming less effective because of increased rangeland and environmental degradation coupled with weak policies to solve these issues. Among the challenges that pastoralists are faced with is the increasing distance to water. Herders often have to walk long distances in search of water for their animals especially during the dry season particularly with the increasing changes in land use which has in some instances blocked the livestock corridors (Coppolillo, 2000). In the “new rangeland paradigm” of the 1990s, pastoral mobility was viewed as being ecologically rational in environments with high natural resource variability.

Changes such as land fragmentation and reduced access to rangelands because of land tenure changes, population growth and climate change and variability are causing pastoralism as a land use option to change form. Tsegaye et al., (2010) and Robinson et al., (2017) highlight that pastoralist are in a development dilemma due to economic, social, ecological conditions and policy changes. They go on to discuss that government policies have often ignored the

ecological and socio-cultural conditions in the pastoral environment and have given priority to modern agriculture. Transition from pastoralism to crop cultivation mainly due to differentiation of tenure systems has opened new lines of conflict within the pastoralist community (Greiner et al., 2013). Over the years, some pastoralists have lost their animals due to drought and have been forced to undertake coping strategy as cattle herd take time to rebuild after die-offs (Greiner et al., 2013). The increasing scarcity of land has contributed to the collapse of customary land management structures and degradation has increased at an alarming rate. Pastures which were originally reserved for dry season grazing are now under cultivation. Greiner et al., (2013), suggest that this trend will continue in the coming years as pastoralists have limited economic alternatives.

2.4 Livestock mobility in pastoral areas

Arid and semi-arid rangelands are vulnerable with respect to climate change and variability. These regions are where most of the livestock keepers are found. This means that for them to continue to sustain their livestock-based livelihoods, they have to employ a number of practices ranging from technology use to simple indigenous practices to help them to mitigate against and adapt to climate change and variability impacts (Beyene, 2016). Livestock mobility has for a long time been a climate coping strategy to counter environmental variability and has made these pastoral communities to be resilient to climate variability impacts (Butt, 2010; Turner and Mcpeak, 2014). Pastoralists use migration to exploit rangeland spatial heterogeneity and to counteract the negative impacts of natural disasters, drought, disease incidences and climate variability (Behnke & Freudenberger, 2013). Mobility continues to play an important role as a long-term strategy for adapting to climate change and variability. Unlike crop cultivation, livestock production in pastoral set ups can survive drought as animals can be moved to places where there is better rainfall and hence grazing. This is not the case in sedentary systems, where livestock herds may take a long time to rebuild after die-offs, thereby making livestock-based livelihoods prone to poverty. The decision to move livestock is largely influenced by the forage distribution, quality and quantity, competition from other species, water availability and accessibility (tenure restrictions or administrative boundaries) (Turner & Mcpeak, 2014; Wario et al., 2016). These factors vary with space and time and hence the need to strategically time and plan the herd movements.

Forage quality and quantity variation are influenced by variations in soils and climate which are the main determinants of growth and species composition (Molnar, 2014). These movements are also done in such a way that allows livestock to be on a good pasture to not only ensure survival but also be in body conditions that allow breeding to take place. There are different types of mobility employed by herders depending on the distance travelled away from the village (Turner et al., 2014). Proximate encampment is when herders move for relatively short distances of about 40km and this is usually driven by spatio-temporal variability of rainfall and limited grazing near the homestead because of expansion of croplands. Distant encampment (transhumance) is when they move for distances of longer than 40km driven by seasonality in forage quality (Adriansen, 2008). As the livestock move from one area to another, they follow corridors, which are described by some authors as braided network of paths linking water and encampment sites (Brottem et al., 2014). Changes in land use has in some instances either narrowed these corridors or blocked them completely.

The choice of corridor to take is not only dependent on forage and water availability but also the social networks along those corridors (Gonin & Gautier, 2015). These networks are key as they are for managing likely conflicts, and theft along the way as well as providing information about where there is good grazing and water. Inasmuch as forage and water availability are the main determinants of mobility, there may be variations depending on market access. Sometimes herders may deliberately choose sites where they can easily convert their livestock to cash and grain for family use (Adriansen, 2008). The distance to be moved and the size of the herd to move with is also influenced by the number of herders available to do the job versus other household uses (Adriansen, 2008; Wario et al., 2015). Moving with livestock is also influenced to some extent by cultural norms, and the tradeoffs involved. This means that the herders need not only look at the quality of the forage on the other side but also the condition of the animals before moving, whether the animals have enough energy to walk to the desired destination (Samuels et al., 2013). This means that is must be properly timed to avoid livestock losses on the way. The movements are also done in such a way that allows the nutrient requirements and vegetation preferences for the different livestock types and classes to be met, which the herders know from previous experience (Samuels et al., 2013).

Another key determinant in movement decisions is tenure rights. Variations in movement with the community can also come from herd size differences, with those with large herds more likely to move (Robinson et al., 2017). The patterns of movement vary with tenure and social networks. Land reducing mechanisms such as sedentarisation and expansion of crop cultivation have led a decline in the space for pastoral mobility to occur. As mobility is reduced, land degradation is likely as the trampling effect increases. These have implications of altering vegetation productivity in these areas (Butt, 2010). Most policies or theories that argue that pastoralism contributed to land degradation often overlook that the spatial and temporal availability of biomass in rangelands is unequally distributed across the landscape. It also overrides the fact that livestock mobility by pastoralists is often based on the environmental assessments, livestock condition and the indigenous knowledge and practices on tracking of key resources (Adriansen, 2008; Butt, 2010).

Pastoral mobility plays a big role in influencing the savanna landscape by creating nutrient hotspots around abandoned settlements that support a diversity of plants and mammals (Coppolillo, 2000; Roba & Oba, 2013). These unique habitat patches are under threat as the pastoral communities are increasingly becoming sedentary thereby reducing landscape heterogeneity and biodiversity (McAllister et al., 2006). Pastoralists move when grazing areas become finished and water becomes scarce. In some cases, grasslands are converted to shrub lands or woodlands are opened to make easy for grasslands that altering the landscape structure. These alterations in rangeland structure also have a bearing on the livestock and wildlife species thereof because of the differences in foraging behaviors.

2.5 Rangeland fragmentation, ecology management in semi-arid areas

Rangelands are a key resource in pastoral areas as they offer many goods and services that include pastoralism, hunting and gathering of fruits and tubers (Kassahun *et al.,* 2008). They are however characterized with seasonal variation between long dry periods and erratic rains especially in semi-arid areas (Greiner et al., 2013). Vetter, (2005) points out that in a grazing system with relatively predictable rainfall and consequently forage production, livestock populations are regulated in a density dependent manner via competition for feed resources. The author also says that as the population increases towards the carrying capacity, productivity decreases because of increased competition. As a result of this dynamic, it is thus suggested that

the maintenance of a conservative stocking rate in such cases becomes key. Some authors however still argue the relevance of non-equilibrium concepts to arid grazing systems (Desta & Coppock, 2002). Application of non-equilibrium concept are said to be inappropriate in drought prone rangelands of arid areas where climate is variable and pastoral mobility has been restricted. Vetter, (2005) continues to argue that most of the degradation that has occurred is not entirely livestock related but also human induced.

Rangelands are often classified as common pool resources and their management and utilization requires joint efforts by the users (Basurto, 2013, Moritz, et al., 2013a; Ostrom, 1990). Some African rangelands have over the past few years been converted to crop land (Cumming et al., 2005). These land use shifts have been caused by various drivers and have affected the pastoralist way of life and their resources management. The equilibrium paradigm that stated that ecosystem regulation is maintained stable by way of feedback mechanisms was the basis for rangeland management until around the 1970s (Vetter, 2005). This was based on the concept of "tragedy of the commons" (Moritz, et al., 2013a; Tsegaye et al., 2010) which viewed pastoralism as destructive to the environment and disruptive to the ecological equilibrium. Fragmentation leads to a reduction in rangeland size, isolation of key resources like water points, changes in spatial distribution of herbivores and hence directly disturbing the plant ecology (Tsegaye et al., 2010). Some pastoralists have already started moving away from cattle keeping to small stock as a way of coping with limited grazing (ILC, 2013). Different livestock species have different feeding behaviors and a change in the rangeland condition and productivity may have far reaching consequences on the grazing regimes (van de Steeg et al., 2010). These alterations may have adverse effects on livelihoods that depend on livestock for food and income.

2.6 Land use, land tenure security and legal pluralism in pastoral systems

By definition, land tenure is the way in which land is owned and governed by individuals or the community. Land tenure security is defined by FAO (2002) as the reasonable assurance of on-going duration of land rights, supported by the certainty that one's rights will be recognized by others and protected by legal and social statutes when contested. Land tenure rights can include the right to be on the land, the develop it, pass on to the next generation and even sell or restrict other users. One individual or community may have all or some of those rights over a piece of

land. Where one or more customary governance systems exist alongside the formal system as is the case in southern Ethiopia, a situation of legal pluralism exists. Often the formal system may overpower the customary system and render it powerless. The main livelihood activity has a bearing on the structure of the tenure system and rights in a particular area. Pastoral areas require large tracts of land which are often difficult to own and use individually, unlike in cropping sedentary systems where land can be owned and used exclusively by an induvial household. At times a land parcel can belong to different communities at different times of the year, and ownership and claims may overlap, which is termed by Robinson, (2019), complex mosaic regimes. He describes these pastoral systems as having a gradation in strength and clarity of rights over resources. In his description he says property rights are often unbundled and allocated across different governance and social actors and processes.

There may also be multiple uses for a different land parcel, e.g., it can be a grazing site for some, while it's a water source or just a livestock corridor or cultural site for others. Land tenure security and legal pluralism can if not carefully assessed disadvantage some members of the community. Pastoralists require large areas of land to graze their large livestock herds at different times of the year (Moritz, et al., 2013a). Some policy initiatives have fueled conflict among land uses and between the traditional leadership and the government in the pastoral areas as some feel that their rights to use the land are being taken away from them. Just like in neighboring countries, pastoralists in Tanzania are considered vulnerable in terms of land tenure security despite the land related legislations available (ILC, 2013). Pastoralists also fear that when land is made to be under the management of village authorities, they may lose their land and it has been proposed that they register and form groups and be affiliated to a village land use committee. Land use changes are described by Carabine & Wilkinson, (2016) as a risk faced by communities in developing countries.

2.7 The complexity of land tenure governance in pastoral systems

Communal land rights formalization is aimed at addressing the numerous challenges that pastoral systems are faced with, promote investment in land management and reduce poverty. Yet there is another often 'silent' challenge that is, matching the policy reforms with system expectations. Most policies especially with regards to pastoralism, often fail because they do not conform to

mainstream pastoral governance. Some complexities that need to be understood for effective policy implementation in these systems are discussed in this section. In a case study, Fernández-Giménez (2002) highlights that pastoral systems are under pressure to secure land tenure, but this is often complicated by the conflicting need for free and flexible movement to exploit spatial heterogeneity in forage resources. She refers to this unique complexity of these systems as "paradox" of pastoral commons. Pastoralists move with livestock between seasons in search of better feed and water to sustain livestock throughout the year (Moritz et al., 2015; Wario et al., 2016). This is strategically done by assessing both the rangeland and livestock condition. Mobility is a key livestock drought survival strategy in these areas to minimize drought related livestock losses. This "paradox" complicates the application of common property resource management theories in these systems. For instance, clearly defined boundaries are thought and believed to be a pre-requisite for secure tenure and hence common property resource management (Ostrom, 1990). Fernandez-Gimenez (2002) suggests that to avoid the problem of boundary demarcation there is need to focus on rangeland management institutions other than the formalized system. Policies to secure tenure and strengthen governance often undermine the need for flexibility, makes people more sedentary and lead to rangeland fragmentation.

The so-called 'tragedy of the commons' is inapplicable in these systems as they are already in disequilibrium and vegetation dynamics are driven more by climate variability rather than density dependency (Campbell et al., 2006; Martin et al., 2014). According to Behnke (2018), pastoral systems display unique characteristics that makes them not fully conform to conventional common property theories. Behnke (2018) refers to them as "sovereign pastoral commons" as they have unique internal organization where access is based on negotiation, coercion and competition. This makes pastoral systems to be more like legalized open access. They are territorial, and the institutions within them drive the systems more than the influence of external institutions. They are described as having political independence. However, of late these systems have been subject to external decisions mainly by State institutions that has seen some lose their land, weaken local institutions and cause high tenure insecurities. The findings of Behnke (2018) suggest that the advantages of free movement are not absolute but depend on certain configurations on resource availability with space and time. Free movement is open access although is believed by others to promote uncontrolled resource use and lead to degradation although this may not necessarily be the case in pastoral systems as these

movements are done strategically to exploit heterogeneity in resources availability on the landscape (Behnke, 2018).

After some analysis of how pastoral systems behave against popular common property theories, Moritz, (2016) proposes what he calls “open property regimes”. He highlights that in these pastoral systems often open access does not mean the absence of rules but instead refers to the pastoralist rights they have to common pool grazing resources. This is another dimension that confirms what Behnke, and others suggested about the non-conformity of pastoral systems to common property theories. Calling these systems open property regimes solves this problem of non-conformity and hence opens an opportunity to target policy and development programs that are tailored for these systems (Moritz, 2016). Resource use in these systems is driven by the temporal and spatial variability across the landscape thereby necessitating the need for seasonal mobility. The boundaries are flexible and porous, and pastoralist social fabric has a strong bearing on rangeland governance. One of the key components of open property regimes as described by Moritz (2016), is that there are no territorial boundaries, and the areas are usually large.

Galaty (2016) discusses the evolution of property theories as being expected to move from open access to common property and finally private property continuum. He continues to highlight that under conditions of climate variability and institutional changes, some state or private land may actually end up going back to either open access or common property, in a theory he refers to as “reasserting the commons”. Lesorogol & Boone (2016) share similar ideas as Galaty (2016) where they ask a question on whether the new land tenure (privatization) will lead to a “new commons” or “privatized commons”. Often landscape approaches aim at achieving one “best” level of governance and give little attention to the cross level and scale interactions (Robinson et al., 2017).

CHAPTER 3 AN ASSESSMENT OF THE IMPLICATIONS OF ALTERNATIVE SCALES OF COMMUNAL LAND TENURE FORMALIZATION IN PASTORAL SYSTEMS

3.1 Abstract

Pastoralism faces diverse challenges, that include, among others, land tenure insecurity, which has necessitated the need to formalize land rights. Some governments have started regularizing rights for privately owned land, but this is complex to implement in pastoral areas where resources are used and managed collectively. The aim was to assess how the scale of communal land tenure recognition in pastoralist systems may affect tradeoffs among objectives such as tenure security, flexibility, mobility, and reduction of conflicts. A participatory scenario-building approach was used to investigate alternative scenarios of land tenure recognition in southern Ethiopia where a new communal land tenure system is in the early stages of implementation. Through key informant interviews, focus group discussions, and a workshop, respondents analyzed the likely outcomes of communal land tenure recognition at different scales. The findings suggest that there is a good chance of success when the tenure policy is embedded onto customary structures. All scales have some shortcomings, but Reera seems best, yet pastoralists preferred the Dheeda which despite its challenges, is the best for maintaining flexible mobility. There are multiple uncertainties and complexities, which suggest the for multi-pronged approaches and various support mechanisms when implementing a formal land tenure system in these areas.

3.2 Introduction

Pastoralist livelihoods are under threat from a variety of challenges, among them the fragmentation and loss of grazing land to other uses (Clavijo et al., 2005; Desta & Coppock, 2004; Schmidt & Pearson, 2016; Tessema et al., 2014). Other challenges include unplanned settlement, expansion of cropping into rangelands, drought and bush encroachment, all of which can disrupt traditional grazing patterns (Abebe et al., 2012; Greiner et al., 2013). These factors

undermine productivity and increase vulnerability to drought and other shocks and stresses. They also contribute to conflicts among communities and among land use options (Greiner et al., 2013; Reid et al., 2005).

Insecure collective tenure has compounded these challenges and has been a key driver of rangeland fragmentation (Behnke 2008). There is preemptive panic land grabbing by pastoralists themselves in reaction to land losses through reallocation to other uses by the governments. Vulnerability of pastoralists is increasing and hence there is an urgent need to secure their rights. There is growing recognition of the need to start realigning land use and land rights policies in such a way that ensures collective tenure security and sustainability of these land-livestock based livelihoods.

Over recent years, securing land rights has become an issue of global concern as it has implications for poverty reduction, economic development, peace keeping and environmental care (Rakotonarivo et al., 2018; UN-Habitat, 2018). The need for secure land rights has attracted increasing attention in the world development agenda and is strongly backed by some of the most influential institutions such as the World Bank and the International Monetary Fund (Benjaminsen et al., 2009; Greiner, 2017). Over 70% of the world population still do not have registered land rights (UN-HABITAT, IIRR, 2011). The Food and Agriculture Organization of the United Nations (FAO) has also taken some strides in supporting responsible tenure governance. The organization has come up with voluntary guidelines for tenure governance that are intended to contribute to national and global efforts to eradicate extreme poverty and hunger by recognizing the importance of land development and promoting tenure security and equitable access to land. These guidelines also emphasize the need to legitimize and protect the tenure rights of citizens (Herrera; et al, 2016). The Africa Union (AU) has developed a Land Policy framework that urges governments to pay attention to the land administration issues and gives guidelines on how these can be implemented (United Nations. Economic Commission for Africa., 2011). It is against this background that some countries are moving towards this direction and working on legitimizing the customary land rights and implementing various land

tenure reforms (Greiner, 2017). Some governments have been overwhelmed by these calls and have been compelled to move fast to implement these policies with minimum consideration of the aftermath, and only to come back years later, trying to reverse the consequences through time consuming and costly processes (Asiama et al., 2017; Benjaminsen et al., 2009).

Where progress has been made in recognizing communal property rights, policies have been informed in some measure by the scholarship on commons based on the work of Elinor Ostrom, including the oft-cited design principles for effective governance of commons. Among these principles are recognition by authorities of the rights of communities to manage the commons, and the need for clear territorial and social group boundaries in order to group members to be able to exclude unentitled parties and prevent free riding (Ostrom, 1990).

The lack of secure tenure for pastoralists in developing countries contributes to land fragmentation and other challenges mentioned above. However, crafting frameworks to provide secure tenure for pastoralist rangelands is challenging. Traditional pastoralist governance regimes are seldom understood or even recognized by national governments and are not easily harmonized with conventional land tenure systems implemented by modern states. Policies to secure tenure and strengthen governance often overlook the need for flexibility and, in the process, undermine it. Reconciling the conflicting, and seemingly incompatible, needs of secure tenure on the one hand, and mobility and flexibility on the other, is the "paradox of pastoral land tenure" (Fernández-Giménez, 2002) suggests that to avoid the problem of boundary demarcation there is need to focus on customary rangeland management institutions rather than the formalized system. While in many countries progress has been made in formalizing property rights for privately owned land, the recognition of communal property rights is lagging. This has mainly been due to the numerous complexities that are involved in common pool resource use and management, which complicate effective policy formulation.

There remains a critical question on how policies can therefore be drafted in such a way that they serve multiple objectives including ensuring secure tenure without undermining the need for seasonal mobility. Among the choices to be made in crafting a communal land tenure

framework is how the "communities" are to be defined and delineated, and at what scale communal territories are to be recognized.

The new framework is being piloted by the Department of Rural Land Administration and Use, in collaboration with the USAID's Land Administration to Nurture Development (LAND) programme. The expectation is that the land rights formalization, commonly known as "land certification" in Ethiopia, will bring about positive change in reversing and stopping the current challenges in pastoral areas. In focus group discussions, a workshop, and key informant interviews, respondents analyzed the likely outcomes of communal land tenure recognition at different scales. The findings show that customary structures are a far better option for implementing communal land certification than land units based on administrative boundaries, and that effects on mobility is the main criteria for assessing tenure reforms in pastoral areas. Yet, even among the different types of traditionally defined rangeland territories, none of them constitute an ideal choice to become the "community" in this communal tenure system.

The objectives for a formal land tenure system in pastoral areas will not be achieved solely by allocating clearly defined property rights over clearly defined territories to clearly defined social groups, as might be inferred from a simplistic reading of commons scholarship. Instead, there is a need for a multi-pronged approach and various development and support mechanisms. Every option for delineating communities in Ethiopia's new communal land rights system has its strengths but also drawbacks. This chapter therefore explores how the scale of communal land tenure recognition in pastoralist systems may affect tradeoffs among objectives such as tenure security, flexibility and mobility, and reduction in conflicts. A participatory scenario-building approach was used to investigate alternative scenarios of land tenure recognition in a pastoralist system in southern Ethiopia where a new communal land tenure system is now in the early stages of implementation.

3.3 Methodology

3.3.1 Site description

The Borana zone of Southern Ethiopia is an ideal setting for this kind of study as it is going through a process of regularizing communal land rights for pastoralists. The Government of Ethiopia, with support from the United States Agency for International Development, has begun a process of regularizing land ownership by putting up new tenure arrangements (Cotula et al., 2004; Kuusaana & Bukari, 2015). The study was conducted in Dirre (03° 55' 37" N, 04° 46' 24" N, and 037° 58' 10" E, 039° 05' 05" E) Figure 3.1, which is one of the five grazing units (Dheedas) of the Borana zone in Ethiopi

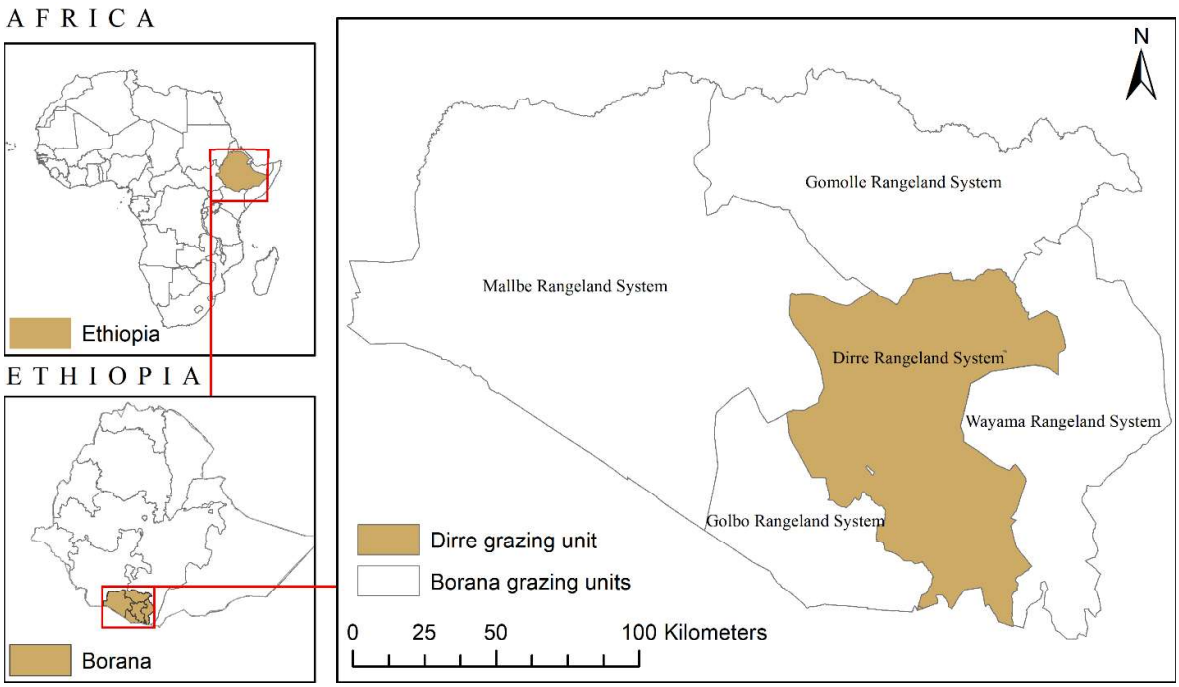

Figure 3.1 Location of the Dirre grazing unit, in the Borana, Ethiopia (03° 55’ 37” N, 04° 46’ 24” N, and 037° 58’ 10” E, 039° 05’ 05” E)

The Borana zone of Southern Ethiopia is an ideal setting for this kind of study as it is going through a process of regularizing communal land rights for pastoralists. The Government of Ethiopia, with support from the United States Agency for International Development, has begun a process of regularizing land ownership by putting up new tenure arrangements (Cotula et al., 2004; Kuusaana & Bukari, 2015). The study was conducted in Dirre (03° 55' 37" N, 04° 46' 24" N, and 037° 58' 10" E, 039° 05' 05" E) which is one of the five grazing units (Dheedas) of the Borana zone in Ethiopia. The vegetation in Dirre is mixed savanna dominated by perennial grasses namely *Cenchrus, Pennisetum, and Chrysopogon spp,* and woody plants like *Acacia* and *Commiphora spp* (Liao, 2014). It stands at an altitude of 1723m above sea level, with average temperatures ranging between 19 and 24 degrees Celsius. Rainfall is bimodal, and the annual average varies between 350mm and 900mm with a variability of between 21% and 68%, the least received in August and the highest in April (Homann et al., 2008; Deke, 2016; Liao, 2014)

3.3.2 Data collection and processing

The research employed a participatory scenario-based approach in the data collection. This involved key informant interviews (KIIs) with the different stakeholders who work on pastoral systems, land administration, and land rights issues to get an understanding of the objectives of the new communal land certification framework in pastoral areas. These stakeholders were involved at different stages, between November 2017 and May 2018. The Department of Rural Land Administration and Use (DRLAU), NGOs and the Zonal Pastoralist Development Office (PDO) were key in providing the background information that helped inform the checklist to be used for the focus group discussions. The KIIs was done with 4 national government land administration including the LAND project, 1 at regional government level, and 4 at zonal level and the 5 Reera heads and the 1 Dheeda head. The focus group discussions were conducted in Dirre Dheeda with pastoralists from five out of the five sub grazing units (Reeras), namely Dubluk, Web, Melbana, Soda and Romso. On average each focus group discussions had 12 to 15 participants of different ages and both genders. The stakeholders meeting included the different Federal government ministries, regional government of Oromia and the Borana zonal administration, research institutes, Dheeda traditional leadership and elders, and some FGD participants form the 5 reeras to get an in-depth understanding of the implementation plans and the perceived implications on pastoral system facets.

The focus group discussions were guided by the key research questions that sought to understand the future of pastoralism under different certification regimes in thirty years to come. The key facets and challenges of the system were identified with the key informants and through the focus group discussions. The current status of each facet was assessed and used as the basis for making a decision about its state in the future. The different certification scales (Reera, Dheeda, Kebele and Woreda) and a non-certification option were used as the different possible pathways to the future of pastoralism. The magnitude and direction of change for each facet were estimated by the participants. Visioning was used to create scenarios of how the future would look like under different pathways, and the rationale for the future state for each facet was discussed. This helped to visualize the unforeseen possibilities in the future and the likely tradeoffs involved. The process incorporated to every degree possible the alternative perspectives of different participants. Nevertheless, it emerged that there was broad consensus among the focus group discussions. The emergent issues were further discussed in a multi stakeholder workshop that brought together representatives of the pastoralists from the five Reeras, local government and non-governmental organizations and the local research institute. The aim of the workshop was to collate and validate the ideas from previous key informant and focus group engagements. The stakeholders also identified key uncertainties that has a bearing on the successful implementation of the land certification policy.

The participants also listed the most important reasons to pursue to achieve the goals of certification and then performed a scoring to assess how each of these would be met at different scales of certification. This was then used to choose the most preferred certification scale using the pairwise ranking in the Analytical Hierarchical Process (AHP) method developed by Thomas Saaty in the early 1980s. This method performs pairwise ranking by generating ratio data (Yatsalo et al., 2015) and it captures both objective and subjective aspects of the decision-making process, checks for consistency and hence reduces the element of bias. Eight reasons why certification is needed as discussed in the groups were used as the criteria in an AHP approach to decide which certification scale option is the most preferred. The AHP is a component of the multi criteria decision analysis (MCDA) as described by (Dodgson et al., 2009; Kiker et al., 2005; Yatsalo et al., 2015). The MCDA uses a set of evaluation criteria, and in this case, it was the rangeland health, livestock mobility, customary institutions, conflict reduction, ease of communication, control cropping in rangelands, tenure security and community-based

rangeland management (CBRM) as mentioned by the stakeholders. These were used to assess which certification option achieved the most desirable trade off by generating weights for each criterion. The higher the weight the more important was those criteria in terms of achieving the objectives of certification. The criteria weights were then combined with the option scores to determine the overall score to be used for ranking. The overall score for a given option is the weighted sum of scores it achieved with respect to all the criteria (Yatsalo et al., 2015).

3.4 Results

3.4.1 Future scenarios of pastoralism with or without certification

The focus group discussions identified the main facets and challenges that are key to the sustainability of pastoralism as a livelihood. Twelve key facets of pastoral systems were identified by the stakeholders. These were discussed individually to capture their dynamics and expected outcomes thirty years from now. The focus group discussions each did separate assessments, which were then presented to a larger group in the stakeholder workshop. There was little variation among the focus group discussions in terms of the perceived magnitude and direction of change. The stakeholder workshop further refined and analyzed the focus group findings to produce a consensus on expected outcomes under different scales of communal land certification as presented in below.

Table 3.1 The expected outcomes of the facets of pastoralism under different scales of certification as mentioned by the respondents

Pastoralism facet	**Expected outcomes without certification**	**Expected outcomes for certification at:**			
		Reera	**Dheeda**	**Kebele**	**Woreda**
1. Rangeland condition	A large decline as there will be less land available for grazing and encroachment of cropping increases, more land losses to outsiders without compensation continues, no incentive to invest thereby compromising rangeland management	A huge improvement as the area is small hence stronger sense of tenure security, high motivation to invest in rangeland management, easy to communicate and mobilize the community	Easy to plan grazing into seasonal grazing zones thereby allowing other sections to regrow but a moderate improvement as the large size makes progress in range management slow.	More animals might be confined in a small area because of likely mobility restrictions resulting in a large decline in rangeland condition.	Area will be large hence less overgrazing is expected but, cut across different grazing and customary units, difficult to plan grazing and rangeland management activities so the condition will decline moderately
2. Land degradation	A huge increase as the grazing rules are broken and hard to enforce, increase in the cropping on prime land.	Impossible to divide the rangeland into different grazing zones but easy to implement CBRM hence degradation may continue but	A small decrease as it will be easy to plan grazing, and settlements but difficult to mobilize the community for CBRM	Small land sizes and hence overgrazing, resulting in large increases in degradation	A large increase as no one will be no one vested in controlling land degradation

		by a small margin.			
3.Community Based Rangeland Management (CBRM)	Moderate decline as there is no incentive in investing on land they might lose. It will get even more difficult to mobilize people who are not motivated and insecure. Maybe only possible for NGO supported programs	Small size, which is good for managing grazing and easier to mobilize people to work, easy communication and monitoring hence a large improvement in the involvement	Easy to divide the land into seasonal grazing regimes but mobilizing people to work and to enforce rules may be harder because of the large size hence a small improvement.	Management and decisions about the land will be made by the Kebele officials seeing a large decline in CBRM	A large decline as community mobilization will be impossible as it will bring together communities from different grazing units and clans
4.Strength of customary institutions	A large weakening as the government role becomes stronger especially in decision making about land allocations and investments	Governing a smaller tenure secure group will be much easier a moderate increase in strength is likely	Community leaders will have their authority revived but difficult to bring all on board due to slow information flow hence a small increase	A huge weakening as pastoralists will feel insecure and as they will be governed by the Kebele officials.	A huge weakening as pastoralists as the government administration, which is more formal would be more in charge.
5.Tenure security	Very high tenure insecurity as there could be more land taken without compensation as already seen in other regions.	A huge strengthening as the small size makes it easy to have ownership deeply rooted within the	Easier to stop outside interference, but not so much as its big size may limit the ability of locals to be directly involved in decision making hence a	A huge decline as land related decisions will be done by the Kebele officials, risk of more land losses.	A huge decline as this will bring in people from other Woredas into same grazing regime and weak local institutions, locals

		pastoralist communities, small size also means that participation in decision making would be easier	moderate increase		no longer have a strong voice.
6.Livestock herd sizes	Productivity will go down because of decline in rangeland condition, overall numbers would eventually go down.	A moderate decline as the carrying capacity declines and there will be a need to supplement the rangeland, scale down on numbers and/or intensify production.	Free and flexible mobility and division into seasonal grazing will encourage herd growth but climate stresses will still force pastoralists to scale down a little	Pastoralists' loss of land governance power and even smaller grazing areas will cause a mild decrease in herd sizes.	Risk of thefts, conflicts and poor rangeland condition making it hard to keep a large herd but a mild decline as pastoralists are livestock people
7.Livestock species compositions	A small increase to curb the feed shortages, pastoralists will keep other livestock types, but poor rangeland will be a limiting factor	Small area size and high risk of restricted mobility would push to scale down, intensify but maintain current species composition	Free and flexible mobility support cattle keeping which is the main activity so this could be chance to focus more on cattle	Small land available for grazing will make it hard to diversify, scaling down is likely	Poor rangeland condition push to the keeping of other livestock types but only a small increase because of grazing access limitations
8.Livestock prices	A small increase because of less animals being available for sale, but poor body condition will	Limited livestock numbers and improved quality that may push the	There may be an improvement in rangeland condition and hence livestock quality	The prices may decline because of more distress sales, and as the	The prices may decline because of more distress sales, and as the

	minimize the price increase	prices up but by a small margin	and prices but may later stabilize as the market gets more animals	livestock condition declines, the price will slightly go down	livestock condition declines, the price will slightly go down
9.Livestock mobility	Small decline within the Dheeda but there may be more out-of-Dheeda movement because the rangeland would bad state and herders will go far	A large decrease in mobility to try and protect the limited available grazing	No change as the seasonal grazing patterns will be revived	Small size will cause a huge increase restricted mobility.	Large size good for mobility, high risks of conflicts, theft in new areas hence a small decline in mobility
10.Conflict incidences	A high increase in grazing related conflicts as grazing becomes less available	Conflicts may increase as there may be mobility restrictions	No change as the customary institutions get stronger and grazing rules are revived	Very high because of limited area size and restrictions.	Very high increase in conflicts as there will be stepping on other people's territories
11.Area under cropping	Many will be pushed to go into cropping as they see their livestock die of drought. However, the area is generally not good for rainfed crop production, hence a small increase	Easy to control random cropping and settlement and with good prospects of improved rangeland and hence livestock production	May decrease slightly as some may still feel they are not benefiting from large scale certification	A small increase as there is more support for cropping to cope with a filing livestock production system	Same as for Kebele certification
12.Alternative livelihood	Very limited opportunities from pastoralism, high	Better opportunities for	Slow progress in livestock production but	Limited opportunities from	A huge increase in seeking alternative

sources	risk of land losses, high conflicts and degradation, hence a huge increase is expected	intensive livestock production, but the high drought risks hence a small increase	possibility of improved tenure security hence a moderate increase in people seeking alter-native livelihood sources	livestock keeping hence a large increase in people seeking other livelihood sources	livelihood sources as pastoralism becomes less attractive.

3.5 The scenario narratives

Based on the different pathways and visions of the future, the outcome of the key informant interviews, focus group discussions and the stakeholder workshop the following narratives of the scenarios were created. These narratives were largely informed by the rationale for the magnitude and direction of change for each of the pastoralist facets identified by respondents as summarized in table 3.1 above.

3.5.1 No certification scenario

"free falling system, no hope for pastoralism"

With no certification, a large decline in rangeland condition is expected because there is likely to be less land available for grazing as encroachment of cropping into rangeland and land losses to outsiders with no compensation continues. A huge increase in land degradation is expected as investment in rangeland management declines, bush encroachment increases, collapse of grazing rules continues. High tenure insecurity and more grabbing of land and rules will be eroded as customary institutions become weak. Some rangeland management activities may be driven by NGOs and pastoralists will participate for immediate benefits such as food aid from the NGOs. The stakeholders strongly felt that a large weakening of the role and authority of customary institutions is likely to be seen while the government role becomes stronger especially in decision making about investments on the land. The huge decline in rangeland condition will cause productivity to go down as well as herd sizes which will destabilize prices as they go up because of shortage but not so much as the condition will be poor. To curb the feed shortages, pastoralists would find themselves diversifying into keeping other livestock types especially camels. This will not be a large increase as some are already into camel keeping and, in some areas, camels are also dying of drought. Camels and goats are also good users of bushes so they may increase slightly while cattle numbers may decline by a small margin. The respondents unanimously agreed that there would be more out-of-Dheeda movement because the rangeland would be in a bad state and herders will be forced to go far.

Conflicts might increase but, moderately as more land will be degraded and not attractive for livestock rearing or cropping. It is envisaged that that there would be a small increase in the land under cropping as the pastoralists lose livestock to drought related deaths. However, the area is generally not good for rainfed crop production, so this might not increase

significantly. The observations by the respondents were that some people were already beginning to move to the cities in search of alternative livelihood sources, and this is expected to increase.

3.5.2 Certification at the scale of customary territories scenarios

"hope for pastoralism"

The hope to continue pastoralism with certification being implemented according to the Borana customary structures seems to be restored. There are still however tradeoffs between the two customary scales in meeting the overall multiple objectives of the land certification.

(a) Reera scale

"secure tenure, major changes, modern livestock production"

The participants from the focus group discussions and the stakeholder workshop strongly agreed that Reera level certification offers an opportunity for a stronger sense of tenure security because of its smaller size as compared to the Dheeda or Woreda. Participants suggested that this would in turn make it easy to mobilize the community to invest in rangeland management activities, leading to a huge improvement in rangeland conditions as compared to business as usual. It will also be easier to control cropping and unplanned settlements in the rangeland. The strength of the Borana-wide customary institutions may not increase much as there might be fragmentation of the rangeland and the social fabric. Mobility is highly likely to be restricted as the community protects their rangeland from outsiders and in turn get restricted too. There may be need for long negotiation processes before animals are moved and this may contribute to some conflicts as not all Reeras are endowed with all the necessary resources such as water pans and other sources. The small size of the Reera will make it difficult to divide the rangeland into seasonal grazing zones.

For these reasons, some degradation may still occur but at levels much slower than when there is no certification. Small grazing area at Reera will force the pastoralists to either scale down the livestock numbers, supplement feeding or venture into more intensive means of livestock production like pen fattening. Proper land use planning will be necessary to allow more productive use of the limited land resources. There will be good prospects of making a living from intensive livestock production, but the drought related risks may still make it unattractive to many hence a small increase in people seeking alternative livelihood sources like employment in the cities may be experienced.

(b) Dheeda scale

"free and flexible mobility"

With Dheeda level certification, the respondents emphasized that its large size makes it easy to plan grazing into seasonal grazing zones, thereby allowing other sections of the rangeland to regrow. This, together with ease of control of settlements will also translate to moderate improvement in rangeland conditions. A small increase in the strength of customary institutions is expected as the community leaders will have more authority but there is a risk of slow information flow, and it could either take time to make decisions or the process may not be inclusive enough. However, its large size may make community mobilization difficult hence the small progress in rangeland management activities and some degradation may still continue. On the other hand, a medium increase in tenure security may occur at as it would be easier to stop outside interference, but not so much as its big size may limit the ability of locals to be directly involved in decision making, the system could be prone to external manipulation. A small decrease may occur in livestock species composition to spread the risks associated with drought, some may start keeping more camels and small stock. Mobility will be free and flexible because of the large size of the Dheeda which would be ideal for herd growth, but this will be kept in check by drought. Conflicts within the Dheeda may be less as movements will be planned, but conflicts outside the Dheeda may continue. A moderate increase may occur in people seeking to alternative livelihood sources like moving to the cities as there may still be drought related challenges that slow progress in livestock production.

3.5.3 Formal administration certification scenario

"customary system collapse"

It was unanimously agreed by the participants that certification according to the formal structures will present a unique scenario. For example, the Woreda is large but cuts across different grazing and customary units, thereby making the pastoralists feel more insecure about ownership and access and will not be compelled to invest in rangeland management. People may be forced to even do cropping to try and cope with limited options and because the area will be small particularly at Kebele, high levels of degradation will occur. A large decline in the strength of customary institutions is expected because decisions on land

management will be made by the Kebele officials and pastoralists will feel they are not in charge anymore. Community mobilization will be impossible at Woreda level as it will bring together communities from different grazing units, clans and traditional leadership. Some of these communities are already in land related conflicts. It was widely agreed that this would be a "chaotic," scenario and the whole customary system would crumble. The land users highlighted that they would feel completely excluded as most decisions including conflict resolution will be handled by the formal government administration. High risks of conflicts and livestock theft in new territories, but the large size (at Woreda) may still facilitate more flexible mobility. The government at Kebeles and Woreda are providing more extension support for cropping and with limited options pastoralists may want to diversify into cropping. The unsuitability of the area for cropping production could still be a reason why a small increase is expected. With the livelihood options in the pastoral areas becoming more limited under this certification regime and livestock production being difficult there will be a huge increase in people seeking alternative livelihood options like moving to the cities or venturing into construction businesses.

3.6 Some key uncertainties to consider

During the stakeholders' workshop, focus group discussions on the likely outcomes under different scales of certification, the issue of uncertainties came up many times. These were said to be the likely setbacks or "fears" that could derail the success of the land rights formalization program despite the scale of implementation. The respondents repeatedly emphasized that these should not be overlooked in planning but be treated as important red flags, that the policy implementation should be on the lookout for. The respondents were not sure how these would pan out or how exactly their implications on the certification would be and hence were described as uncertainties. The key uncertainties identified are presented in Table 3.2 below.

Table 3.2 Key uncertainties as mentioned by the participants in the focus group discussions

Key uncertainties
1. Increasing human population which may also mean overall increase in livestock numbers and hence degradation and this may stimulate conflicts
2. Climate change and variability: pastoralists acknowledge that the climate is changing and if this trend continues, the traditional grazing management rules may fail to be compatible with the new certification regime and there may be a need for a review.
3. Ageing pastoralist population: youths are more towards education, moving to the city and with limited interest in herding animals.
4. Culture loss and weakening of customary institutions
5. Urbanization: there is an upward trend in the development of small shopping centers in the pastoral areas into urban areas and these may continue to grow into the rangelands

3.7 The preferred scale of certification

The criteria to decide on which certification method was most preferred was based on the eight criteria identified by respondents as the main reasons why certification was needed. These were identified as the need for good rangeland health, ability of invest in CBRM activities, stronger tenure security, stronger customary institutions, reduction of conflicts, free and flexible mobility, ease of communication and control cropping in rangelands. The ranking of each criterion using the AHP was based on the likelihood of the scale being able to meet the objectives of certification.

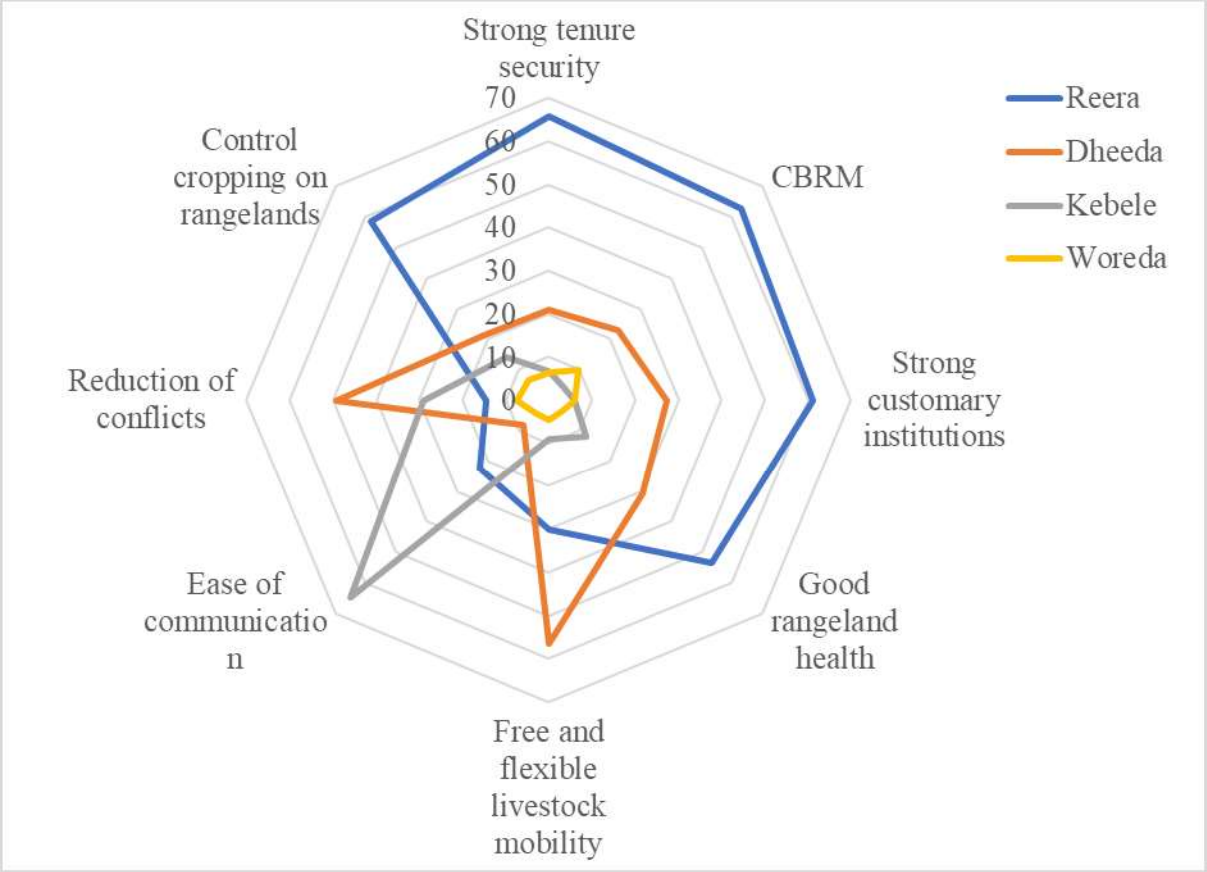

Figure 3.2The criteria for choosing the most desired certification pathway

The Reera scale certification appears to be the most preferred based on the eight criteria as shown in Figure 3.2 above, having scored highest in most of the selected criteria. However, because of it being smaller than the Dheeda, it scored lower for facilitating flexible mobility. The government structures (Kebele and Woreda) are not preferred for many reasons as discussed in the previous section and have the lowest scores under most criteria except the ease of communication at Kebele level. Despite the Reera scoring high in most of the criteria, the pastoralists still chose Dheeda level certification as it offers a good chance of free and flexible mobility which is what they said matter the most for the sustainability of pastoralism as a livelihood source.

3.8 Discussion

The overall aim was to understand how communal land rights formalization at different scales would unfold and what the implications for pastoral land governance would be. Several issues emerged from the participatory scenario development process. Firstly, there is clearly a shared vision about the objectives of the certification policy. Both the NGOs and the

government (Federal and Regional) emphasized the biggest reason for certification as being the need to secure the rights of pastoralists as enshrined in the constitution. This is expected to be useful in the event of major developments going on the land, as pastoralists can be compensated. The findings however suggest grave shortcomings for certifying the land using the boundaries formal structures (Kebele and Woreda) as compared to the customary territories (Reera and Dheeda). The major weaknesses for the government administrative units relate to the incongruity between their borders and those of the Borana customary system. The respondents in the research overwhelmingly agreed that using the administrative units to create the "communities" for communal land certification would present challenges for all the important criteria mentioned above, particularly tenure security, livestock mobility and conflict. The Dheeda level has its own unique challenges: its huge size makes it attractive for mobility, but not tenure security and investment in community-based rangeland management. One elder from Dubluk Reera said,

"*dao fago dhamoch hin dho wit*"

meaning "*a coat kept far away will not keep you from shivering*". He was explaining that a certificate given at Dheeda level and kept by the head of the Dheeda will not make them feel very secure as the large size of the dheeda will limit them from relating closely with it. So, based on the eight criteria, Reera would seem the best.

Yet, the pastoralists who participated in the research strongly prefer the Dheeda as the unit for communal land certification, despite them having scored it relatively lower than Reera for most of the criteria. This is not a question of irrelevant criteria being used in the scoring—the eight criteria were derived from the participants 'own listing and were acknowledged by them as being important. Certification at the Dheeda level, however, scored highest on two criteria: *free and flexible livestock mobility* and *reduction of conflicts*. Even certification at the Reera level was not preferred despite it being based, like the dheeda, on one of the traditional territorial demarcations, and despite it being seen as having the best chance to establish secure communal tenure, facilitate effective rangeland management systems, and contribute to improved rangeland conditions. Instead, the need for livestock mobility trumps all other concerns. For pastoralists, inasmuch as secure tenure is very important, it is clear that a desirable and sustainable tenure system for them is one that is implemented at a scale that allows flexibility and freedom of movement in times of feed and water scarcity. As the piloting of communal land certification based on dheedas moves forward in Borana Zone, the

results of the scoring suggest that some challenges can be expected. The Dheeda is a very large scale at which to implement rules on grazing and other natural resource management interventions. The vast extent of dheedas—the smallest being Golbo at 307248 ha. in area—imply that it is not the ideal level at which to address problems of exclusion and free-riding. That the participants scored the smaller Reera as being superior to the Dheeda on five out of the eight criteria indicate that they are completely aware of these challenges. Even the matter of whose name should appear on the dheeda land certificate is unclear, as there has not been a strong, clearly defined, and formally constituted management institution at this level.

The tradeoffs among the various criteria, and particularly between flexible mobility and secure tenure, provides another example of the "paradox of pastoral tenure" (Fernández-Giménez, 2002). Policymakers seeking to design land governance systems will seldom be able to choose an option which optimizes all criteria but must craft arrangements that provide the most suitable tradeoffs among different objectives, including the establishment of secure tenure, maintaining the flexibility inherent in traditional pastoralist systems, and others. The social relations, livelihood dynamics and ecological implications that can be expected with formalization of communal land tenure over different kinds of territories show that effective tenure implementation in these areas is not just about getting the scale right. Clearly it is important to take the scale into consideration when formulating policies, and understand the scale challenges (Cash et al., 2006), but in pastoral systems there is no single best fit that will simultaneously achieve all objectives (Robinson et al., 2017). The array of objectives for a formal land tenure system in pastoral areas will not be achieved solely by allocating clearly defined property rights over clearly defined territories to clearly defined social groups, as might be inferred from a simplistic reading of commons scholarship.

In some pastoralist settings, including the traditional system of the Borana, it has been argued, that the land and resource governance arrangements that have emerged are not conventional commons but rather are complex mosaics characterized by unbundled and often overlapping rights, and a reliance on a range of governance mechanisms in addition to property rights (Robinson, 2019). It is therefore suggested that effective implementation of formal tenure systems need to understand these realities. It seems there are larger chances of success of the certification when embedded onto the local governance structures and higher preference to smaller scale certification but what is most important for pastoralists is mobility. The complex mosaics model suggests that overlapping claims over resources, and high levels of spatial heterogeneity in resources make the need for mobility and access to key

resources found in territories belonging to other communities at certain times inevitable. Every option for delineating communities in Ethiopia's new communal land rights system has its strengths but also drawbacks. An understanding of this dynamic is important for tailoring policies that are relevant and fit into these systems.

The multiple uncertainties and complexities, therefore, suggest that a multi-pronged approach and various support mechanisms will be needed. What this means is that development policies ought to make this work in such a way that the challenges of the system are reduced and at the same time meet the pastoralists expectations and enhance livelihoods through livestock keeping. This is a critical time for there is a lot of pressure from the pastoralists and the need to align with global expectation by national governments but, policies still need to be carefully formulated. It is important not to look only at the short-term benefits of securing land rights through certification, but to look at the long-term implications.

Rainfall variability across the landscape results in the need to move to other areas unavoidable. In fact, this land certification comes at a time when the climate variability is rapidly increasing in the horn of Africa (Pricope et al., 2013). Land based livelihoods are already under a lot of pressure, due to, for instance the increasing human population and changing climate. The land use and tenure policies therefore need to be carefully formulated and take an implementation path that mitigates against these external pressures and at the same time achieve a better life for all.

3.9 Conclusion

One of the implications of the findings is that effective communal land governance is driven by a complex mix of community dynamics, social relations, and the biophysical characteristics of the landscape. It is certainly not just about getting the scale right as no single scale meets all the criteria. Secondly, it is seen through the scenarios that there is need for further development and policy interventions to facilitate sustainable communal land rights formalization. Thirdly, it is important to note that all this is taking place in a world of high uncertainties and these need to be taken into consideration when planning and implementing a new land tenure policy. Finally, there is clearly a need for a more inclusive approach in the planning process instead of basing the arguments about tenure on one theory.

More broadly, the reality is that many African countries have challenges related to land access and ownership and it causes a lot of problems such as degradation, conflicts and

declining livelihoods. There are different solutions to tackle these land issues, with different implementation plans, for example the Fast Track Land Reform (FRLR) in Zimbabwe, the land expropriation policy in South Africa, the Village Land Use Planning in Tanzania and the Kenya county spatial planning among others. The world is taking the direction of more improved transparency and accountability in different facets for sustainable development and food productivity, as seen by many calls for responsible governance and approaches to land reform (Asiama et al., 2017).

From this work some learning points are suggested for many other countries such as Mongolia, Bangladesh and Colombia, Malawi, Burkina Faso and Zambia, which are faced with similar tenure challenges and are seeking to begin the process of regularizing land rights and strengthen customary land governance structures. The findings show that customary structures are a far better option for implementing communal land certification than land units based on administrative boundaries, and that effects on mobility are the main criteria for assessing tenure reforms in pastoral areas. Yet, even among the different types of traditionally defined rangeland territories, none of them constitute an ideal choice to become the "community" in this communal tenure system. The objectives for a formal land tenure system in pastoral areas will not be achieved solely by allocating clearly defined property rights over clearly defined territories to clearly defined social groups, as might be inferred from a simplistic reading of commons scholarship. Instead, there is a need for a multi-pronged approach and various development and support mechanisms.

The participatory scenario building in this context was important for eliciting key considerations, preferences, and uncertainties involved. It also oriented stakeholders in viewing the implications of different scales of implementation with several lenses thereby informing the decision-making process about the important tradeoffs involved which can be used for building monitoring guidelines. Future scenarios of pastoralism are important in that they unpack critical outcomes of how the biophysical issues like rangeland health and degradation will change under different certification options. This is important as it prepares and helps both decision makers and resource users to not only look at the maximum benefits but to also strike a win-win situation between resource conservation and livelihood benefits (Basurto, 2013; Mcginnis & Ostrom, 2014).

CHAPTER 4 THE INTERACTIONS BETWEEN THE FORMALIZATION OF COMMUNAL LAND TENURE AND SOCIO-ECONOMIC DRIVERS THAT SHAPE LAND USE IN PASTORAL AREAS

4.1 Abstract

The increasing demand for land in pastoralist communities coupled with tenure insecurity has contributed to land losses, degradation, decreasing household herd and incresing poverty and food insecurity. In response, pastoralists are gradually transforming their livelihoods and land use patterns. At the same time, land rights formalisation programs aimed at protecting communal land rights are being implemented in pastoral communities in various countries. The study sought to explore how formalization of communal land tenure in pastoralist areas may interact with livelihood and demographic drivers that shape land use. A household survey was conducted with 187 households in Dirre dheeda, of the Borana Zone, in Ethiopia. Seventy-five percent of the respondents expect an improvement in the participation in rangeland management activities if land certification is implemented, while 76.5% expect a decline without certification. The study also found that pastoralists strongly believe that land certification will secure land rights, enable better management of rangelands, and improve livestock-based livelihoods. However, the findings also suggest that certification will not necessarily reverse individualization and the ongoing shift in livelihoods toward agropastoralism. The respondents overwhelmingly intend to expand crop farming whether land certification is implemented or not. It is concluded that, while strengthening communal tenure for pastoralists is key, the drivers toward individualization and adoption of crop agriculture are such that implementing a formal communal land tenure system will not always in itself be sufficient to stem individualization. The reasons for livelihood transition go beyond land tenure security.

4.2 Introduction

In developing countries, land is at the center of development challenges. With the demand for land soaring, securing and prioritizing land rights for citizens has become a priority

(Deininger & Binswanger, 1999; Enemark, 2016). Land rights formalization policy reforms have been gaining momentum on the world development agenda owing to the importance of land for poverty reduction, and economic wellbeing (Flintan, 2011; Meur., 2005; Woodhouse, 2012). Over recent years, considerable progress has been made towards enhancing livelihoods by ensuring secure land rights (Deininger et al., 2007; Ghebru & Lambrecht, 2017). The World Bank emphasizes the importance of land as a platform for economic emancipation and poverty alleviation (Deininger et al., 2008; Deininger & Binswanger, 1999). The African Union has also developed a framework and guidelines on land policy in Africa which guides governments on how to strengthen land rights, enhance productivity, and secure livelihoods (African Union et al., 2014). Amid these developments is a growing local, national, and international interest in acquiring and investing in land, putting communally owned land at risk of being reallocated for commercial agricultural projects (Archambault, 2014; Roe et al., 2013; Tura, 2018). In many locations, the "land rush" has seen large scale land acquisitions putting the rights and livelihoods of land-dependent communities in jeopardy (Anseeuw et al., 2011). In most of these cases, this is occurring with minimal efforts to protect communal land rights as the institutions that are expected to play the role of protection are often weak (Flintan, 2011; Alden-Wily, 2018).

Pastoral areas have not been spared from the effects of increased land demands, experiencing continued land losses through reallocations with no compensation (Manzano, 2018; Notenbaert et al., 2012). The increased demand for land has been exacerbated by a combination of drivers, such as rapid population growth and economic growth as well as urbanization (Teklu, 2004). This has contributed to such challenges as land degradation, declining livestock populations, increasing poverty and food insecurity. Recurrent droughts and erratic rains have also contributed to livestock losses for many pastoralists (Baird & Gray, 2014; Desta & Coppock, 2004). Over recent years, with land becoming scarce, grazing options have become limited and people end up losing animals to droughts (Burnsilver et al., 2007). Some households are able to recover while others fail to do so and become food insecure (Desta & Coppock, 2002; Dressler et al., 2019; Scoones & Graham, 1994). Land scarcity also comes at a time when land is being reallocated for other uses. This has led to many pastoralists adapting to change by diversifying into other livelihood strategies, including cropping (Aklile & Beyene, 2014; Dressler et al., 2019; Scoones & Graham, 1994). This has, however, further led to a web of interconnected challenges that include an increase in unplanned settlements, cropping on marginal lands, conflicts, and further degradation of

rangelands (Bassett, 2009; Mwangi, 2009). These challenges have spiralled into further consequences such as fragmentation of the rangelands, blocking of livestock migratory corridors, and the collapse of traditional grazing management systems (Mwangi & Dohrn, 2006; Schmidt & Pearson, 2016).

Secure private land tenure incentivizes investment and improves livelihoods through improved productivity and sustainable management of resources (Alden-Wily, 2018b). For communally owned land, there is evidence, albeit highly variable and site specific, that secure tenure may translate to better investment and improved productivity (Bassett, 2009; Deininger & Feder, 2009; Ege, 2017; Ghebru & Lambrecht, 2017; Schmidt & Pearson, 2016). Deininger et al., (2008) reports that most African countries are producing below their productive potential, and this was linked in part to low investment in agriculture because of lack of secure land rights. In pastoral areas, the justification given by proponents of strengthening communal land rights is based on the reasoning that secure collective land rights will increase the willingness to invest in better management of rangelands and curtail land grabbing and fragmentation (Elias & Abdi, 2010).

However, in some cases, clarifying and devolving communal land rights, rather than curbing the trend toward fragmentation, sedentarisation, and land alienation, has been found to accelerate it (Asiama et al., 2017; Manzano, 2018). This is usually because the relationship among land, livestock, and the people in pastoral societies are often poorly understood, thereby complicating the provision of secure tenure (Herrera et al., 2016; Moritz, et al., 2013b). This limited understanding of biophysical, institutional and social dynamics further adds to the complexity of implementing policies in the drylands (Tilahun et al., 2016). In some pastoral areas, shifts in livelihoods were enhanced by the government sedentarisation policies and land rights reforms (Chimhowu, 2018; Chimhowu & Woodhouse, 2006, GFDRE, 2003). In other cases, clarifying and devolving communal land rights, rather than curtailing the trend toward fragmentation, sedentarisation, and land alienation, can accelerate it (Asiama et al., 2017; Manzano, 2018). A study in Afar, a region in Ethiopia, reported an increase in the need to diversify and do more cropping under the new land governance system (Schmidt and Pearson, 2016).

Arguments for strengthening communal tenure in pastoral systems are often formulated with some inbuilt assumptions about land use, livelihoods, and governance. Researchers, policymakers and development professionals often assume that pastoral rangelands either are or should be commons (Moritz et al. 2013a). This assumption has been disputed by some researchers who have found that many pastoral rangelands are not regular commons and defy categorization according to the usual land tenure categories (Behnke, 2018; Moritz, 2016; Robinson, 2019). Failure to adequately understand the dynamics of mobility, resource access and governance of pastoral systems may lead to crafting of policy interventions that can unintentionally create more problems than solutions. An example is the case of the Borana in Ethiopia where the establishment of additional water sources unintentionally disturbed grazing rules and other indigenous knowledge-based natural resource management systems (Bambio & Agha, 2018; Homann et al., 2008). Another classic example of the implications of land and resource policy on pastoral livelihoods and rangeland management is the group ranch system in Kenya. This was put in place by the Government of Kenya to increase the productivity of pastoral lands by establishing clear group rights to land, reducing landlessness, improving offtake, and halting rangeland degradation. The group ranches were also meant to indirectly sedentarise pastoralists, make them realize the extent of land scarcity, and encourage investments on land improvement (Kibugi, 2011). This did not go as planned due to multiple complex factors that included the reluctance to sell livestock and the drive to move from group tenure to private individual tenure.

Many ranches were later subdivided leading to small land shares, and increased cultivation on both good and fragile marginal lands. This meant that there was less grazing land available to contain the livestock population, thereby causing severe environmental degradation, and conflicts. Other ripple effects of the subdivision were the damages to the pastoral social structure, increase in poverty, and food insecurity (Kibugi, 2011; Veit, 2011). The group ranch concept was an alteration to the land tenure system which was meant to prevent the degradation but overlooked the socio-ecological interactions in the pastoral systems. The history of Kenyan group ranches shows that fragmentation of rangelands may still be an issue even with land tenure reforms which in theory should be strengthening collective property rights and reducing fragmentation.

Elsewhere, in other land-based production systems, the use of top-down, one-size-fits-all approaches has led to failed tenure regularisation programs (Deininger & Feder, 2009). Land

tenure formalization in pastoral areas often fails to take into consideration the complexity of pastoral systems (Deininger & Feder, 2009). Interactions between drivers of land use and formal land tenure systems have not been widely explored, particularly in pastoral areas. Often there is a mismatch between the aspirations of land users vis-à-vis the government land registration objectives, which often overlook the complex, adaptive nature of these systems (Scoones and Sirling, 2020; Cumming et al., 2005) In these areas, uncertainty is high; for example, rainfall variability and climate change have not really been well articulated and predicted to ensure accurate planning (Pricope et al., 2013). There are many other uncertainties such as disease outbreaks, political unrest and the ever-changing global market trends. An understanding of this high uncertainty therefore needs to be carved into the policy making process, by capturing how pastoralist are already reacting to changes they see now or envisage (Bassett, 2009).

The discourse on land tenure reforms often makes assumptions about investment, livelihoods and land use (Ghebru & Lambrecht, 2017). In pastoral areas, land tenure formalisation may affect pastoralists in dynamic and unexpected ways, hence the need to understand how these would potentially interact with livelihoods and other land use drivers. The livelihoods of pastoralists are in flux, and land use and livelihoods are influenced by various complex drivers. Therefore, development work and land tenure policy reforms should avoid simplistic assumptions about collective tenure security but also consider what pastoralists are already doing (Moritz, et al., 2013b; Robinson & Berkes, 2010). There is a need to be cognizant of the array of different influences on land use in pastoral areas, and how these interact with and potentially constrain the efficacy of recognizing communal tenure. Given the key role of land in economic wellbeing, protection of pastoralists and rangelands remains an issue to be treated with urgency and to be supported by legal instruments (Mwangi & Dohrn, 2008). It is critical, however, that land tenure reforms be formulated in a way that take into account changing livelihoods and land use patterns and reflect the land users' views and aspirations.

This chapter explores how formalization of communal land tenure in pastoral settings may interact with other facets of livelihood, socio-economic and demographic drivers that shape land use. Household data from the Borana in Southern Ethiopia was used to assess the proportion of pastoralists who perceive specific changes in the different pastoralist facets in the context of land rights formalization, in Ethiopia referred to as "land certification". A case is built about what changes may occur with certification by first capturing the current state

affairs for livelihoods, rangelands, and livestock herd sizes. The study also assesses if perceptions about the future livelihoods are influenced by wealth status and if there were differences in current household demographics, livestock herd sizes, and cropping dynamics among the wealth classes. The findings show that the ongoing adoption of crop farming by pastoralist households is not driven only by land tenure insecurity and is not likely to be curtailed by communal land certification, as important as that may be.

4.3 Land certification in Ethiopia

In Ethiopia, the ultimate ownership of land is with the State, and land rights formalization involves the issuance of a land rights "certificate" that recognizes individual or communal property rights. This process is referred to as *land certification.* Ethiopia has made some progress in the formalization of land rights for its citizens. The 1994 Constitution declared in Article 40 that "Ethiopian pastoralists have a right to free land for grazing and cultivation as well as the right not to be displaced from their lands" (Ambaye, 2012). Certification has been successfully rolled out in the agricultural highlands of Ethiopia for individual/family land but in pastoral lowlands, a different framework for certifying communal lands was needed and the process has been lagging (Deininger et al., 2007; Holden & Bezu, 2016; Samuel, 2006). Continued losses of land to development projects without compensation have contributed to high levels of tenure insecurity, which in turn has spurred an increase in individualization through grabbing, fencing off and at times cropping some land parcels (Aklile and Beyene, 2014; Anseeuw et al., 2011; Tura, 2018). It was only in 2017-2018 that land certification in pastoral areas started gaining momentum under the support from The United States Agency for International Development's (USAID's) Land Administration to Nurture Development (LAND) project in collaboration with the Department of Rural Land Use and Administration (DRLUA).

4.4 Methodology

4.4.1 Site description

The Borana zone in Ethiopia (Figure 4.1) is a relevant case study context because it is a pastoralist area, and a communal land tenure framework is in the early stages of

implementation led by the Department of Rural Land Use and Administration supported by the USAID's LAND project.

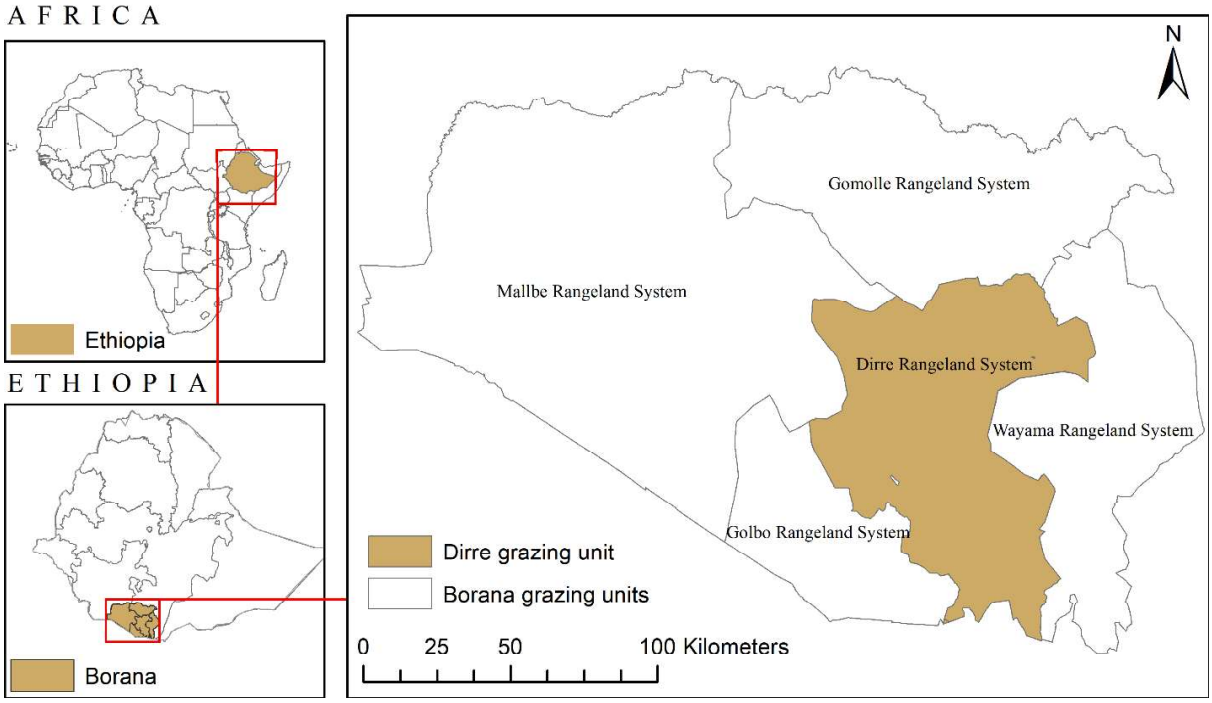

Figure 4.1 Location of the Dirre grazing unit, in the Borana, Ethiopia (03° 55' 37" N, 04° 46' 24" N, and 037° 58' 10" E, 039° 05' 05" E)

The Borana people, the main ethnic group in Borana Zone in southern Ethiopia, are governed by a set of customary institutions referred to collectively as the Gada system (Homann, 2004). In this system, the rangeland is divided into five grazing units called dheedas (Dirre, Golbo, Malbe, Woyama, and Gomole - Figure 4.1), based on the landscape characteristics in each (Wario et al., 2015). These dheedas are subdivided into smaller grazing units called reeras and Dirre Dheeda has six of them. Dirre dheeda in the Borana Zone was chosen as the study site as it is one of the three dheedas that have recently (2018) received communal land certification. Certification had just been implemented at the time of the field research and many pastoralists were familiar with it as the Department of Rural Land Use and Administration together with the USAID's LAND project had done awareness meetings and community consultations on land certification. Pastoral and livestock production is mainly dominated by cattle and small stock, and camels to a lesser extent.

4.4.2 Data collection

The study employed a mixed-methods approach that included key informant interviews, focus group discussions, a workshop, and a detailed household survey. The key informant interviews were conducted with the national, regional, and local level stakeholders who work in pastoral systems, as well as rural land administration. A total of five focus group discussions were conducted in Dirre Dheeda with pastoralists from five of the six "reera" sub-units of the dheeda, with each meeting being attended by between 12 to 15 participants (both men and women). The focus group discussions sought to understand the future of pastoral livelihoods and other pastoral system attributes with and without certification. Different livelihood options, participation in community rangeland management activities, and other elements that matter in pastoral areas (as defined by pastoralists) were discussed as well as their perceived magnitude and direction of change.

For the household survey, a multistage sampling approach was implemented beginning with the identification of reeras. For logistical and security reasons, only five out of the six reeras were sampled, namely, Dubluk, Web, Romso, Melbana, and Soda. Purposive sampling of households with livestock either in the form of sheep, goats, cattle, or camels was done. This criterion was used to capture changes concerning livestock herd dynamics. The study also sought to profile households by wealth as it has been observed that livestock numbers particularly cattle are the main measure of wealth in the Borana (Tache and Sjaastad, 2010). The list of all households with livestock in each of the five reeras sampled was obtained from the reera head with the assistance of the Kebele managers. Yamane's formula below was used to determine the sample size in each of the reeras, and it came down to 50 households per reera (Yamane, 2019)

$$n = N/ (1+N (e)^{2})$$

Where n is the sample size, N is the population size and *e* is the precision level.

The 50 households were then randomly selected from the list of livestock owners in the reera. To identify these households, local field guides were used. A total of 187 households from all the reeras were eventually interviewed. The data was then aggregated and analyzed at a dheeda level, at which the land certification had been implemented.

Data for the household survey was collected using a semi-structured questionnaire on the Open Data Kit (ODK) software between October and November 2018 with each

questionnaire taking between one and a half to two hours to complete. The questionnaire was translated into the local language (*Afaan Oromo*) and the translations were confirmed and harmonized during the training of the enumerators. Five of the enumerators were researchers from the local government research institute, while the sixth was the translator used in the project. Questions about household sizes, livelihood sources, livestock types kept, production constraints, herd dynamics, land holdings, and land tenure security, were asked followed by a series of questions on perceptions about the implications of certification on rangeland productivity and other biophysical and sociological facets. The questionnaire ended by asking about the planned livelihood changes for the future with or without certification. For questions that pointed out specific periods and ages of household heads, the Borana traditional calendar was used for the pastoralists to be able to relate.

4.4.3 Data Analysis

The key informant interviews included inquiring about the objectives of certification, the process, how far it had gone in the Borana, and who was driving the process. These were further discussed in the focus group discussions. The findings from the focus group discussions were collated into themes and further discussed in a stakeholder workshop. For the household survey, data cleaning and post-coding for responses that were not pre-coded were done. The total number of livestock units was used as a proxy for wealth definition as per the Borana's perception of wealth (Tache and Sjaastad, 2010). Wealth categories were created using total livestock numbers-cattle, sheep, and goats and camels converted into tropical livestock units (TLU) as in (Njuki et al., 2011). This methodological approach was based on the wealth classes defined in Desta and Coppock, (2002); and Homann, (2004) that put households into three wealth categories (poor- <10TLU, medium 10-20TLU, and better off >20TLU). TLUs were used as a grouping variable in R, and all the descriptive statistics were done in R using data manipulation and cross-tabulation functions. A two-tailed t-test was used to compare means for the household sizes, area under cropping, the number of years cropping and the desired cropping land sizes between any two of the three wealth categories. A t-test at 95% confidence level was conducted, rejecting the null hypothesis at 5 percent level of significance. The perceptions were categorized into three levels of change increase/improvement/strengthening, decrease/decline/weakening, no change, and one category for those who did not have an opinion about the direction of change. For questions

relating to perceptions about changes that might happen with or without certification, a Chi-square test at $p<0.05$ was performed to assess if there was any association between perceptions and wealth for the different variables. The chi-square statistic was computed using the chi-square function in R.

4.4.4 Community feedback sessions

In January 2020, the preliminary findings were summarized and presented to stakeholders who participated in the research. For the national, regional and zonal level stakeholders, these were done through one-on-one meetings, while for the pastoralists these were in the form of focus group discussions with between 8 and 15 participants in four reeras (Melbana, Soda, Romso, and Dubluk). The feedback sessions were mainly for triangulation purposes and to share the findings as had been previously highlighted during the data collection phase, to get feedback and validate the results. The livestock herd sizes as reported in the surveys were also presented and discussed with the stakeholders, who confirmed the reported numbers, trends and distribution by wealth.

4.5 Results

4.5.1 Pastoral livelihoods under the current customary tenure

Household demography and herd sizes

The households fall into three wealth categories based on the total livestock ownership measured in tropical livestock units (TLUs), as shown in Table 4.1. The age distribution of household heads and family sizes for the different wealth classes are also presented in the same table.

Table 4.1 Herd and Household sizes by wealth categories

Wealth categories	Average TLUs	Proportion of households (%)	Age of household head (years) by %			Average household size (members)
			60 and above	43-59	26-42	
Poor (<10 TLU)	5.2	56.1	13.5	17.8	25.4	6.9[a]
Medium (10-20 TLU)	14.4	21.9	8.1	7.57	6.5	8.3[b]
Better off (>20 TLU)	45.3	21.9	10.3	8.1	2.7	10.7[c]
Total	16.0	100	31.9	33.5	34.6	8.0

Column means with different superscripts (a or b) are significantly different at $p<0.05$

A comparatively large proportion of the households fall in the poor category (56.1%) with an average of about 5.2 TLUs, while the better off and medium wealth ones contribute 21.9%

each with 45.3 and 14.4 TLUs respectively. Family sizes for the three wealth classes are all significantly different from each other. Better-off households have the largest family sizes.

Livestock herd dynamics

Table 4.2 below shows the proportions of the respondents' views of the changes about the observed changes in the livestock herd sizes over the last 5 years.

Table 4.2 Changes to the livestock herd over the last 5 years

	% Responses		
Livestock type	Increase	No change	Decrease
Cattle (n=182)	20.3	1.1	78.6
Small stock (n=181)	24.3	5.0	70.7
Camels (n=58)	31.0	17.2	51.7

The changes in average household livestock herd sizes over the last five years as reported by the majority of respondents show that there has been a decline in numbers for all livestock species (cattle - 78.6% of the respondents, small stock - 70.7%, and camels - 51.7%). The participants gave several reasons for the changes they have observed in the herd sizes for the different livestock types as shown in Table 4.3

Table 4.3 Primary causes of change in herd sizes

Cause		Percentage of respondents reporting the *primary* cause of herd size change for…		
		Cattle	Small stock	Camels
Inflows (%)	births	72.3	57.3	52.2
	bought in	17.0	24.0	43.5
	received as a gift	10.6	18.7	4.3
	Total	100%	100%	100%
Outflows (%)	sold	14.5	16.9	26.7
	drought-related deaths	51.3	18.7	13.3
	disease-related deaths	14.9	38.3	60.0
	lost to predators	4.5	6.7	0.0
	slaughtered for home consumption	7.8	7.1	0.0
	gave away as a gift	4.8	8.0	0.0
	other	2.2	4.3	0.0
	Total	100%	100%	100%

The main inflows for all livestock types were births. However high drought (for cattle, reported by 51.3% of the respondents) and disease-related mortalities (for small reported by 38.3% of the respondents) offset this resulting in overall herd sizes reduction. Although a reasonable proportion of households purchased camels (43.5%), most households (60%) reported diseases as being a major challenge and this has kept the herd sizes low.

Livestock production constraints

Respondents' opinions of the most restricting resource for livestock production for all households is summarized in Figure 4.2 below.

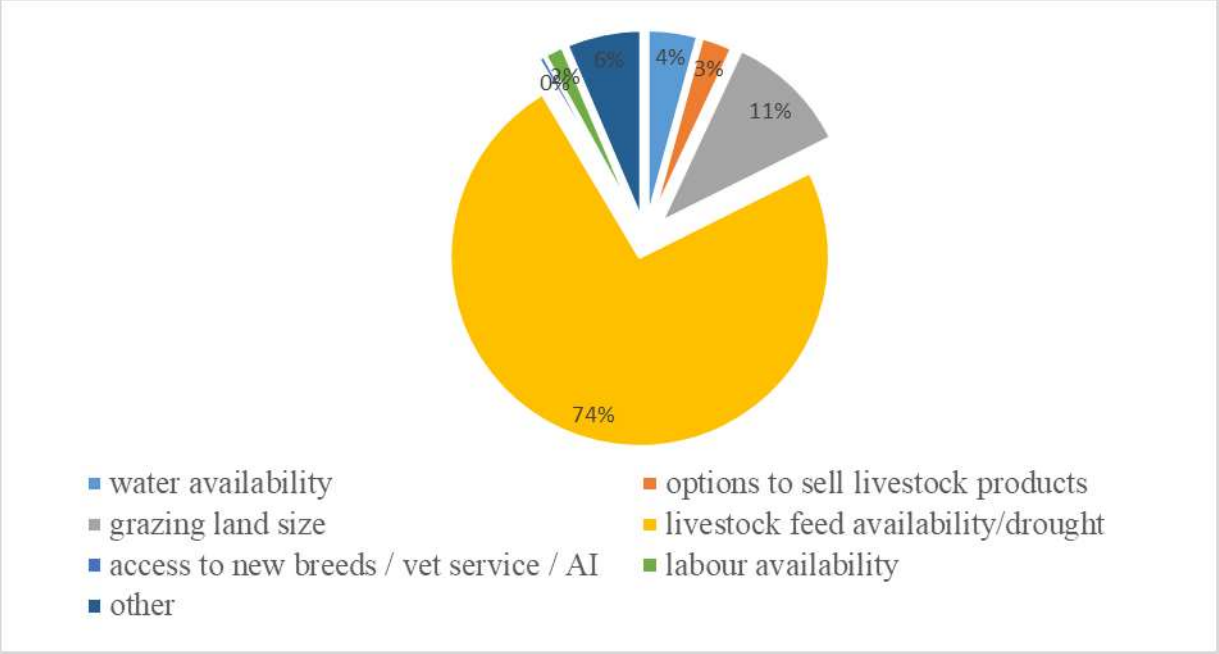

Figure 4.2 Livestock production constraints

Livestock feed availability/drought was mentioned by 74% of the households as the main constraints limiting livestock. This was followed by grazing land size (11%) which was said to be becoming smaller.

Cropping and yield history

A total of 88% of the interviewed households are engaged in some cropping activities (see Table 4.4). Various factors are influencing this shift from purely pastoralist livelihoods. One of these is small herd sizes and the need to diversity livelihoods. Asked why people want to invest in cropping, a pastoralist who participated in one of the feedback sessions said,

"The other reason we want to do cropping—as you said—it is true that most of the pastoralists no longer have big herds (as you said, that 56% have less than 5TLUs). So, these people need to do cropping to make sure they get food."

One of the key informants also highlighted that some pockets are good for cropping which needed to be maximized on. On average most households started doing cropping not so long ago—about 13.6 years on average

Table 4.4 Years cropping, area under cropping and yield history by wealth categories

Wealth categories	Households cropping (%)			Average years cropping	Area under cropping (ha)	Desired land sizes (ha)	Do you get enough for home consumption? (% of households that do cropping)	
	Yes	No	Total				Yes	No
Poor	84	16	100	11.6[a]	1.3[a]	10.7[a]	22	31
Medium	95	5	100	12.7[a]	1.8[a]	8.9[a]	8	15
Better off	91	9	100	19.9[b]	1.8[a]	9.4[a]	9	14
Total	88	12	100	13.6	1.5	10.0	40	60

Each column means with similar different superscript (a or b) not significantly while those with different superscript are significantly different at $p<0.05$

The better-off households have been cropping for much longer than the poor and the medium wealth households. The areas under cropping are similar for all the households with plot sizes ranging between 1.3 to 1.8 hectares. All households desire to have more land under cropping and there are no significant differences between different wealth classes in the areas of land desired. The respondents overwhelmingly intend to expand crop farming (see Table 3.2). On average, households desire to have around 10 hectares of land under cropping. Of the households that do cropping about 60% reported not getting enough for home consumption. Although the area under cropping does not differ among the wealth groups, more respondents in the poor category reported not getting enough for home consumption. The study did not

explore the reasons for this outcome, but it may be that the rich get better yields because of better access to inputs.

Conflict incidences and causes in recent years

A total of 84% of the respondents reported having heard of or experienced conflicts in the last 5 years. The main conflict causes were highlighted as mainly over water point and grazing site use and mixing of herds as they converge on ever-dwindling pastures as well as rangeland privatization especially through the creation of private enclosures and overstepping boundaries between regions. Many (63.9%) highlighted that conflicts occur very often (at least four times in a year) and often (about three times in a year), while some (28.1%) said they rarely happen (none to once per year).

4.5.2 The future of pastoral livelihoods with and without land certification

Livelihood sourcing

The respondents gave details regarding what livelihood activities they would focus the most on with or without certification and this is presented in Table 4.5 for all the pastoralists interviewed.

Table 4.5 Planned livelihood changes by different wealth categories with respect to certification

Livelihood options	Wealth Category (% of respondents)			
Without Certification	Poor	Medium	Better off	Total
Venture into business (salt collection, construction, shop)	6.4	4.3	0.5	11.2
Sell my livestock (destock/reduce herd size)	6.4	3.7	4.3	14.4
Continue keeping livestock	3.2	2.1	2.1	7.5
Migrate to other areas	4.8	3.2	2.7	10.7
No plans yet	18.7	7.0	8.0	33.7
Depend on remittances	0.5	0.0	0.5	1.1
Look for a job in the city	2.7	0.0	0.0	2.7
Do more cropping	5.3	1.1	1.1	7.5
Try to get a certificate	8.0	0.5	2.7	11.2
With Certification				
More livestock	5.3	3.2	2.7	11.2
More cropping	7.0	2.1	2.1	11.2
Do both crop and livestock	32.6	11.8	12.3	56.7
No plans yet	7.5	2.1	3.7	13.4
Side business	3.7	1.6	0.0	5.3
Other	0.0	1.1	1.1	2.1

With certification, pastoralists expect to have more options about livelihood sourcing, including venturing into small businesses (11.2%), migrating (10.7%) and destocking (14.4%). Around 33.7% of all the pastoralists did not have anything planned yet, with 18.7% of this group being the poor households. With certification more than half of the respondents are intending to do both cropping and livestock-keeping (56.5%—32.6% poor, 11.8% medium, and 12.3% better off). Some intend to intensify livestock production alone (11.2%) and crop production alone (11.2%).

Perceptions about the direction of change in different system characteristics with and without certification and the rationale for the perceived changes

The direction of change for various social and ecological characteristics expected by survey respondents is presented in Table 3.6 below. The Chi-square test to determine if there is an association between perceptions about different variables and wealth groups showed that these were independent of one another. The Chi-square statistic was 1451.9, df = 255, p-value < 2.2e-16. Most pastoralists (68.4%) mentioned that, with certification, the area under cropping would increase. A total of 75.9% of the survey respondents expect an improvement in participation in rangeland management activities with certification, while 76.5% anticipate a decline in participation without certification (see Table 4.6). Our questionnaire respondents, key informants, and workshop and focus group discussion participants expect that, with land certification, improvements in the management of rangelands through planned grazing will result in improved rangeland condition and availability of feed, and ultimately increased herd sizes. Over 50% of the respondents also said that with certification, they expect an improvement in soil health, rangeland condition, area of cultivated land, food security, growing of fodder crops, involvement and participation of women in land and livestock-related matters, tenure security, small stock and cattle herd sizes and a reduction in livestock diseases. On the other hand, without certification, a majority of the respondents thought that there would be a decline in soil health, involvement in rangeland management activities, rangeland condition, food security, livestock diseases, growing of fodder crops, involvement, and participation of women, tenure security and small stock and cattle herd sizes. Yet, the size of land under cultivation was reported by 68.4% of the households to be expected to increase with certification. For livestock water availability and the strength of local

institutions, a fair proportion (36.9% and 42.2% respectively) of respondents expect an improvement with certification.

Table 4.6 Expectations for the direction of changes

		Perception on the direction of change (% households)			
	Certification scenario	Increase/ Improve	No change	Decrease/ Decline	Not sure
Cattle herd sizes	Without	34.2	6.4	52.9	4.3
	With	51.9	5.9	35.3	4.8
Small stock flock sizes	Without	32.6	5.9	54.0	4.8
	With	54.0	5.9	32.1	4.8
Rangeland condition	Without	15.5	4.3	75.9	3.2
	With	76.5	3.7	15.5	3.2
Involvement in rangeland management activities	Without	16.0	4.8	76.5	2.1
	With	75.9	4.8	16.6	2.1
Soil health	Without	13.4	5.9	77.5	2.1
	With	78.6	5.9	12.3	2.1
Livestock water availability	Without	26.2	29.4	36.9	5.9
	With	36.9	28.3	27.8	5.9

Livestock diseases prevalence	Without	66.3	17.1	3.2	11.8
	With	5.3	16	64.7	12.3
Size of cultivated land	Without	21.4	5.9	68.4	2.7
	With	68.4	7	21.4	2.1
Food security	Without	12.8	6.4	75.9	4.3
	With	65.8	4.8	12.8	4.3
Tenure security	Without	36.9	4.8	55.6	1.6
	With	61.5	5.3	30.5	1.6
Growing of fodder crops	Without	10.2	11.2	64.7	9.6
	With	65.8	10.2	9.6	9.6
Strength of local institutions	Without	17.6	27.8	38.5	14.4
	With	42.2	28.3	15.0	13.9
Involvement and participation of women in rangeland management activities	Without	12.8	9.6	62.0	14.4
	With	62.0	10.2	12.8	12.8

Many respondents believe that the area they have under cropping will decrease without land certification as land would become scarcer and there would be an uncontrolled influx of outsiders. The justification for the increase in area under cropping with certification was so that they could diversify, produce more food, and have some land to pass onto their children. Better rangeland management is expected when there is land certification as communities would be more willing to invest in rangeland management and to enforce grazing rules.

During the feedback sessions, the pastoralists reiterated that with certification there will be an improvement in rangeland condition and herd sizes. One of the pastoralists said,

“YES, because ownership gives reason to take care of whatever is in your hands because it becomes your property. With no ownership, people will relax, for example here in the Borana there is a famous saying that says all the cattle are ours but within that, you have what is yours. This means that if there is land certification allocated to a group of people it doesn't mean that we cannot disallow others to use, but it gives us the responsibility to take care of it”.

The Department of Land Use and Administration was said to be currently working on supplementing pastoralist livelihoods by promoting diversification because not all pastoralists have enough livestock numbers to sustain them. The other likely reason why pastoralists were shifting towards cropping was said to be the construction of the main road that has led to the growth of small "towns" in the area and increasing the demand for food. With certification, improvements in livestock water and grazing management are also anticipated to assist in the control of the spread of diseases that come with uncontrolled mobility and grazing management. No big differences in the strength of local institutions were expected as the Borana believe they have a strong traditional governance system. Some, especially the village leaders, believe it might give them a stronger authority while others do not think so. For tenure security, certification is anticipated to improve such things as uncompensated land losses and conflict management.

Tenure security

Perceptions of tenure security were assessed by asking respondent's expectations about being able to use the land they are currently using for residential, grazing, and cropping purposes in 30 years. Figure 4.3 shows the perception as the proportion of the total respondents.

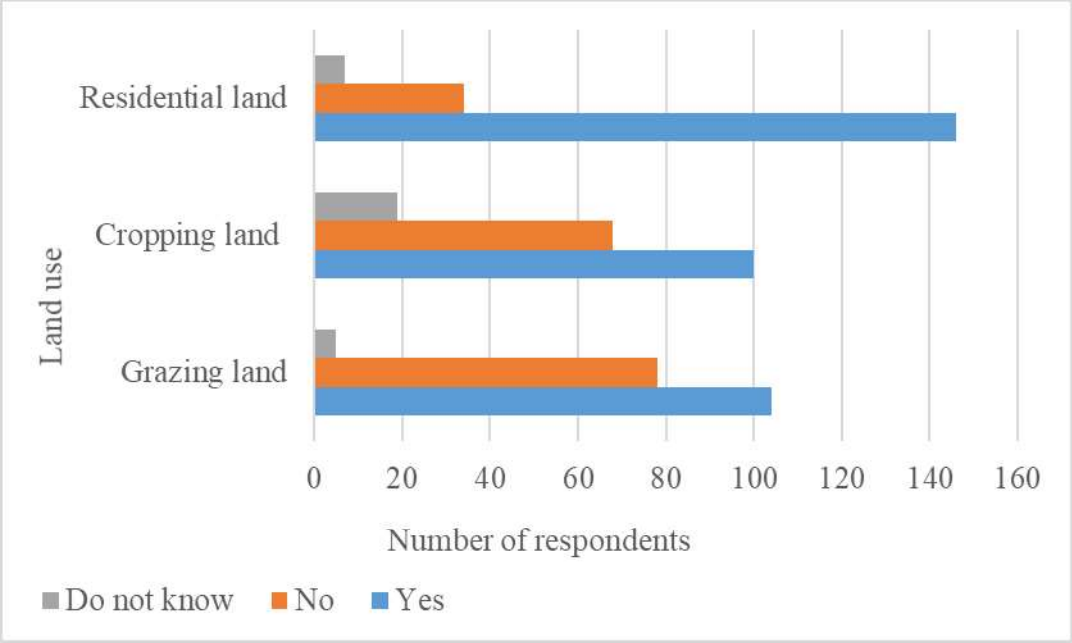

Figure 4.3 Continuing on the same land in the next 30 years

Households had varying views about tenure security without land certification, which was assessed by the likelihood of being able to still use the same land for different activities in thirty years. Most households are sure that they will still be able to use the same land they are currently using for residence (78% of the respondents), but for land used for cropping and grazing the confidence drops only 56% and 53%, respectively. Investments done on the land, food security, age of the pastoralists, availability of options, and climate were found to be among the factors that play a role in shaping the perceptions about what the way forward in livelihoods will be without land certification

4.6 Discussion

Pastoral livelihoods and land use under the two tenure regimes (insecure customary versus the formalized system)

Our findings elucidate the state of pastoral livelihoods in a tenure-insecure environment against formalised collective tenure conditions. In the study area, various factors are affecting the use and governance of land, including the current state of livestock-based livelihoods. As also reported in other studies (Davies et al., 2016; Holden and Ghebru, 2016) per capita livestock holdings in the study area are low. Household herd sizes for all the livestock types have gone down over the last five years, particularly cattle and small stock. Droughts and livestock feed shortages were reported as the most important factors

contributing to these low numbers and limiting overall livestock production. Although pastoralism traditionally has been the major economic activity for the Borana community for years, we found not only that the vast majority of households are already farming, confirming the findings of other studies from southern Ethiopia (Flintan 2011), but also that most households want to expand their farms. The widespread desire to continue crop farming and to increase the area under cropping is an indication of the degraded state of the rangelands, which can no longer sustain large herds and a sign that the system is moving towards agropastoralism.

For the average household, the declining herd size makes it difficult to rely solely on livestock keeping, hence the push to diversify into other livelihood options (Greiner et al., 2013, Holden and Ghebru, 2016). In a study by Tsegaye et al (2013) in Afar region of Ethiopia, households that were practicing both crops and livestock were found to be less food insecure than those that were still practicing pure pastoralism with no cropping. Agropastoralism is a livelihood adaptation strategy that reduces the vulnerability of households and secure tenure is an incentive for this to be done by many and with better investments of resources (Schimdt and Pearson 2016). Moreover, the lack of recognition of communal tenure until now has prompted people to fence off and plough a land parcel as a way of laying claim to it. The unplanned manner in which this happens has consequences for the rangelands and livestock production. Much of the land that is being converted is prime grazing land located in bottomlands close to settlements and permanent water that are crucial for dry season grazing, and loss of these pasture areas, therefore, has a disproportionate effect that goes beyond the mere percentage loss of grazing land. This has worrying consequences for degradation, livestock-based livelihoods, and conflict.

The respondents—pastoralists themselves as well as personnel from government and NGOs—expect that formalization of communal land rights will help alleviate such challenges and enable protection and better management of common pool rangelands. National and regional level stakeholders highlighted that communal land certification was being done to facilitate pastoral livestock production. The majority (75.9%) of the survey respondents expect an improvement in participation in rangeland management activities with certification. There is an expectation that, with land certification, improvements in the management of rangelands through planned grazing will result in improved rangeland condition, better availability of feed, and ultimately healthier livestock and increased herd sizes. In this respect, the respondents' views reflect the thinking of mainstream commons scholarship,

which highlights the importance of having clear property rights for communal land and resources (e.g., Ostrom, 1990), including for pastoralist rangelands (Elias and Abdi, 2010; Mwangi 2009). Without the security that land certification is expected to provide, the pressure to find alternative livelihoods, and the risk for conflicts if alternatives are not found, are likely to be stronger. The proportion of respondents who reported not having any plans for their livelihood without land certification also shows how secure tenure is crucial for enabling people to plan. Some respondents even indicated that in the absence of certification, they would migrate to other areas or focus on getting a certificate.

However, even though communal land certification can be expected to make an important contribution towards collective management of rangelands, our findings suggest that it is not likely to reverse individualization, confirming the risks associated with land formalization (Putzel et al 2015). The ongoing shift in people's livelihoods away from pure pastoralism toward some mix of cropping with livestock keeping will continue. The shift to cropping is driven by multiple factors. In recent decades, livelihood diversification has become a pivotal driver of this system (Mcpeak and Little, 2019; Turner et al., 2016). From our findings, pastoralists of all wealth classes from the study area share similar perceptions about the need to have a diversified livelihood. Despite significant differences in the household herd sizes and the fact that the better-off households generally have been cropping for much longer than the poorer ones, the desire to expand farms cuts across all wealth groups. For many, livestock herd sizes have declined to the point that a pure pastoralist livelihood is no longer viable as also reported for other pastoral settings by Davies et al., (2016) and Holden and Ghebru (2016), echoing the “too many people, too few livestock” thesis (Sanford, 2006). However, “pull” factors are also significant in attracting pastoralists to settle and farm—people respond to opportunities and adjust their livelihood as changes in the environment unfold (Dressler et al., 2019; Nori, 2021). National and regional level stakeholders believe, for instance, that the ongoing shift in livelihoods is driven not only by the decline in herd sizes but also by the opening up of market opportunities as seen by the increase in the number of farmed areas near the small towns that are mushrooming especially along the main road.

The implications of the agropastoralist trend for land certification

This shift is certain to have profound implications for the outcomes of land certification. Although the lack of tenure security for communal land has helped to impel the drive to claim individual parcels of land, communal land certification will not necessarily reverse the trend.

A large proportion of our respondents indicated that they were willing to invest meaningfully in crop farming as long as they are assured of secure access to land. As has been noted in other settings (Tsegaye et al., 2013, Veit, 2011), once land rights are secured in Borana Zone—even collective land rights—the shift is likely to continue, perhaps even on a larger scale.

None of this implies that livestock is going to disappear from Borana livelihoods or that communal land certification is doomed to failure. From the study, it is apparent people still want to maintain some animals, even as they try to expand the place of farming their livelihoods. Moreover, while most people feel secure in terms of residential tenure, many more feel insecure when it comes to land for grazing, and there is a clear indication that secure tenure will contribute to the capacity of Borana communities for the collective management of rangelands. With certification, on the other hand, our respondents see a future with strengthened rangeland management, healthier rangelands, and more productive and larger herds. However, pastoralists in Borana Zone, driven by food insecurity, the desire to diversify, and other factors, also see security over tenure as something that will enable them to expand their farms more confidently. This has the potential, in combination with the increase in livestock numbers that they expect with land certification, to aggravate degradation. Yet, communal land certification also has the potential to mitigate these dangers. The strengthening of communal land rights through the certification process can be used as an opportunity by the government and other development stakeholders to guide this transition so that it represents, as characterized by Bollig (2016), a reorganization rather than a collapse of pastoralism.

4.7 Conclusion

This study explores expectations of pastoralists for their livelihoods under a more secure land tenure regime. This has forward-looking implications for the government and other development stakeholders as they prepare to build on the land tenure formalisation by coming up with pastoral livelihood-oriented development policies. The study identifies the land tenure-related push and pull factors that contribute to new patterns of livelihoods in the Borana. It supports the expectation that strengthening communal tenure for pastoralist communities will help provide security against outside land grabbing and will contribute to improved protection and management of rangelands. Nevertheless, inasmuch as pastoralism

has been the main livelihood of the Borana for generations, the current herd sizes for most households make it difficult if not impossible for pastoralists to rely only on livestock keeping. The drivers toward diversification and adoption of crop agriculture are such that implementing a communal tenure framework holds little potential for quelling the shift to agropastoralism as originally assumed by the objectives of the land certification. It may in fact serve as a vehicle to facilitate this transition: we found that pastoralists in Dirre Dheeda strongly believe that land certification will help to secure land rights and enable better management of rangelands, as well as enabling them to invest in diverse livelihood options.

Understanding peoples' aspirations for their livelihoods and their expectations of how a new land management framework will affect their livelihoods is important for informing the objectives and implementation of that framework. The caveats derived from this study suggests that rather than pushing for secure tenure with a pure pastoralism system lens, the emerging livelihoods options make it prudent to develop a more encompassing land formalization policy, and hence there is a need to adjust the narrative around land certification objectives to ensure that it reflects local realities and aspirations. Given the ongoing shift towards more diversified livelihoods and the widespread desire to expand farming while continuing to raise livestock, the focus should not be saving pastoralism or reversing the agropastoralist trend, but rather securing land rights to enhance the people's capacity to make sound livelihood decisions in the face of environmental and other changes. For the pastoralists in our study area, the desire for secure tenure is not only about securing communal rangelands and maintaining traditional pastoral livelihoods but is also more broadly about how they can continue making a living off the land. This is not only about the poorest pastoralists being forced to adopt an alternative livelihood; we found that all wealth groups share a desire to farm more land and have similar perceptions about the implications of certification on pastoralism and their livelihoods. Land certification should thus be crafted in a way that supports extensive livestock production while enabling other developments and livelihood diversification to take place sustainably. Undoubtedly, pastoral livelihoods are tightly linked with land availability, access and tenure security as seen by the shifts in livelihoods in both tenure secure and insecure environments. Pastoral livelihoods need to be strengthened through a land tenure system that enables them to make livelihood investments (Flintan 2011).

One way of doing so would be to ensure that strengthened communal land rights are complemented by land-use planning and other interventions that guide the transition to intensified resource use in a sustainable way—e.g., protection of livestock migration corridors and key pasture areas, crop-livestock integration such as through post-harvest feeding on stover, transparent and equitable methods for allocation of land for conversion to farmland, etc.—led by communities. This points to questions for further research, such as through simulation modelling, and issues for policy dialogue. *If all or the majority of community members are enabled to diversify livelihoods by beginning or by expanding cropping, what are the thresholds? How much area can be converted to croplands versus remaining as rangelands, and which land? What can be done to promote an integrated crop-livestock system such as through the trading biomass or temporary grazing rights on croplands and could this help to mitigate resource conflicts?* Such considerations will help ensure that communal land certification in pastoral areas does not turn out to be just another policy that will have undesirable consequences on livelihoods, and the environment, causing pastoralists to fall deeper into poverty.

CHAPTER 5 MODELLING THE EFFECTS OF TENURE REFORM INDUCED GRAZING MANAGEMENT ALTERATIONS ON RANGELAND PRODUCTIVITY, LIVESTOCK POPULATION DYNAMICS AND LIVELIHOODS

5.1 Abstract

The Borana Zone in Ethiopia is one of the sites where communal land certification is being implemented. Pastoralists believe that if this is done at a dheeda scale it will offer a good opportunity for mobility and for reviving the seasonal grazing management system. It is however unclear how the vegetation dynamics and pastoralist wellbeing would be affected by such policies and alterations in grazing management. A coupled human-natural systems (CHANS) simulation modeling approach was used to explore these effects by recreating the tenure reform enhanced grazing access scenario and to examine the long-term social-ecological implications. SAVANNA, a process-based ecological model and DECUMA an agent-based household models were used. The simulations show that planned grazing prolongs the availability of pasture, but the ecosystem continues to be degraded, to a point that ultimately nullifies the benefits of planned grazing. Overall, the grazing scenarios only seem to preserve marginal levels of palatable grasses, but do not help protect against the increase of unpalatable species. In a lower rainfall year grazing management has less impact, as everything suffers under the dry conditions. As the land certification program in pastoral areas move forward, it should aim at enhancing pastoralist livelihoods and their capacity to manage rangeland, halt degradation and allow the rangelands to recover to be able to sustain livestock production for longer. This means that planned/seasonal grazing alone will not be the answer to all problems that pastoralism faces. There is need for it to be coupled with intensive rangeland reclamation, and management efforts, and even intensify livestock production through and diversification into other livelihood activities.

5.2 Introduction

Traditional pastoral livelihoods are increasingly getting under pressure, as rangelands are becoming smaller and degraded (López-i-Gelats et al., 2016, Liao and Clark 2018). Increase in human population has also contributed to an increase in the competition for the limited resources, further contributing to the deterioration of the rangeland condition. The Borana Zone in Ethiopia is one such area where customary institutions play a role in rangeland governance. In this region, rangeland use is communal, and management is governed by a council of traditional leaders under the *Gada* system as it is known locally.

Pastoralists play a role in shaping the rangeland vegetation dynamics through their herding and resource use strategies (Dixit et al., 2013; Odadi et al., 2017). In the Borana zone the rangeland is subdivided into rangeland units called *dheedas* which are further divided into smaller grazing units called *reeras*. These units are headed by traditional leaders called *Aba dheeda*s and *Aba reeras* respectively. The dheeda is usually divided into seasonal grazing zones, classified as the wet and dry season grazing areas depending on what season the grazing is used (Figure 5.1 for Dirre dheeda). The wet season grazing area is normally far from the home and primarily used for the dry cows and male herds (Degen, 2011). The dry season grazing is near-home and ideally reserved for the lactating cows, calves, and the weak animals.

For a long time, among the Borana, livestock movement followed a seasonal pattern between the wet and dry season (Degen, 2011, Wario et al., 2016). The animals were moved to the wet season grazing area at the onset of the long rainy season and again at the beginning of the short rainy season. Some policy developments that included water development in the Borana unintentionally disrupted these grazing patterns (Degen, 2011; Homann et al., 2008; Wario et al., 2016). Instead of moving, back to the dry season grazing areas the animals now stay permanently in the wet season grazing area. This has had implications that moving to the wet season is no longer beneficial as it would be already grazed. For these reasons, much of the Borana rangelands have slowly been converted into an all-year-round grazing system (Degen 2011, Wario et al., 2015).

Outcomes of these reforms are diverse and may be positive and negative. The positive ones may include secure tenure, strengthening of traditional institutions, the revival of local grazing management structures and access, investment in rangeland management and improved agricultural production, and enhanced wellbeing (Chimhowu, 2018; Holden & Ghebru, 2016; Krantz, 2015). There may also be some unintended negative outcomes, which in pastoral systems can be restricted access to grazing through rangeland fragmentation and blocking of livestock corridors (Boone & Hobbs, 2004; Mwangi, 2009; Thornton et al., 2006). These outcomes may have different implications on rangelands, livestock, and pastoral livelihoods which are the pillars of pastoralism (Desta & Coppock, 2002, Moritz, 2010). At times there may be immediate benefits to livelihoods but with some ecological consequences that may initially be overlooked, but their effects may become more pronounced in the long-term (Hobbs et al., 2008). Pastoral systems of East Africa, have in the past two decades seen a decline in the populations of both livestock and wildlife a result of droughts, land policy reforms and continuous rangeland degradation ((Almeida-Gomes et al., 2016; Thornton et al., 2006, Desta and Coppock, 2002; Thornton et al., 2019).

In recent years rangelands in southern Ethiopia continued to experience a gradual shift towards more woody vegetation cover from open grasslands (Liao & Clark, 2018a). This shift has implications for ecosystem processes and biodiversity (Liao & Clark, 2018a) as woody species may supress the growth of the herbaceous layer as they form thickets that create a shade effect. The increase of woody encroachment, which has implications of reducing carrying capacity thereby threatening the livelihoods that depend on the land via livestock production (Liao et al., 2018b). The vegetation structure and productivity are also largely driven by many factors that include climatic factors on a broader scale and herbivory on a local scale (Walker, 2017; Liao et al., 2020). Intensive rangelands use that comes with restricted mobility may bring about transitions in the vegetation structure, and lead to some undesirable states like bush encroachment (Liao and Clark 2018b).

Ethiopia is one of the African countries that has started working towards formalizing and articulating specific land rights for its citizens, including pastoralists (Ambaye, 2012; Deininger et al., 2007; Tura, 2018). According to the pastoralists in the Borana, dheeda scale land certification offers a good opportunity for mobility and for reviving the seasonal grazing management system (Senda et al., 2020a). It has always been unclear and difficult to predict how pastoralist wellbeing gets affected by these changes and what adaptation mechanism

they may employ considering the uncertainty in these systems. There is thus a need to understand what that the ecological and pastoralists' wellbeing implications would be.

A coupled human-natural systems (CHANS) simulation modeling approach by Boone and Lesorogol, (2016), is used for this purpose. Through CHANS the study recreates the tenure reform enhanced grazing access scenario and to examine the long-term social-ecological implications. In this case two models are linked i.e., a process-based ecological and an agent-based household model to capture feedback between rangeland productivity, livestock populations and pastoralists livelihoods.

This chapter analyzes the potential direction of change and patterns in the rangeland vegetation dynamics and associated outcomes on livestock and pastoralist livelihoods under different tenure reform enhanced grazing management and access scenarios in a pastoral system. The question on what the potential effects of reviving seasonal grazing against an all-year-round grazing system will be for rangeland ecology and pastoralist livelihoods is explored through simulation modelling.

5.3 Methodology

5.3.1 Study site description

The study was conducted in Dirre (03° 55' 37" N, 04° 46' 24" N, and 037° 58' 10" E, 039° 05' 05" E) Figure 5.1, a grazing unit of the Borana Zone in southern Ethiopia Figure 5.1. It covers an area of 15876 square kilometers. Dirre, stands at an altitude of 1723m above sea level, with average temperatures ranging between 19 and 24 degrees Celsius. Rainfall seasonality is bimodal ranging between 300 and 900mm, characterized by high spatial and temporal variability. Most of the rain received in the long rainy season (March to May) and the least received in August to September (short rainy season). The long dry season usually ranges from October to March and the short dry season from June to July (Desta and Coppock,2002, Degen 2011, Deke, 2016; Liao, 2014). The vegetation in Dirre is mixed savanna dominated by perennial grasses namely *Cenchrus ciliaris*, and some species of *Pennisetums* and, and *Chrysopogon.* There are also woody plants such as the Acacia species (*Acacia Senegal, A. tortilis, Acacia drepanolobium and Acacia seyal*) and *Commiphora africana* (Boone et al., 2001; Liao, 2014). Grazing land is becoming smaller because of the

expansion of cultivation and bush encroachment through progressive loss or degradation of drought grazing-reserves between 1985 and 1991 (Desta and Coppock 2002).

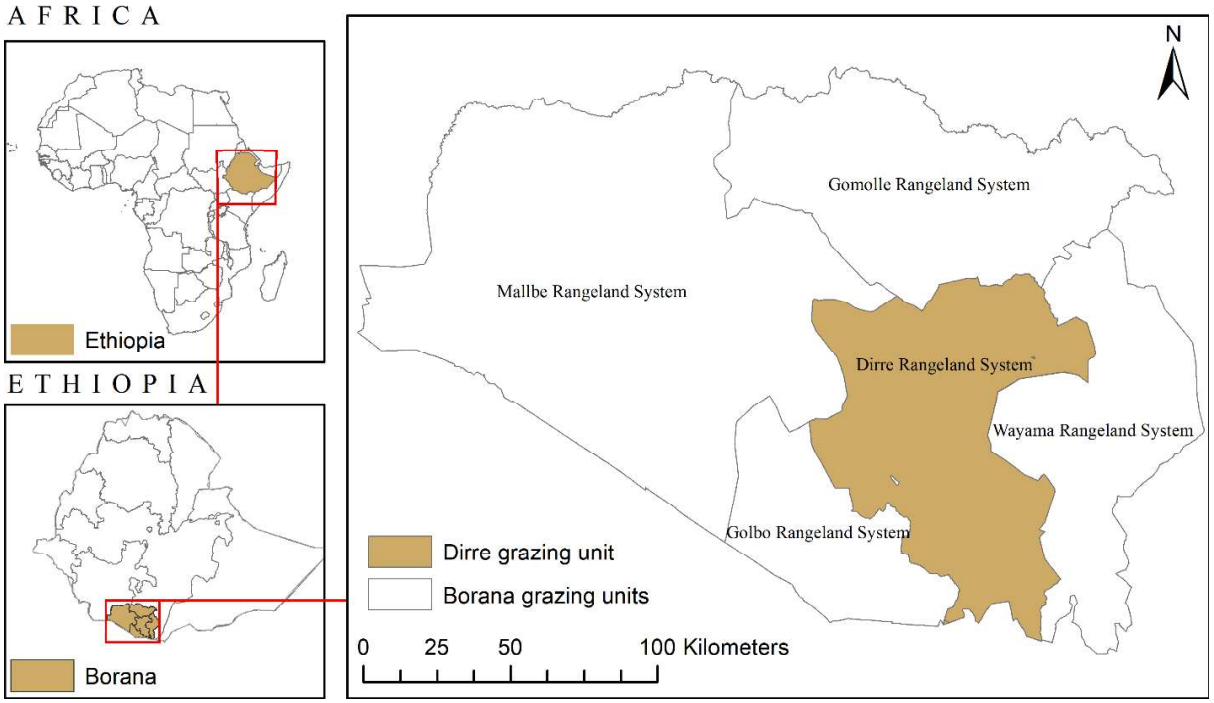

Figure 5.1 Location of the Dirre grazing unit, in the Borana, Ethiopia (03° 55' 37" N, 04° 46' 24" N, and 037° 58' 10" E, 039° 05' 05" E)

The Borana are the main ethnic group. Livestock production in the area is mainly dominated by cattle, small stock, and camels to a smaller extent. Young male cattle are sold during the year to provide households with an income base for the year (Degen, 2011). Livestock peak sales are in Jan Feb March May June. By the early 2000s, cattle sales were still low and cash needs were modest. During the 1977 to 1991 period the government-controlled grain markets, and this forced the Borana to sell cattle at below-market prices (Degen, 2011). The livestock sales quotas were removed in 1991 and this made the cattle prices start going up (Degen, 2011; Desta & Coppock, 2002b). Most livestock mortalities occur during the long dry season (October to March) and does food purchase. Average annual income ranges from 5 to 30 thousand birr for the very poor and better off households respectively (USAID, 2017).

Teff (a local cereal) is the main staple food and is supplemented with some homegrown maize. Maize is mainly grown for household consumption. Teff, wheat, and haricots beans all have a higher market value and are mostly grown for sale. Teff is available for 6 months i.e.,

June-Nov, Maize, for 6 months Jan to June, and beans for 7 months from June to December. The most important staple foods purchased from local markets are maize. Staple food purchases increase from December to June. Purchased food covered 50% to 60% of annual needs (Degen, 2011; Desta & Coppock, 2002), (USAID, 2017). Other part time income sources like artisanal mining, charcoal sales, honey charcoal making, and handicraft, and trading are available for four months. The main sources of protein are meat and milk. Milk is either from own production or purchased from other pastoralists. Milk sales take place from May to September (five months). Other food items on their diets include lentils and haricot beans (USAID, 2017).

5.3.2 Coupled human and natural systems (CHANS) modeling

CHANS was used in this study as it takes into account the complex nature and the adaptation possibilities of these system as the Borana. To understand the implications of changes in grazing access on pastoral livelihoods and livestock numbers an agent-based model DECUMA-**DE**cisions under **C**onditions of **U**ncertainty by **M**odeled **A**gents (Boone et al., 2011; Lesorogol & Boone, 2016) and an ecosystem model SAVANNA (Coughenour, 1993; Senda et al., 2020b) were linked. SAVANNA simulates ecosystem processes (water, biomass and herbivory) and its outputs are utilized by DECUMA to simulate household level livelihood dynamics (food production/consumption, livestock management and finances, (Boone et al., 2011; Boone & Coughenour, 2001; Lesorogol & Boone, 2016). Both models were parameterized from existing literature and surveys and are summarized in the following sections.

5.3.3 The SAVANNA modeling system

The SAVANNA modeling system is a grid-based, ecological modeling system (Coughenour, 2004; Weisberg, Coughenour, & Bugmann, 2006) was used as the base model for all simulation activities in this study. The model is spatially explicit, process-oriented, and computes different rates of plant production, forage intake by animals (Galvin et al., 2004). Early development of SAVANNA began in the Turkana district in Kenya simulating pastoralist effects on vegetation (Coughenour, 2004). The model simulates processes such as vegetation quantity, quality, distribution, and the spatial redistribution of herbivores in response to changes in vegetation quantity. Figure 5.2 below shows the spatial representation of SAVANNA which simplifies spatial heterogeneity into a set of point-scale simulations that are weighted according to weighted area within each grid cell (Coughenour, 1993).

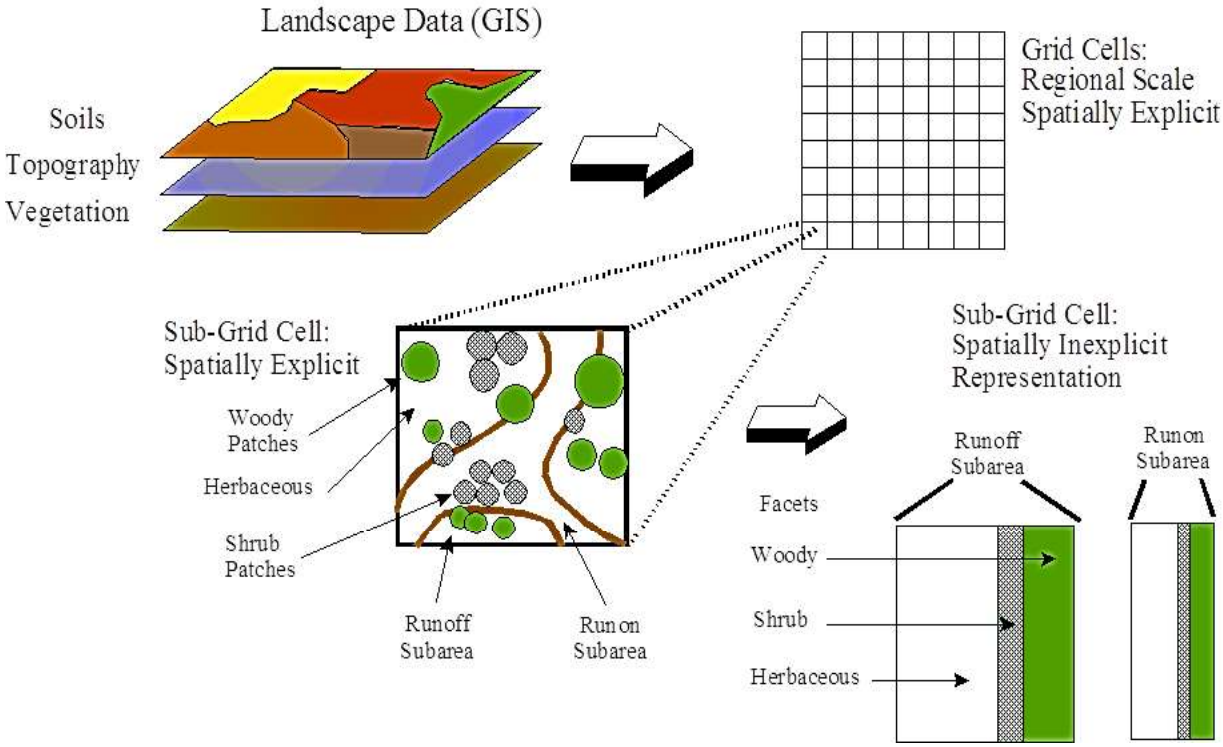

Figure 5.2 Spatial representation of SAVANNA

Spatial simulation of landscape-scale vegetation in SAVANNASpatial input grids for climate, soils, vegetation and topology are used to define local grid values for subsequent vegetation and herbivore simulations. While some spatial inputs are constant throughout the simulation (elevation, soil type, etc), other spatial state variables such as vegetation factors (areas dominated by grass, shrubs or trees) can vary in weighted area and plant composition depending on simulated features such as fire, herbivory and plant competition. SAVANNA provides mechanistic sub-models of major savanna ecosystem dynamics including the following: (1) soil moisture/nutrient availability, (2) vegetation biomass, structure and cover, (3) herbivore intake, populations, distribution and condition as well as (4) fire behaviour and spread (Coughenour, 1993).

5.3.4 Adapting SAVANNA to the Dirre agro-ecosystem

SAVANNA uses geographic information layers as input maps/grids as seen in the example Figure 5.3. In this study, a 1 km^2 grid cell size was used for computational efficiency and yet maintain enough detail to simulate the whole of Dirre dheeda. Vegetation maps were

upscaled from the European Space Agency (ESA) 20m resolution. The land classification map (ESA, 2017) was used to delineate grasslands, shrublands and forest areas in Figure 5.3. The Digital Elevation Model (DEM), the slope, and aspect which were all obtained in 90m resolution from the Shuttle Radar Topography Mission (SRTM) global coverage (CGIAR-CSI GeoPortal, 2019) These were resampled upwards to 1km using the resample function in ArcMap based on the mean sampled values. The extract by mask function was used and the Dirre grazing site polygon was used as an extraction input file. Fire was not simulated as burning was banned in the area around the 1990s (Degen, 2011; Homann, 2004).

SAVANNA functional vegetation parameters were configured using those from Lesorogol & Boone, (2016), Boone and Lesorogol (2016), Thornton et al., (2006) as a guide for different herbaceous, shrub and woody plants. The vegetation types for the study site were defined from Liao et al (2018) and the classes were from the ESA (see table 5.1). The plant functional groups used in Dirre simulations were classified into palatable grasses, palatable, forbs, unpalatable grasses and forbs, palatable dwarf shrubs, unpalatable dwarf shrubs, palatable shrubs, unpalatable shrubs, deciduous trees (Lesorogol & Boone, 2016, Boone and Lesorogol 2016). Seasonal grazing force maps were constructed to restrict livestock movement for the seasonal grazing scenario as shown in Figure 5.3.

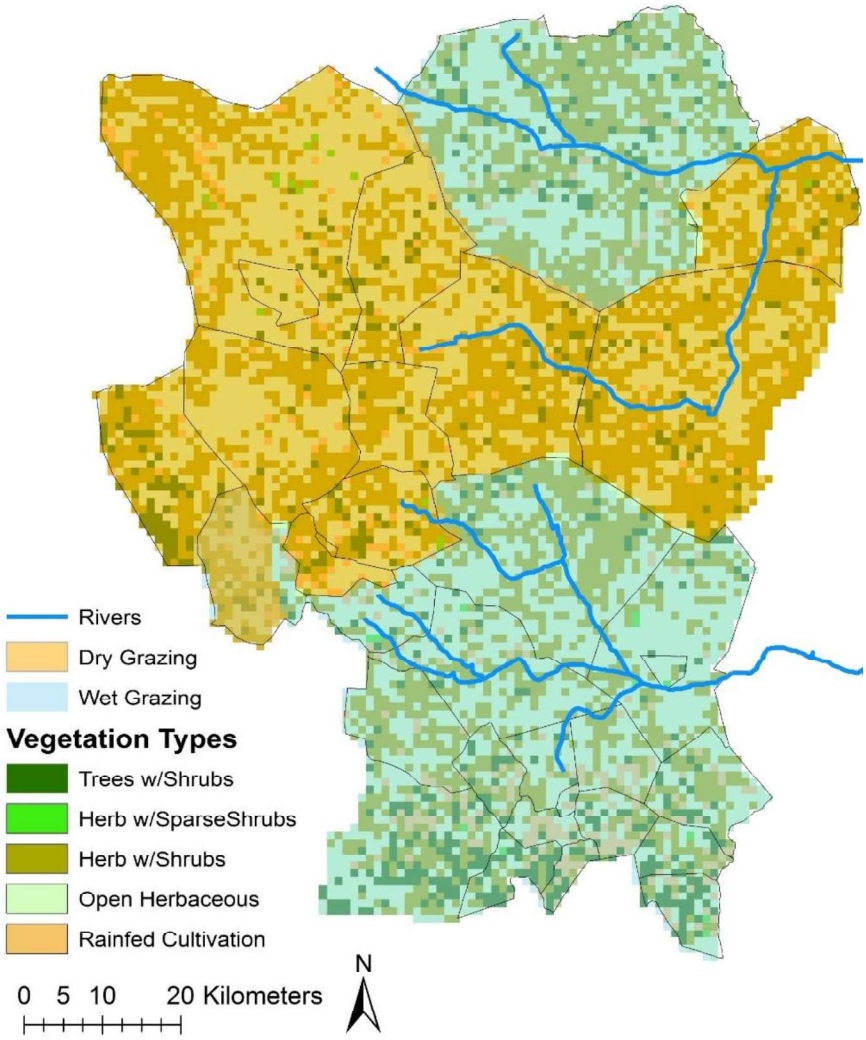

Figure 5.3 SAVANNA simulation domain (1km^2 grid resolution), Dirre agro-ecosystem

Livestock was also simulated in both SAVANNA and DECUMA, placed into three functional groups (cattle sheep and goats) while in SAVANNA it was simulated as two groups (communal cattle and communal shoats). Spatial and time series inputs for SAVANNA/DECUMA are listed in below in Table 5.1. Vegetation classification is provided by upscaled ESA (2017) coverage while dry and wet season areas are also defined for subsequent simulation scenarios.

Table 5.1 Spatial and time series inputs list and sources for SAVANNA parameterization

Parameters	Source	Processing
Vegetation physiology, phenology	(Boone et al., 2011; Lesorogol & Boone, 2016; Thornton et al., 2003)	The vegetation map was processed from the land use map S2 prototype Land Cover 20m map of Africa. From the vegetation parameters described in Lesorogol and Boone, 2011. Four vegetation types from the ESA map were identified.
Land classification map	ESA Climate Change Initiative Land Cover project 2017 (ESA, 2017)	
Animal physiology and energy requirements	Boone et al., 2011; Lesorogol and Boone, 2016; Thornton et al., 2003)	This was already defined for the three functional groups (cattle, sheep, and goats)
Rainfall data from 1981 to 2018	CHIRPS (CHIRPS v2.0, 1981-2016)	This was extracted by polygon (study site) using functions in R
Temperature (1981-2018 (maximum and minimum)	AFDM (Shefield et al, 2014	This was extracted by polygon (study site) using functions in R. The data was then summarized from daily data into monthly averages
Livestock populations in Dirre	CSA (1994-2014)	These were extracted from the Borana livestock surveys
Soils	Obtained from ISRIC and the USDA soil classification was used (Batjes., 2009)	Soils were identified as (loam soils, the silty loam, and the clay loam) and parameters such as field capacity, wilting point, and depth were defined
Digital elevation model-DEM, slope, and aspect	http://www.cgiar.srtm/ at a 90m elevation.	Resampled upwards to 1km using the resample function in ArcMap based on the most frequent value. The extract by mask function was used and the Dirre grazing site polygon was used as an extracting input file
Distance water maps	Own survey data (unpublished)	Average distance to water sources for both the wet and dry season was used to produce the distance to water maps

5.3.5 Adapting the DECUMA Agent-Based Model to the Dirre agro-ecosystem

DECUMA is an agent-based model created by Boone et al. (2011) that simulates household level responses within a spatial landscape to help understand complexity within agro-pastoral ecosystems Boone et al 2011). The primary information flows within and between DECUMA and SAVANNA model is represented in Figure 5.4 below (Boone et al 2011)

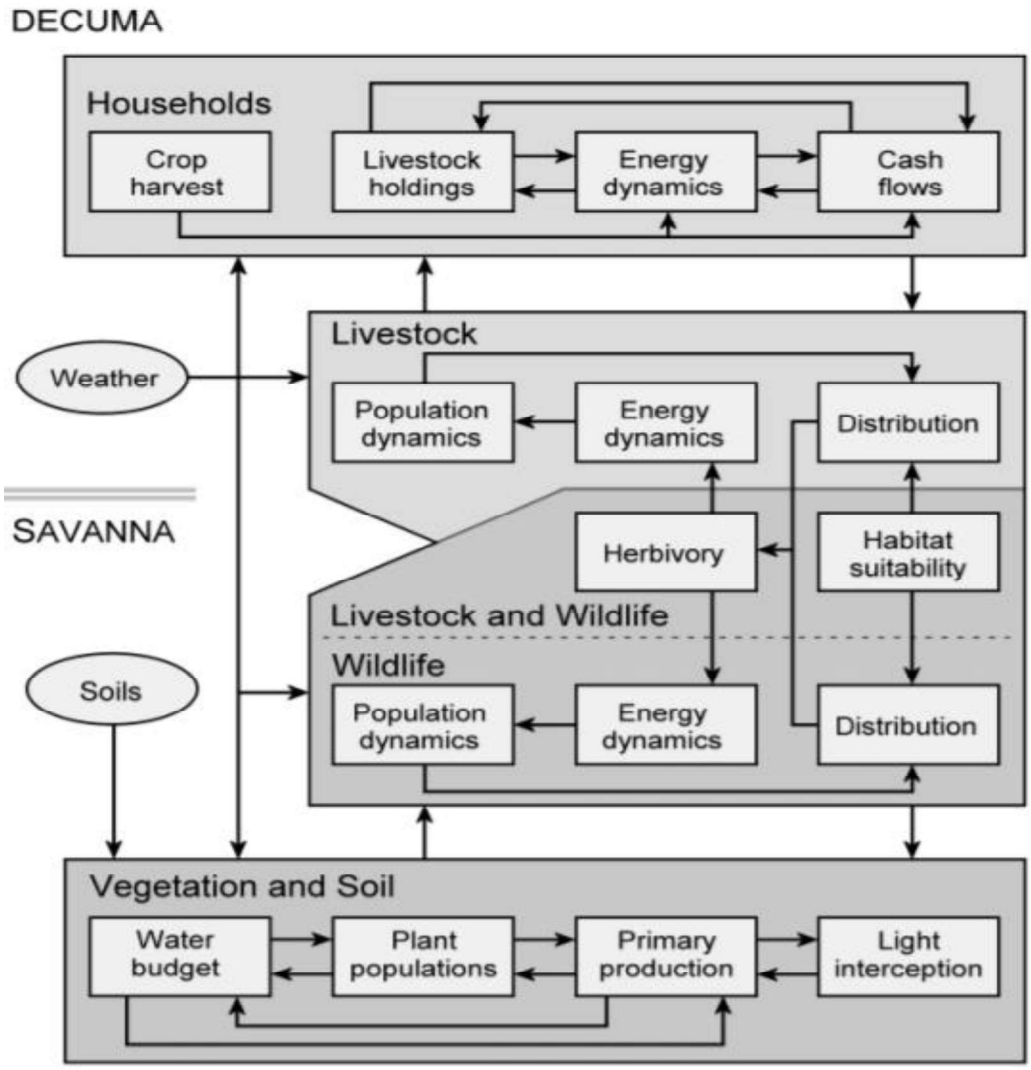

Figure 5.4 Primary information flows within and between DECUMA and SAVANNA

In DECUMA, household agents are treated as part of and interacting with the changing rangeland environment (as simulated by the SAVANNA model) with the capacity to adapt in response to changes in the environment. DECUMA focuses on the uniqueness of each household agent and the potential interactions between them (Boone et al 2011). In some cases, simplistic aggregation of individual households may give some misleading results where pastoralists were simulated as large homogeneous groups (Thornton et al., 2003). DECUMA as an agent-based model has the ability to simulate individual household-level activities concerning livestock, crops, food and finances while incorporating spatial and temporal heterogeneity and interactions. Within the Dirre agro-ecosystem, DECUMA is parameterized from recent household surveys (Senda, unpublished), results of previous

surveys (USAID, 2017, Degen, 2011 Homann, 2004) as well as past literature (Desta and Coppock, 2004, 2002; Homann, 2004; Wario et al., 2016).

To parameterize household agents in the Dirre system, DECUMA requires information concerning household sizes, age and sex distribution, consumption of energy from milk, meat, cereals, income and expenditure on different household needs, sales and purchase of livestock, other sources of income, cropping information and livestock sales. This was obtained from household surveys conducted in 2018 (USAID, 2017, Degen, 2011; Desta and Coppock, 2004, 2002; Homann, 2004; Wario et al., 2016). To simulate different households in the Dirre region, 250 individual household agents were used and distributed across the landscape the Borana reera population numbers (Borana Pastoralist Development Office. unpublished). In DECUMA, sales and purchases of food and livestock are all rule-based for example when the household income needs fall below a specific threshold, the household either sells cattle or small stock depending on the size of the need. Purchases are also based on the triggers to buy that are also rule-based the same way as sales. All household decisions occur on a weekly basis and output can be aggregated at either the weekly or monthly time step. Specific input parameters concerning the rules and thresholds as well as budgets, sales and purchases can be found in the DECUMA input file (*metrics.dec*, Appendix 3). DECUMA outputs monthly time series files as well as spatial maps of households and their moving livestock populations. Time series output averages of livestock populations, sales, purchases, income and expenditure, energy requirements, and food consumed for all the simulated households. Some outputs are presented as standard livestock and human metrics i.e., Tropical livestock units-TLUs for livestock and then adult equivalents (AE) for humans. One TLU is an animal of weight equivalent to 250kg while AEs are assigned 1 for adult males. Adult females and young males were allocated lower values as in (Boone et al., 2011).

5.3.6 Coupled SAVANNA/DECUMA simulations for Dirre agro-pastoral system

The SAVANNA/DECUMA coupled model was executed for a 35-year period (1981-2017) with monthly rainfall and temperature (max/min) along with environmental data detailed and sourced in Table 5.1 above. To account for both larger scale communal livestock and livestock held by specific household agents in the Dirre region, five specific livestock groups were simulated with the SAVANNA/DECUMA model. To account for the grazing pressure exerted by the rest of the households in Dirre that were not explicitly simulated by

DECUMA, a fixed time series of both communal cattle and "shoats" (a parameter combination of sheep and goats) was constructed and input into the SAVANNA model with population estimates based on literature-reported values (Figure 5.5) (CSA, 1980; Desta and Coppock 2002, 2004, Degen 2011, Wario 2016, Homann 2008). Figure 5.5 is a constructed input time series of communal cattle and "shoats" (sheep and goats). This was used incorporate regional livestock population variations as a driver of household level populations of cattle, sheep and goats

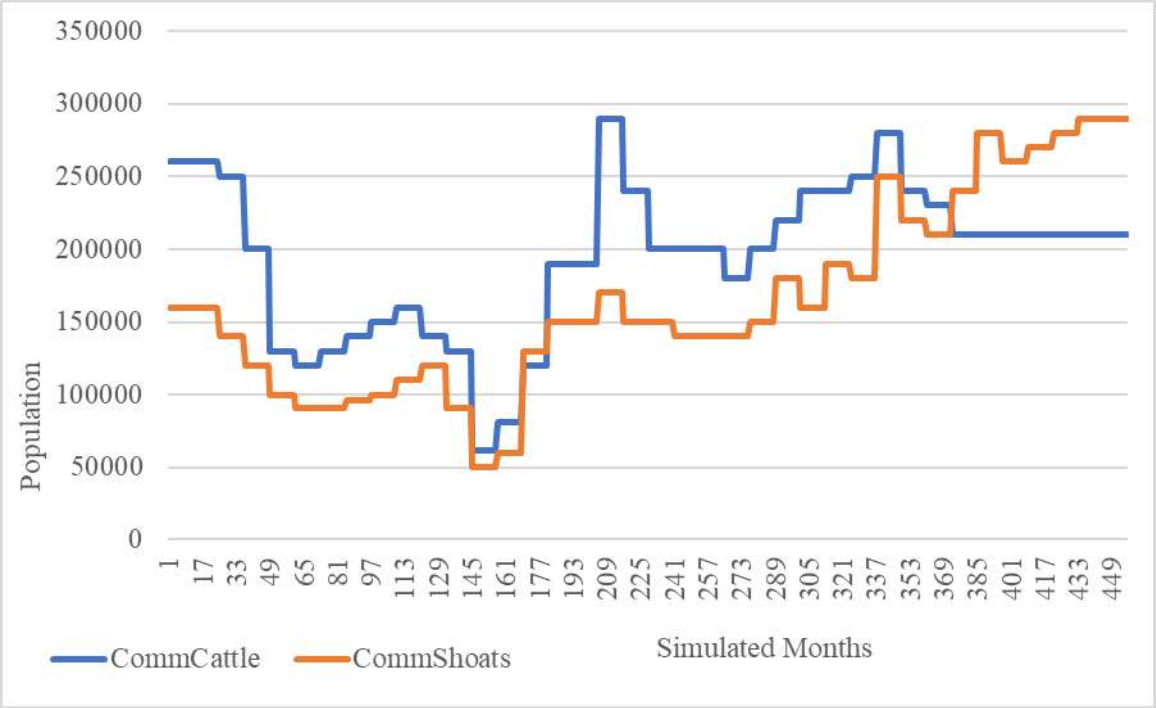

Figure 5.5 A constructed input time series of communal cattle and shoats

The bulk of the livestock numbers were obtained from the Central Statistical Agency of Ethiopia CSA, 1980-1981, CSA, 1995-1991 and 2004 to 2014). The total communal cattle numbers began much higher than that of sheep and goats and subsequently followed a boom-and-bust pattern. Cattle dropped to the lowest recorded during the drought of 1990/1991, getting to as low as less than 100 000. They peaked in the early 2000s after the 1998 drought. On the other hand, shoats' populations also respond to droughts but are not as hard hit as the cattle. They started increasing dramatically in the 1990s and overtook the cattle populations by the 2011 and have continued to increase. The remaining three groups of livestock consist of cattle, goat and sheep populations that are maintained by each household over each weekly time step within the DECUMA model. Household parameters including herd sizes for cattle,

sheep, and goats were also initialized to 1980-1981 levels (CSA 1980-1981). The 250 DECUMA-simulated households were distributed on the landscape both by population and wealth categories using a Python script. The probability of a household being found in a specific regional location and wealth category was calculated based on the number of people in that reera as a proportion of the whole of Dirre (Borana Pastoralist Development Office. unpublished).

5.3.7 Model Testing Using the Pattern-Oriented Modelling (POM) approach

Often rangeland and livelihood systems are studied separately with assumed unidirectionality, except in rare cases where the interaction it is considered, albeit, *ad hoc*, rarely explicitly informed by households/pastoralist livelihood patterns (An, 2012; Crooks et al., 2008; Groeneveld et al., 2017). When modeling a system across scales and at multiple scales it is useful to link the population and ecosystem behaviors to individual adaptive behavior through pattern-oriented modeling (POM), a multi-criteria design for the selection and calibration of models for complex systems (Grimm & Railsback, 2012). POM matches patterns of model outputs at different scales with specific elements of the actual system to assess area of similarity and divergence. While perfect matches between model results and system characteristics are not possible, the process of systematically analyzing sectors of model performance can prove useful in both assessing simulation results and subsequent modifications to model components (Grimm et al., 2005). Pastoral systems are complex and uncertain with humans constantly acting in a local, adaptive capacity, making it very difficult to accurately predict changes over large diverse areas (Moritz et al., 2014, 2018). POM provides a useful approach when modeling these systems as it allows a bottom-up approach informed by local-level agents, processes and patterns (Grimm et al., 2005; Grimm & Railsback, 2012). Both the SAVANNA and DECUMA model results were assessed with respect to selected historical patterns (Degen, 2011; Desta & Coppock, 2002, 2004).

Patterns under consideration.

Multiple observed patterns were used in the SAVANNA/DECUMA and tested are summarized in Figure 5.6.

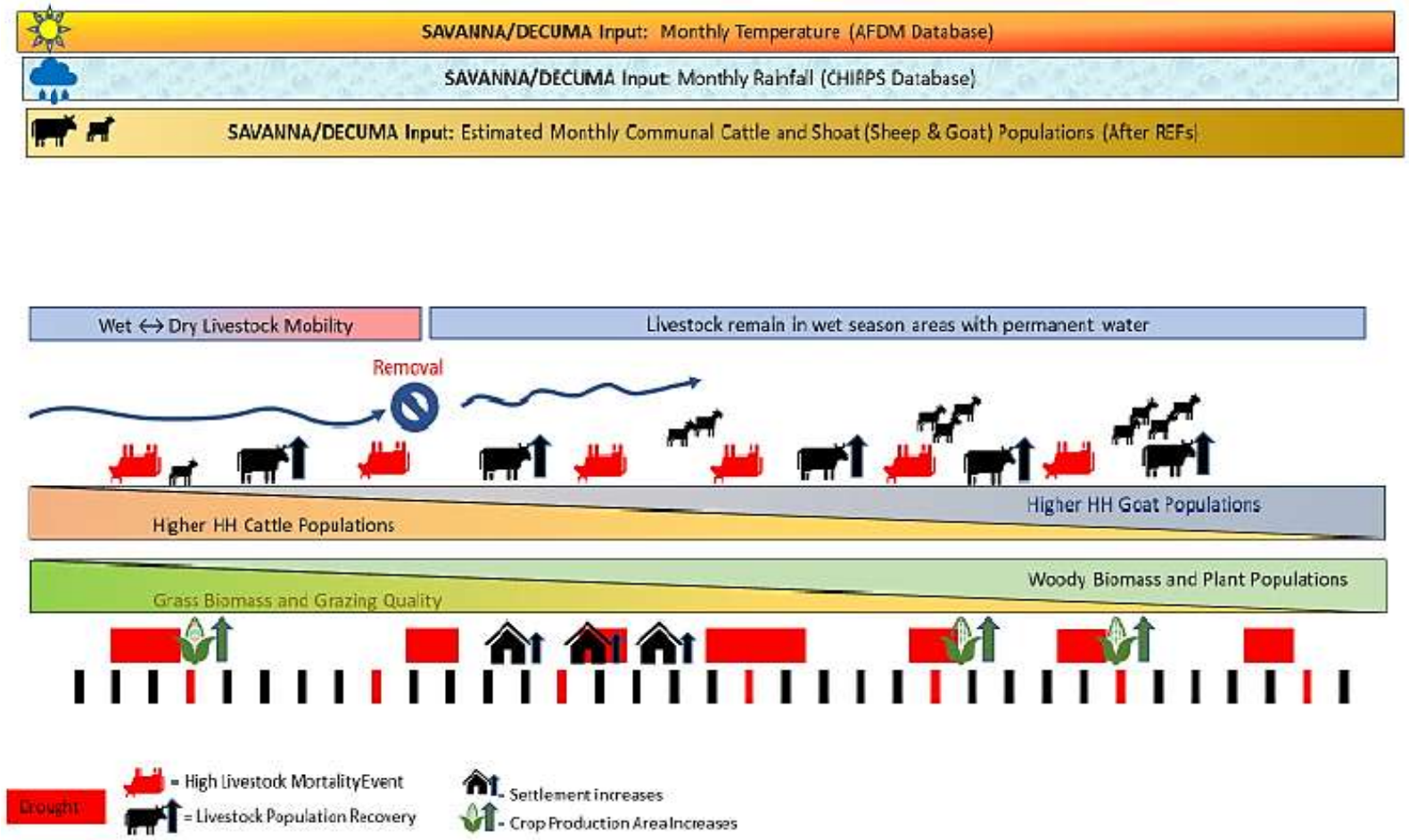

Figure 5.6 A summary temporal drivers and resultant dynamics Dirre 1981 to 2017.

Pastoral system drivers can have complex patterns due to biophysical/ecological factors such as droughts (Degen, 2011; Desta & Coppock, 2002, 2004), vegetative biomass (Degen, 2011; (Odadi and Rubenstein, 2015, Roba & Oba, 2013) and livestock populations with respect to condition/health (Desta & Coppock, 2002; Odadi et al., 2017). The history of droughts in the region shows that there were major droughts in 1983–5 and 1991–3 in 1998/1999, 2005/2006 and one in 2008/2009, large numbers of livestock perished (Degen, 2011; Desta & Coppock, 2002). For herd growth patterns major cattle die-offs in which mortality exceeded 40% occurred frequently, for example during the droughts of 1983/1985, 1991/1993, 1998/1999 and 2005/2006. From 1973 to 2003, bushlands increased by 45% whereas grasslands decreased by 86% (Degen, 2011; Desta & Coppock, 2002). Settlements started increasing in the early 90s, while crop production increased more. on the early 2000s (Degen, 2011; Desta & Coppock, 2002). A summary of critical temporal drivers and resultant dynamics in the Dirre agropastoral ecosystem from 1981 to 2017 is shown in Figure 5.6.

5.3.8 SAVANNA/DECUMA simulation of grazing management scenarios

The grazing access scenarios that were tested are summarized in Table 5.2. The "baseline" scenario (S1) represents rangeland processes and household wellbeing under all-year-round, open grazing management. The "seasonal access" scenario (S2) (planned grazing, wet/dry seasonal grazing) assesses processes when the seasonal grazing zones Figure 5.3 are revived and functional.

Table 5.2 The scenarios modeled, showing the grazing patterns

Grazing area	Months			
ALL YEAR ROUNG GRAZING SCENARIO (**S1**)				
All year-round grazing	*January to December			
PLANNED GRAZING SCENARIO (**S2**)				
Wet season	March, April, May		August, September, October	
Dry season	*	February, June and July		November, December, January

*areas shaded green mean there are animals in that area during those specific months, brown means there are functionally no animals present

In the all year-round grazing scenario S1, there are no restrictions to any herbivores in the system as both communal livestock (cattle & shoats) along with household-based livestock (cattle, goats & sheep) have unrestricted access to all sites within the simulation area covered in Figure 5.3. In the second seasonal grazing scenario S2, both communal and household-based livestock are restricted to the wet season (months: March, April, May, August, September, October) and dry season (months: November, December, January, February, June and July) grazing zones previously described in Figure 5.1

The simulated outputs of interest from both models are summarised in Table 5.3 below.

Table 5.3 Simulated outputs of interest from both models

Model	Category	Broad	Specific parameter
SAVANNA	Ecological	Spatial and temporal patterns of the eight vegetation types functional and vegetation categories (grass, shrub and tree groups).	Total grass green leaf biomass (g/m^2) of palatable grass, palatable forbs, unpalatable grass and forbs Woody plants: total shrub and tree biomass, populations and percent and cover
	Livestock	communal cattle and shoat population distribution (as monthly grids)	Total communal cattle, sheep goats
DECUMA	Livestock	Monthly livestock condition index Individual household time series and spatial outputs Average summary outputs for all simulated	For cattle, sheep and goats Livestock herd populations, condition Cattle/sheep/goat TLUS
	Pastoralist related	Individual household time series and spatial outputs Average summary outputs for all simulated	, financial resources and food consumption Net income, cash used to buy food, cash used to buy replacement animals, running income per AE, cattle income, goat income and sheep income

5.4 Results

SAVANNA/DECUMA results are presented with respect to the overall biophysical/ecological and human/pastoral outputs in two sections: historical pattern comparisons and grazing management scenario-based comparisons. The first section addresses the pattern comparison with historical conditions to explore how the model captures or misses agro-ecosystem dynamics as described in Figure 5.6. The second section addresses the differences between open grazing and seasonal scenarios.

5.4.1 Simulating critical agro-ecological patterns in the Dirre region

The temporal patterns included for the POM include SAVANNA-simulated trends of herbaceous, shrub and tree biomass and populations as well as communal livestock condition as well as DECUMA-simulated trends of household-scale livestock populations and condition index. In the 1981-2017 period, grazing management shifted from more seasonal practice in the first ten years (1981-1991) to more sedentary practices (1992 onward) as seen in Figure 5.6. As such, SAVANNA/DECUMA results are mostly presented from the open access grazing scenario (S1) although the general trends are similar over both scenarios. This POM-related section focuses more on the overall trends as reported in Figure 5.6, concerning vegetation and livestock condition more than a direct grazing management scenario comparison which is covered in subsequent results sections.

5.4.2 SAVANNA-simulated plant and animal patterns

Over the simulation period, significant shifts in herbaceous and woody plant functional groups occurred in relation to droughts and the high livestock stocking rates. Figure 5.7 highlights early increases in both dwarf shrub and shrub biomass levels are then mostly consumed by increasing shoat populations by the middle 1990's and episodic drought periods. Figure 5.7 shows the domain showing a strong increase in unpalatable grass biomass with associated decreases in heavily grazed palatable grasses and forbs by communal cattle and shoats.

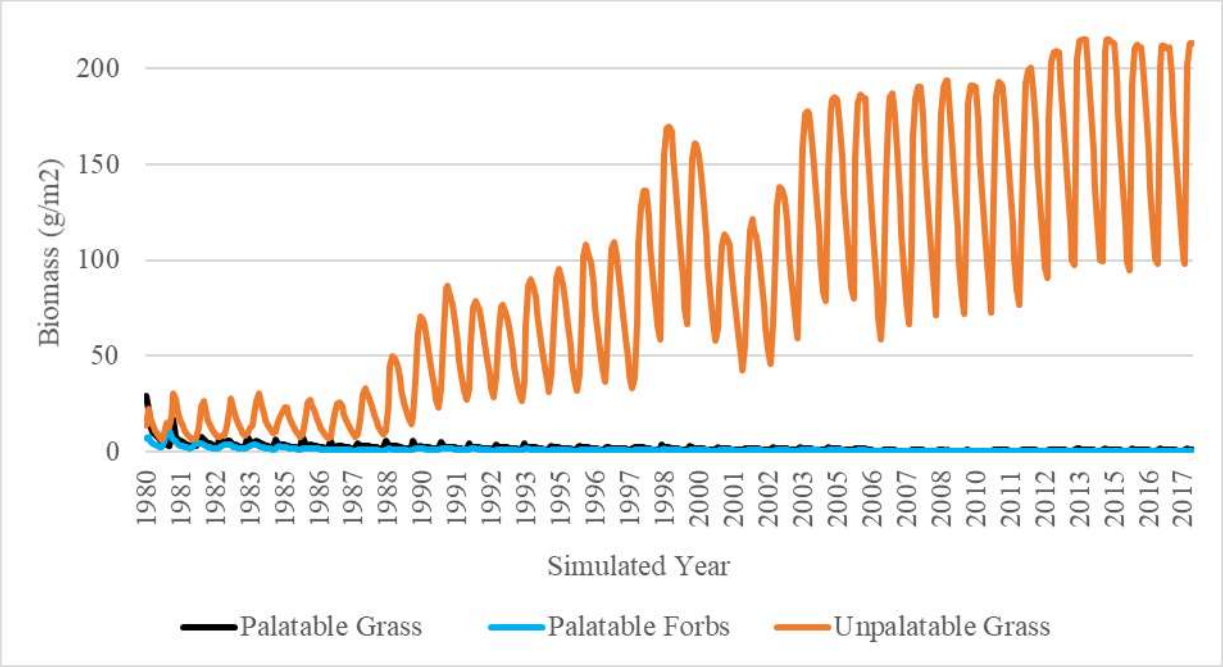

Figure5.7 SAVANNA herbaceous biomass (g/m^2) results over the entire Dirre simulation.

The initial cattle population crashes in the early 1980's and subsequent recovery in the later 1980's systematically suppresses palatable grazing so that palatable species are systematically consumed first where available with consistent favoring of unpalatable grasses in regrowth periods Figure 5.8 domain shows initial increases in shrub biomass under lower communal sheep and goat populations with subsequent biomass decreases under subsequent droughts and higher browsing pressure in the 1990's and onward

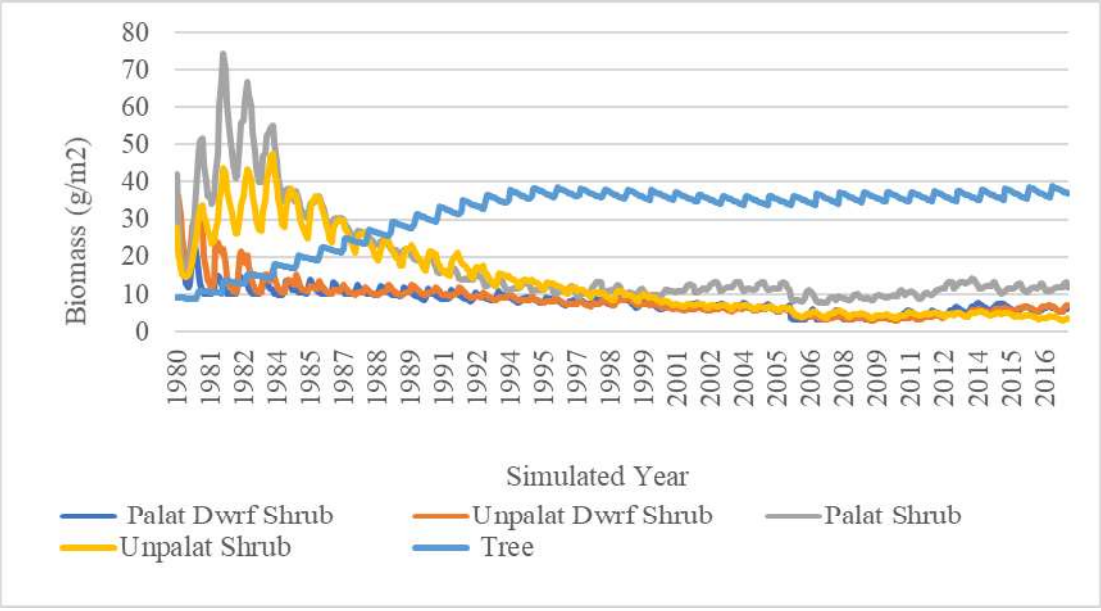

Figure5.8 SAVANNA shrub and tree biomass (g/m^2) results over the entire Dirre simulation

Trees have less sensitivity to droughts and much lower browsing pressure and thus steadily increase. As forest trees are less sensitive to drought periods and are mostly out of the browsing range (0 to 1.5m), there is a steady increase in tree biomass to more than 350 percent over the simulation period. As the SAVANNA model simulates biomass and population separately in each woody vegetation group, the increase in shrub and tree populations are also seen in Figure 5.9 as responses to both drought and high grazing pressure with no fire. Figure 5.9 below is the domain showing increases in dwarf shrub populations until communal shoat populations capitalize on the available fodder from 1990 onwards.

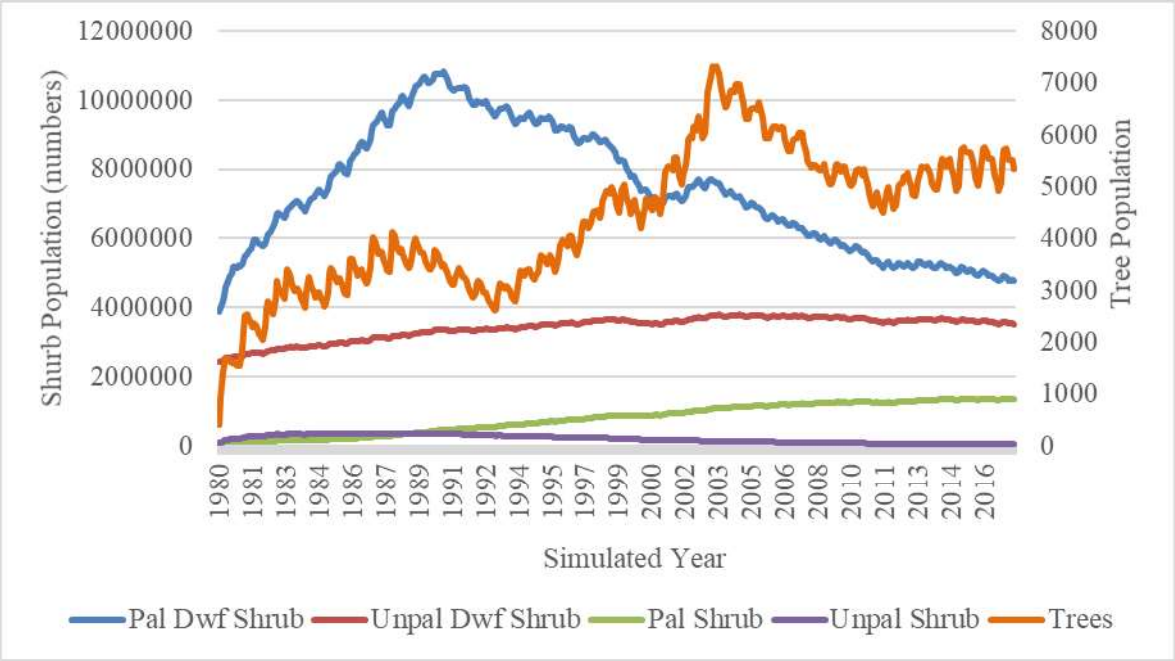

Figure 5.9 SAVANNA shrub and tree populations over the entire Dirre simulation

As the communal cattle and shoat populations are input as times series inputs, the most relevant SAVANNA animal outputs are a calculated condition index (CI) which is the average communal animal's condition to its maximum or minimum body weight. Thus, a CI of 0.0 would mean that most animals are assumed to be near their minimum body mass and in poor condition. A CI of 1.0 would be that the animals are living at their maximum body mass range and are therefore in excellent condition. Figure 5.10 shows that communal cattle CI fluctuates between 0 and 1 in the first few years of the simulation period while grazing conditions and climate are favorable.

Figure 5.10 shows the SAVANNA communal cattle and shoat condition index over the entire Dirre simulation that describes the average animal in relation to it minimum (CI=0) and maximum (CI=1) body weights.

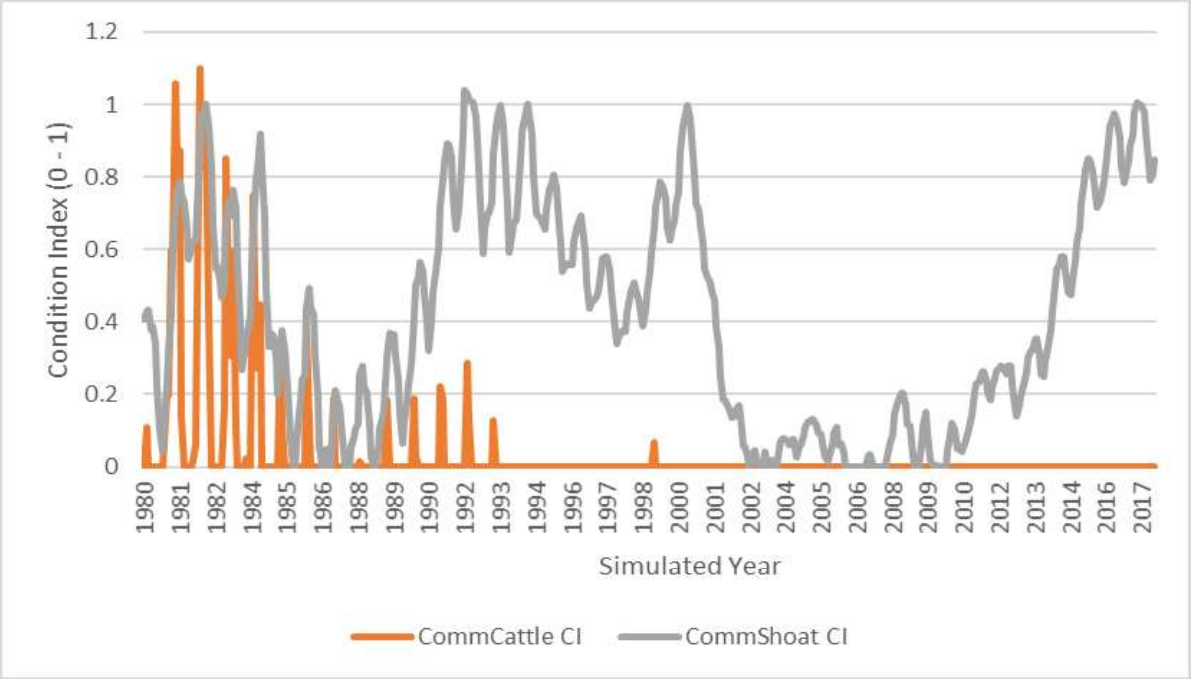

Figure 5.10 SAVANNA communal cattle and shoat condition index over the entire Dirre

With the systematic degradation of grazing resources and the frequent drought periods. The communal cattle CI remains at minimal levels from 1986 onward. The communal shoats CI does not follow this trend but shows periods of strong performance in the 1990's over time as they capitalize on available browsing resources. The long drought of the early 2000's does decrease condition over a long period, but once again the shoats prove more resilient than cattle in recovering condition within an increasingly degraded landscape. This dynamic pattern is also described in the literature and graphically in Figure 5.10 above.

5.4.3 DECUMA-simulated household patterns

The DECUMA model focuses on the households living within a SAVANNA-generated landscape. Within the Dirre simulation, 250 households are simulated on a weekly basis with specific focus on herd dynamics, finances and food production. A fundamental difference within DECUMA is that herd populations at the household level are dynamic and not simulated with input time-series as with the SAVANNA-level communal cattle and shoats. As such both population and condition index are simulated and thus are presented. As before, only results from the open access scenario are shown in this section with specific scenario comparisons in subsequent results sections. Given the large amount of household data for each month, temporal patterns are presented in a time series of box and whisker plots to show the median value (as a horizontal line) nested within the 25th and 75th percentile (box edges) which resides within the 5th and 95th percentile (whiskers). Outlier values are listed as dots above or below the whiskers. Figure 5.11a and 5.11b highlights the systematic decline of household level cattle and the ascent of goat populations over time.

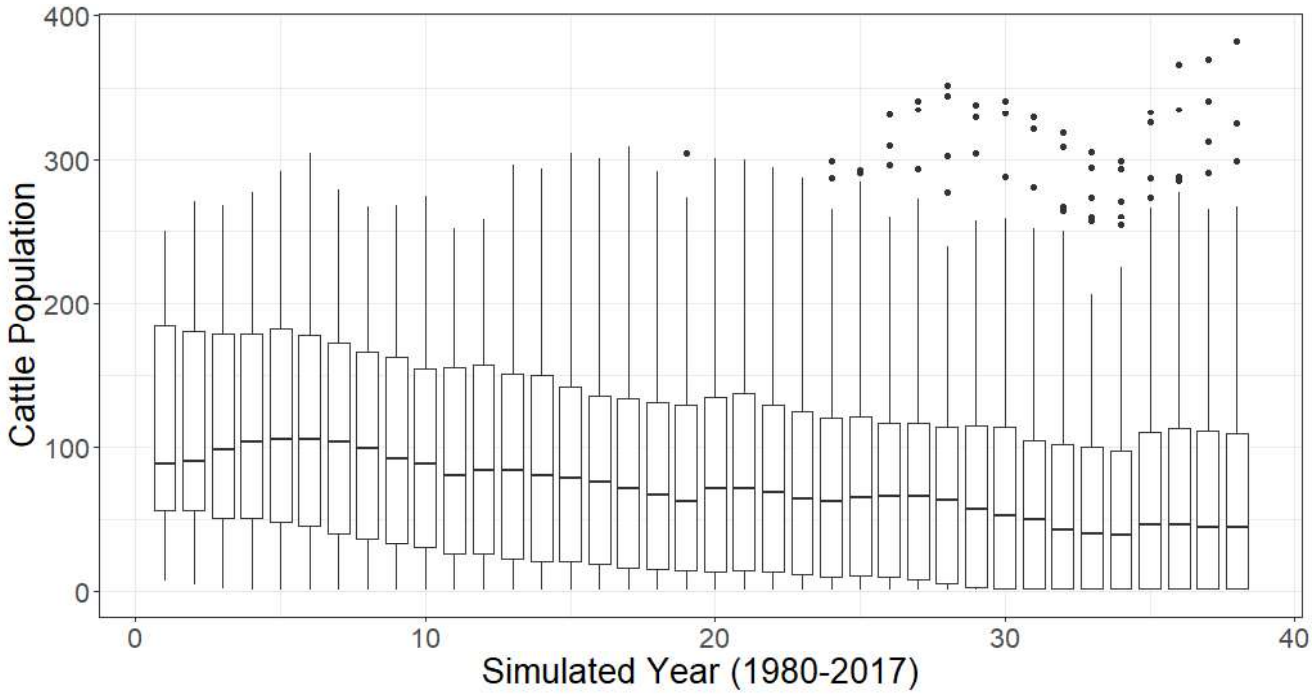

Figure5.11(a) DECUMA household cattle populations for all 250 households

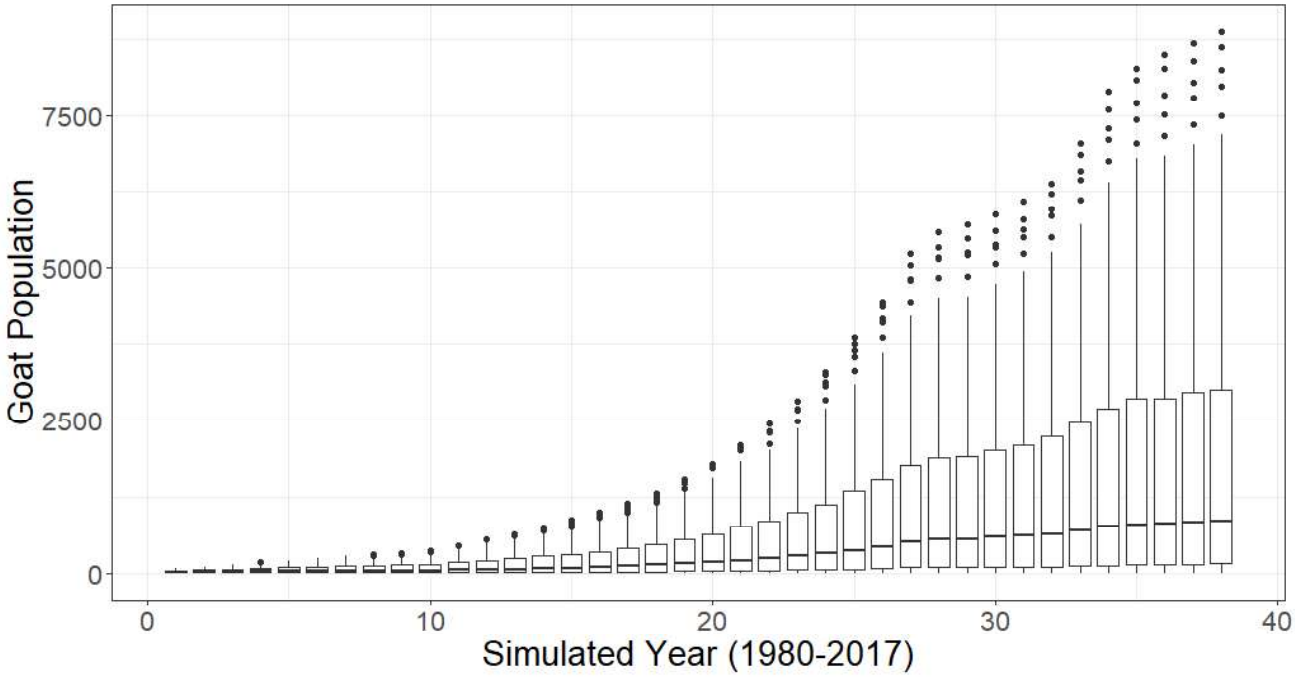

Figure 5.11(b) DECUMA household goat populations for all 250 households

The individual household herd populations over each month are presented in a box and whisker format to show the median value (as a horizontal line) nested within the 25th and 75th percentile (box edges) which resides within the 5th and 95th percentile (whiskers). Outlier values are listed as dots above or below the whiskers.

While there are still some outlier higher wealth households maintaining and even increasing their cattle holdings in Dirre, the majority of households have decreasing amounts of cattle ownership with a significant decrease in the last ten years of the simulation.

Alternately, goat populations increase at an accelerating rate as grazing conditions decrease. This trend is similar to the trend reported in (Desta and Coppock, 2003, 2004, Degen 2011, Homann., 2008). Subsequently, the population seems to level out at year 25 with some slight decreases in higher herd households showing in the last ten years.

Error! Reference source not found. Condition Index (CI) provides a more coupled indicator in its correlation with episodic droughts and corresponding grazing resource degradation. In Figure 5.12a (cattle) and 5.12b (goats) it shows the DECUMA household livestock condition index all 250 households simulated in the Dirre region that describes the average animal in relation to it minimum (CI=0) and maximum (CI=1) body weights.

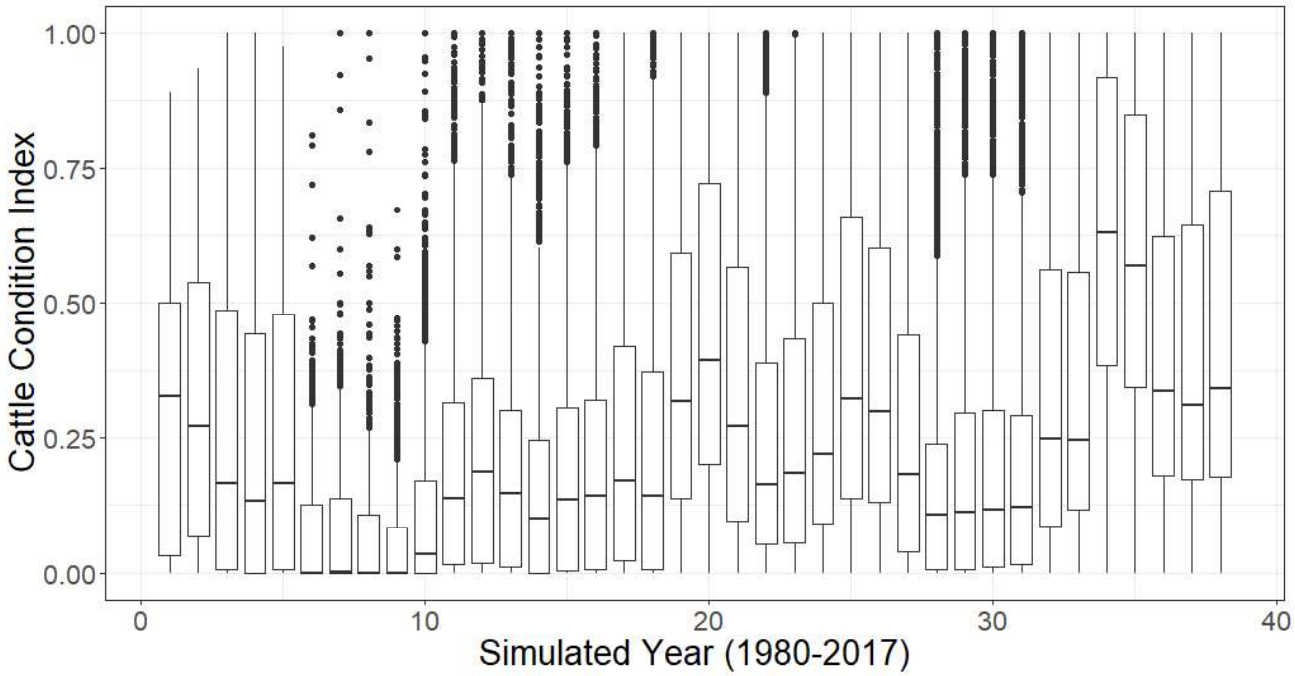

Figure 5.12(a) DECUMA household cattle condition index

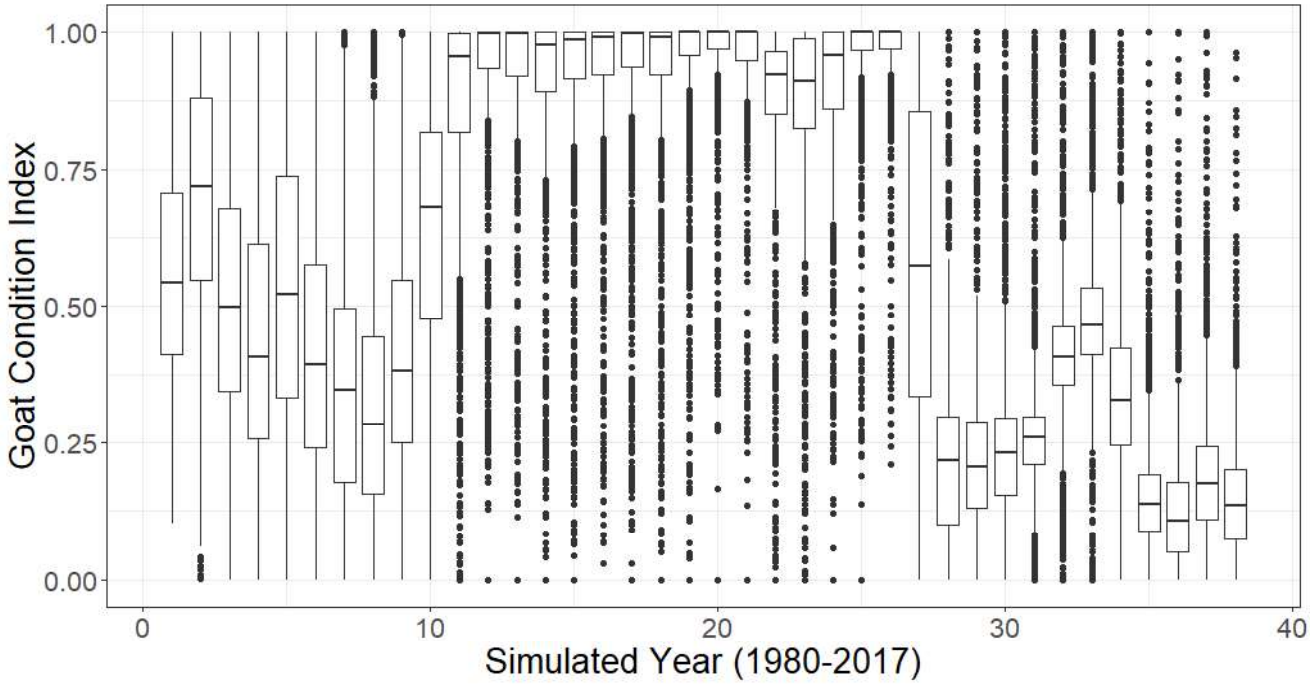

Figure 12(b) DECUMA household goats condition index

The Figure 5.11 also shows the differential reaction in condition of cattle versus goats. In the first ten years of simulation, goats maintain higher condition for longer periods even as the landscape descends into drought. Goat CI recovery in years 10 through 20 are much stronger and proves more resilient than cattle throughout the period up to the significant droughts of the early 2000's. While CI fell in both cattle and goats during this drought period, both

livestock species had mixed results in subsequent years 25-36 (2006-2016) depending on rainfall and forage conditions. In summary, both SAVANNA and DECUMA provide useful and somewhat accurate temporal patterns to show both the systematic rangeland shift from a grassland/cattle agroecological system into a more shrubland/browser system using coupled climate and ecosystem inputs.

5.4.4 Grazing Management Scenario Comparison

In this section SAVANNA/DECUMA results are compared to highlight differences and similarities among the two grazing management scenarios S1-open all year-round grazing and S2-planned seasonal grazing access. SAVANNA-DECUMA temporal outputs are presented for palatable and unpalatable grass biomass, bush encroachment- increase of shrubs, household energy consumption, livestock populations and income from livestock sales and other household level attributes. In addition, the spatial distribution of green grass biomass, for the two scenarios in selected low rainfall versus a higher rainfall year.

Simulated biomass for the grass, shrub and wood layers under two grazing scenarios

For both S1-open grazing and S2-seasonal access scenarios, biomass (in g/m^2) is presented in Figure 5.13 through to Figure 5.15 show the production by the different vegetation types and their palatability as follows: **PGrass**: Palatable grasses, **PForbs** Palatable forbs, **UHerb**: unpalatable herbaceous (grass and forbs), **PDShrb**: Palatable dwarf shrubs, **UDShrb** unpalatable dwarf shrubs, **PShrub**: palatable shrubs, **UShrub**: unpalatable shrubs, **Wood**: woody layer. Figure 5.13 shows that for unpalatable grass levels, the rise of this species occurs regardless of scenario, which is a sign of increased degradation. While there are slightly lower levels in the S1 scenario, the overall behaviour is quite similar regardless of the grazing access scenario.

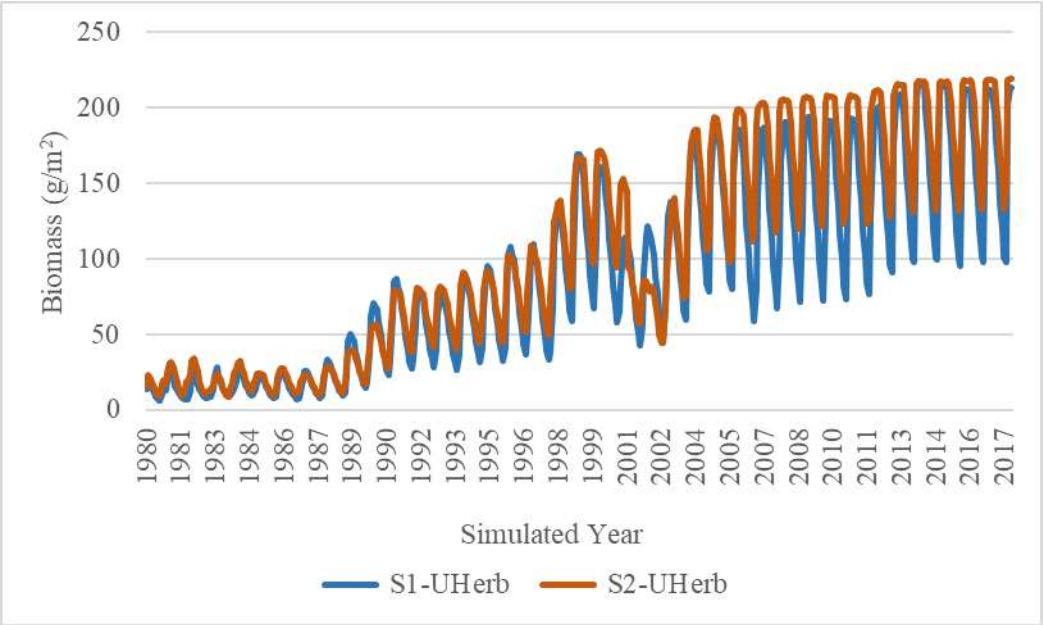

Figure 5.13 Simulated average biomass yields (g/m^2) of the unpalatable grass and forbs

Figure 5.14 does show difference between the two scenarios in that the degradation of palatable grass (PGRASS) occurs at a slower rate in S2 than in the S1 scenario.

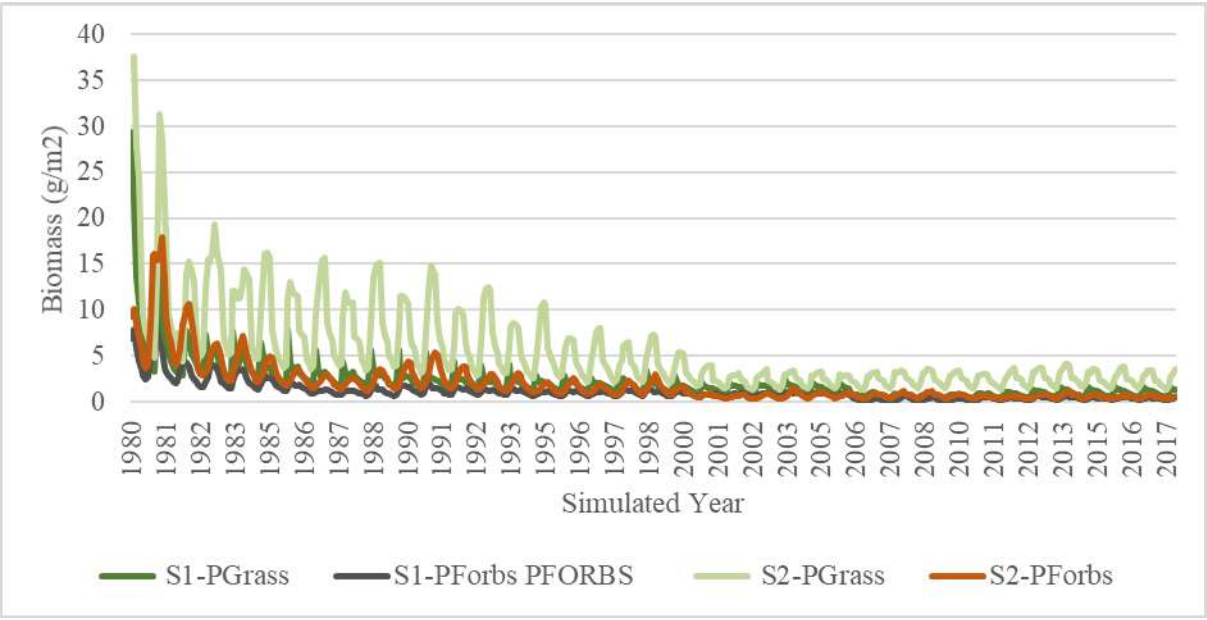

Figure 5.14. Comparison of the simulated average biomass yields (g/m^2) of the palatable grass and palatable forbs

In the S2 scenario, higher biomass levels of palatable grasses are still accessible until the early 2000's drought event as opposed to the much faster removal in S1. Overall, the grazing scenarios only seem to preserve marginal levels of palatable grasses, but do not help protect against the increase of unpalatable species. In terms of woody vegetation, there were few differences in the scenario results.

Figure 5.15 compares the four shrub species (palatable/unpalatable dwarf and full-sized) with some marginal differences in the biomass levels of more palatable species in the planned grazing scenario (S2) until about 2000 when the scenarios converged results.

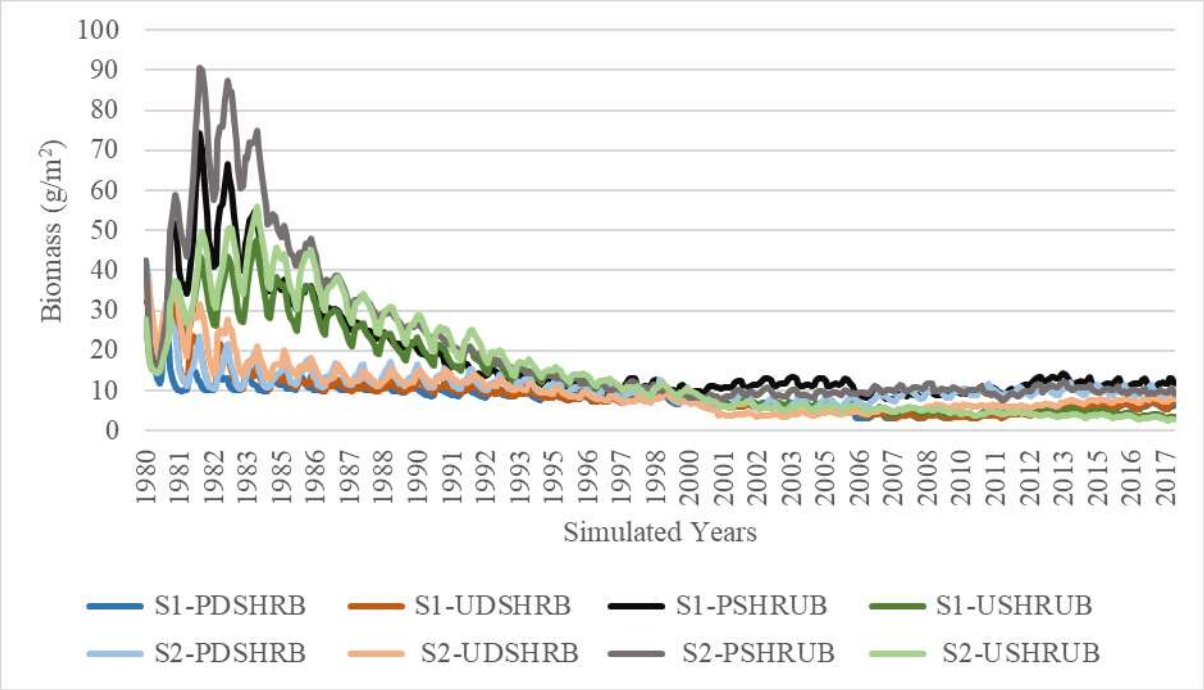

Figure 5.15 Simulated average shrub biomass yields (g/m^2) of the palatable and unpalatable shrubs

This pattern continued with shrub populations as well where the seasonal grazing scenario tended to slow the degradation of palatable plants until about the year 2000 where the scenarios converged. The tree (wood) species (not included in a figure) had no functional differences between scenarios but increased more than 300% over the simulation period given that the group is not heavily browsed. Overall, the grazing scenarios had marginal effects on woody biomass or population for palatable species for about half the simulation time when after the early 2000's drought period, the results were effectively the same. Thus,

for the palatable woody species, planned grazing helps preserve some palatable species (in this case shrubs) over time, but it does not prevent unpalatable species from increasing.

Figure 5.16 shows the monthly differences in grass availability differentiated on higher (1981-82) rainfall season.

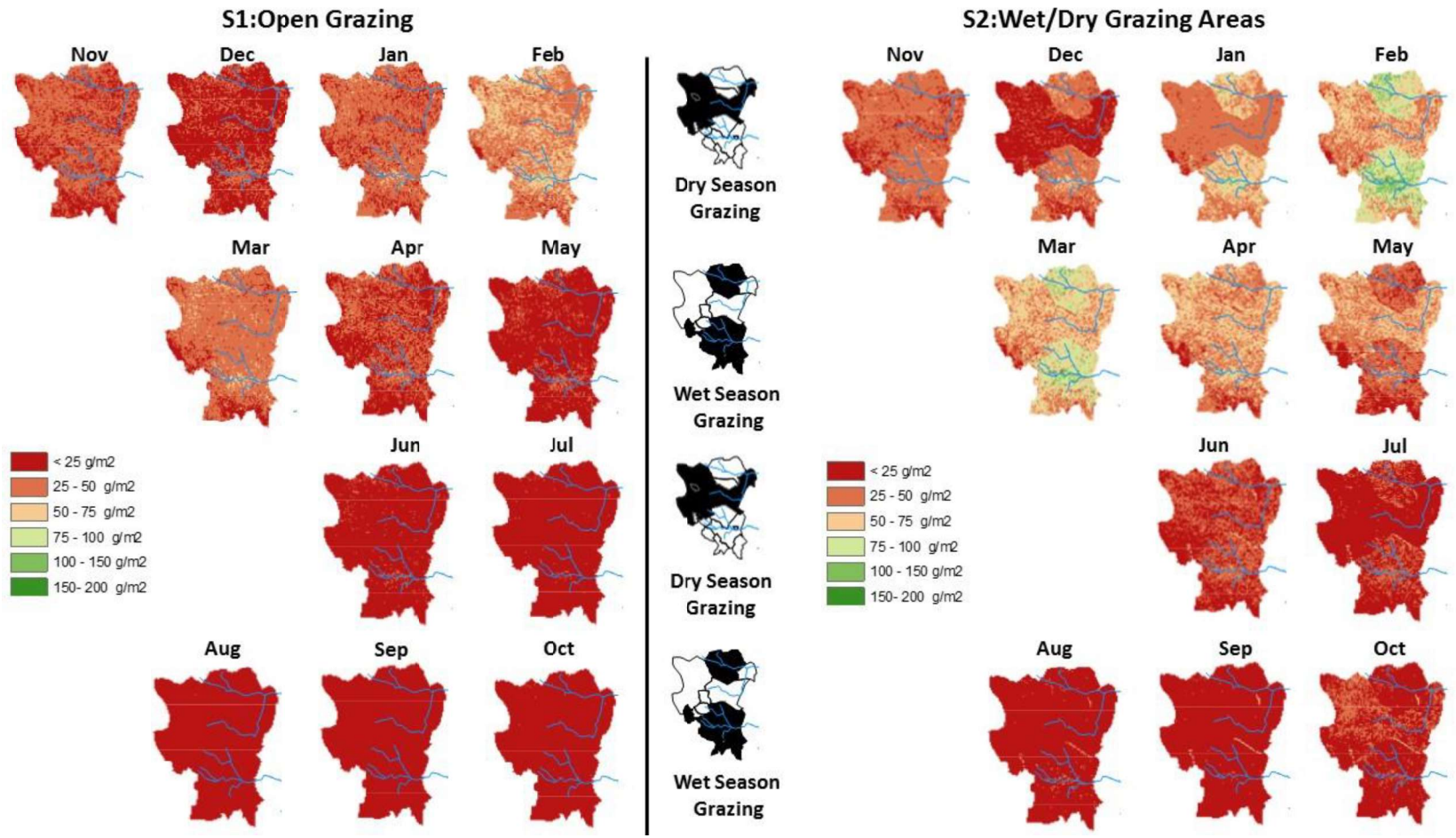

Figure 5.16 Comparison of grass green leaf biomass during a higher rainfall year (1981-82)

Figure 5.17 shows the monthly differences in grass availability differentiated on lower (1988-89) rainfall season

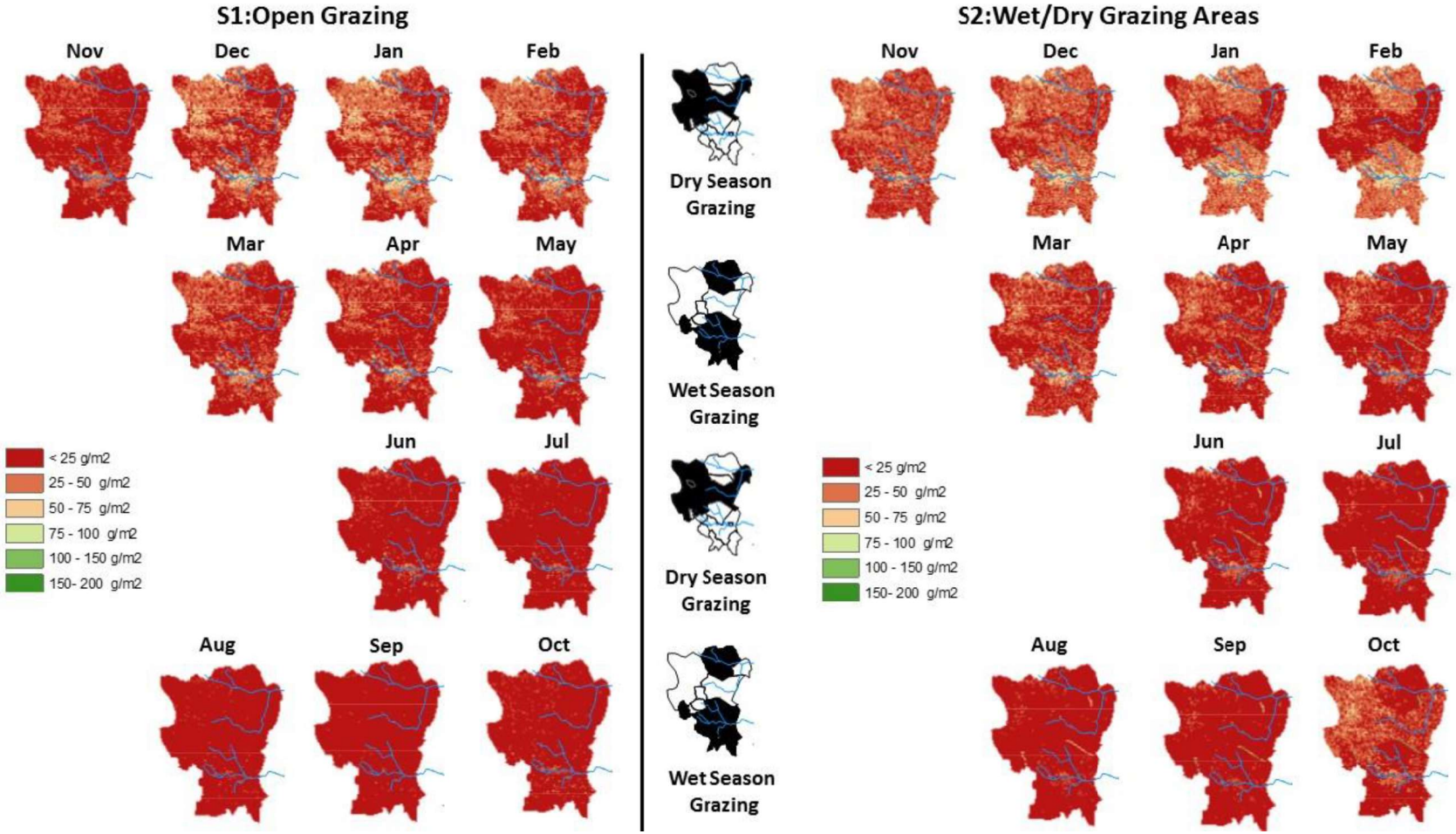

Figure 5.17 Comparison of grass green leaf biomass during a lower rainfall year (1988-89).

Spatial comparisons, shown in Figure 5.16**Error! Reference source not found.** and Figure 5.17 show that there are significant scenario differences with respect to grazing pressure and subsequent available grass biomass. In more dry years, the seasonal grazing still provides some higher returns but are less resilient and pervasive. Both Figure 5.16 and Figure 5.17 show that from earlier in the simulation period when differences among grazing scenarios are more pronounced. Within a higher rainfall year in Figure 5.16 moving the grazing pressure around the landscape allows good grazing to be maintained further into February as well as facilitating recovery in October. In a lower rainfall year such as 1988-89 Figure 5.17, grazing management has less impact, as everything suffers under the dry conditions, although in October there is a marginal amount of growth starting to come up in the S2 scenario.

Simulated household livestock populations and livelihoods under two grazing management scenarios

The following section highlights these results using both SAVANNA and DECUMA outputs. In Figure 5.18 the livestock populations of the simulated households are presented and have strong difference in herd performance across all three household-simulated species (cattle, goats and sheep).

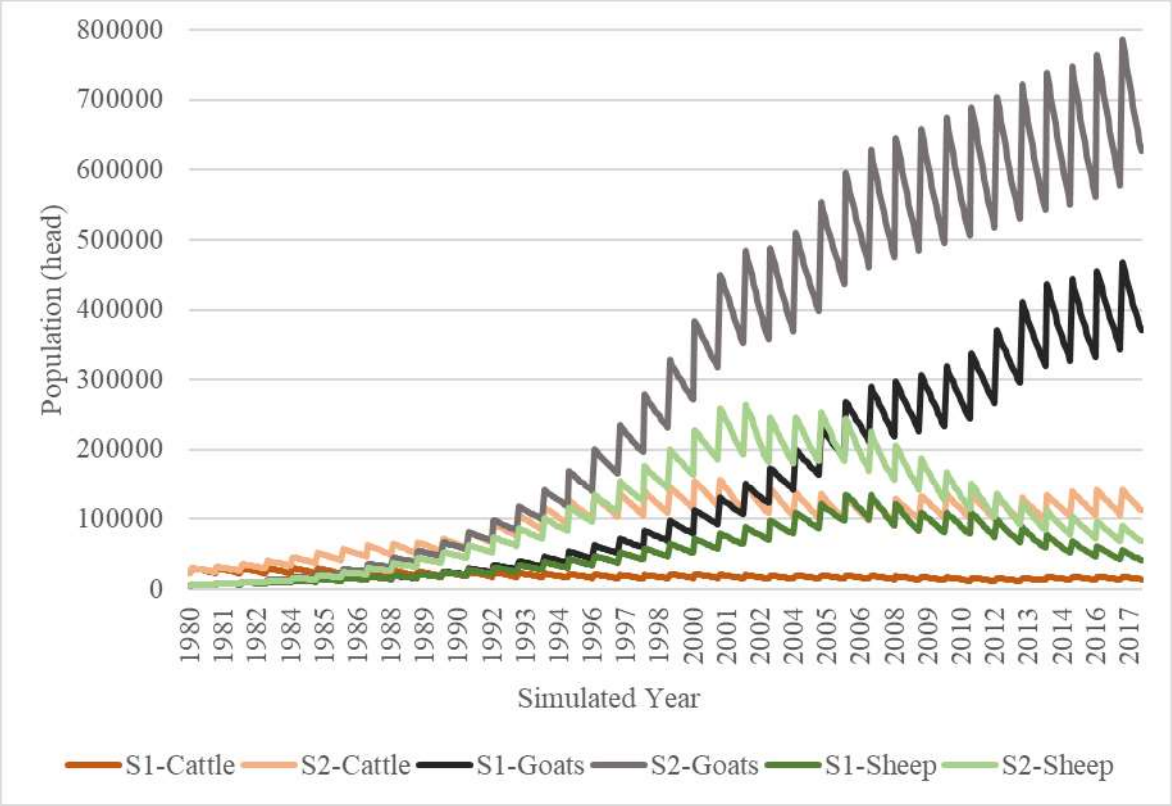

Figure 5.18 Comparison of the DECUMA-simulated livestock

Cattle herds diverge sharply as the open all year-round grazing scenario (S1) simulations systematically decrease across time while planned grazing scenario (S2) herds rise to approximately four times original levels showing capitalizing on the remaining palatable grasses and forbs available. Household goat and sheep populations have even more divergent results across scenarios as goats browse heavily on widely available and increasing woody growth in palatable shrub biomass. Sheep populations also increase in both scenarios but do not sustain higher populations as grazing conditions continue to degrade over time and drought periods reduce their populations to similar levels at the beginning of the 1980's.

A similar scenario comparison occurs when all household livestock are combined into Tropical Livestock Units (TLUs). In Figure 5.19**Error! Reference source not found.** and Figure 5.20 simulated household-level TLU's are summarized in presented in a box and whisker format.

Figure 5.19 shows the DECUMA household tropical units for the open all year-round grazing and Figure 5.20 has some marginal increases in median livestock levels over time with some households in more favorable areas showing much higher gains.

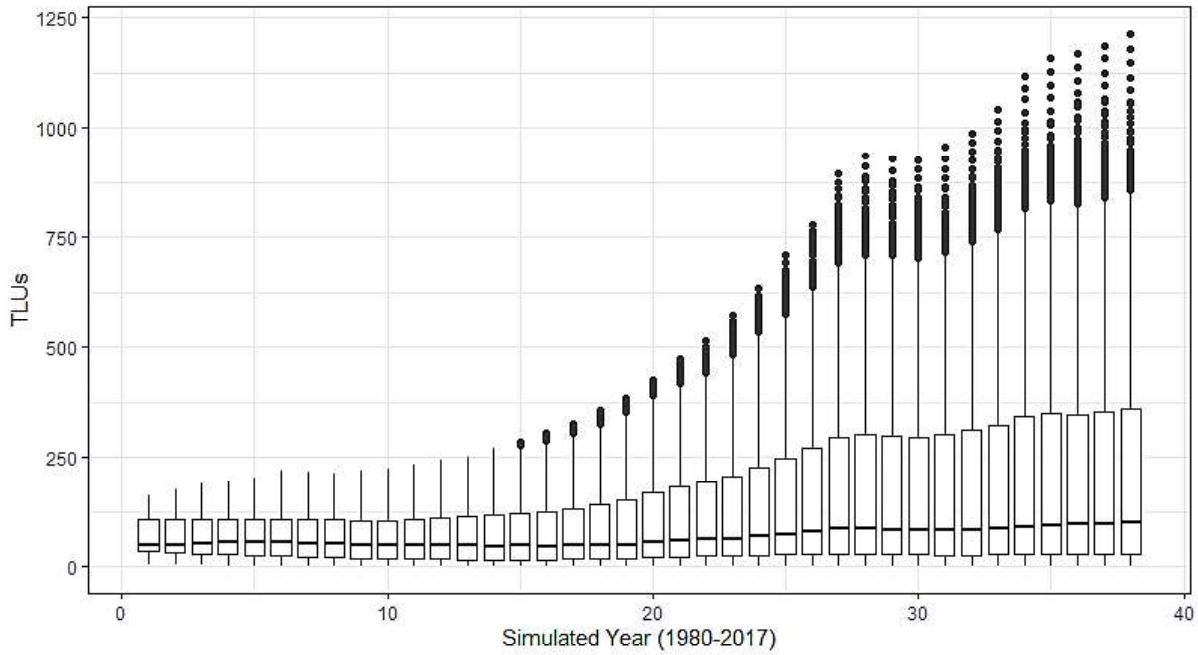

Figure 5.19 DECUMA household Tropical Livestock Units for S1

The planned grazing scenario in Figure 5.20 shows quite striking household livestock results with the seasonal grazing (S2) scenario.

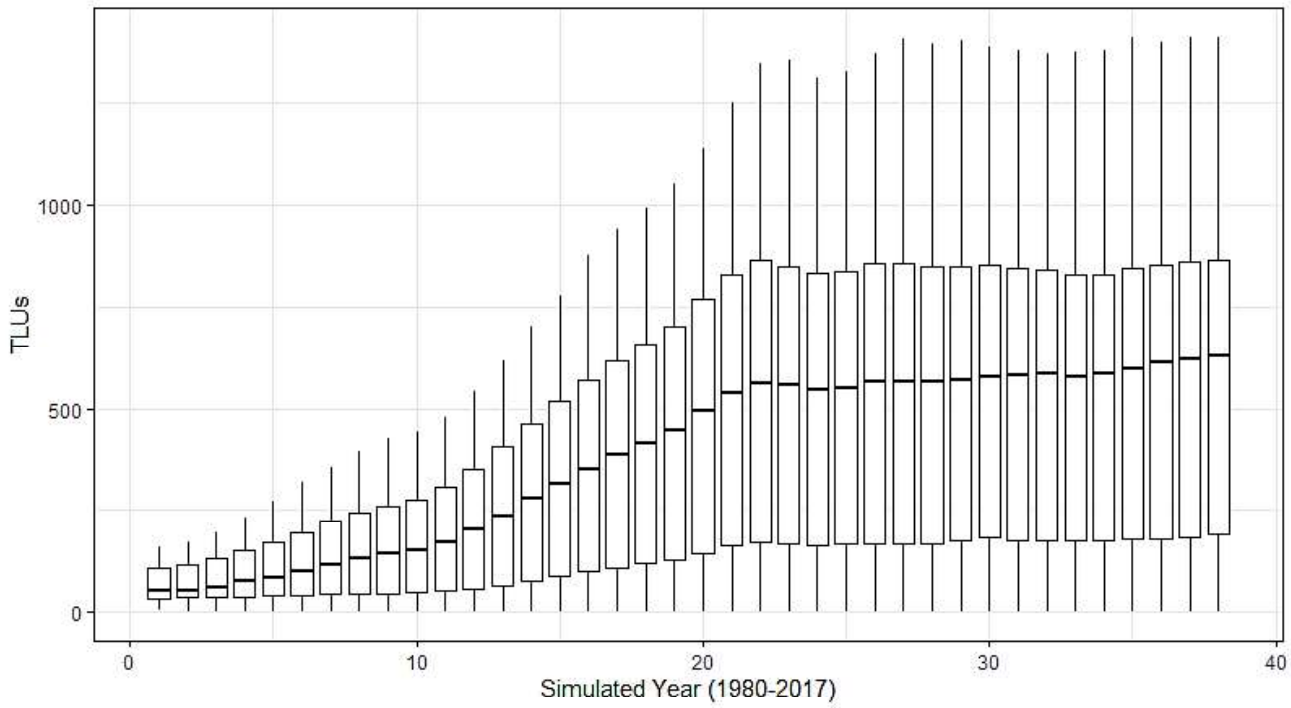

Figure 5.20 DECUMA household Tropical Livestock Units for S2

Household livestock gains are significant, systematic and sustained across most households with median and most percentiles increasing in livestock. As seen in previous figures most of these gains are due to increased reliance on goats as a herd constituent, but gains are also realized in cattle and sheep. One visible aspect to planned grazing scenario (S2) results are the increasingly wide whisker lengths showing that even though most households are experiencing higher numbers, there are minority groups that have few livestock consistently throughout the entire simulation period. Thus, even in more favorable grazing scenarios such as S2, there is rising inequality in household livelihoods. This point will be explored further in the sections below.

The individual household TLU populations over each month are presented in a box and whisker format to show the median value (as a horizontal line) nested within the 25th and 75th percentile (box edges) which resides within the 5th and 95th percentile (whiskers). Outlier values are listed as dots above or below the whiskers.

Household finance results that show highly diverse incomes are presented in Figures 5.21 and 5.22. The individual household incomes over each month are presented in a box and whisker format.

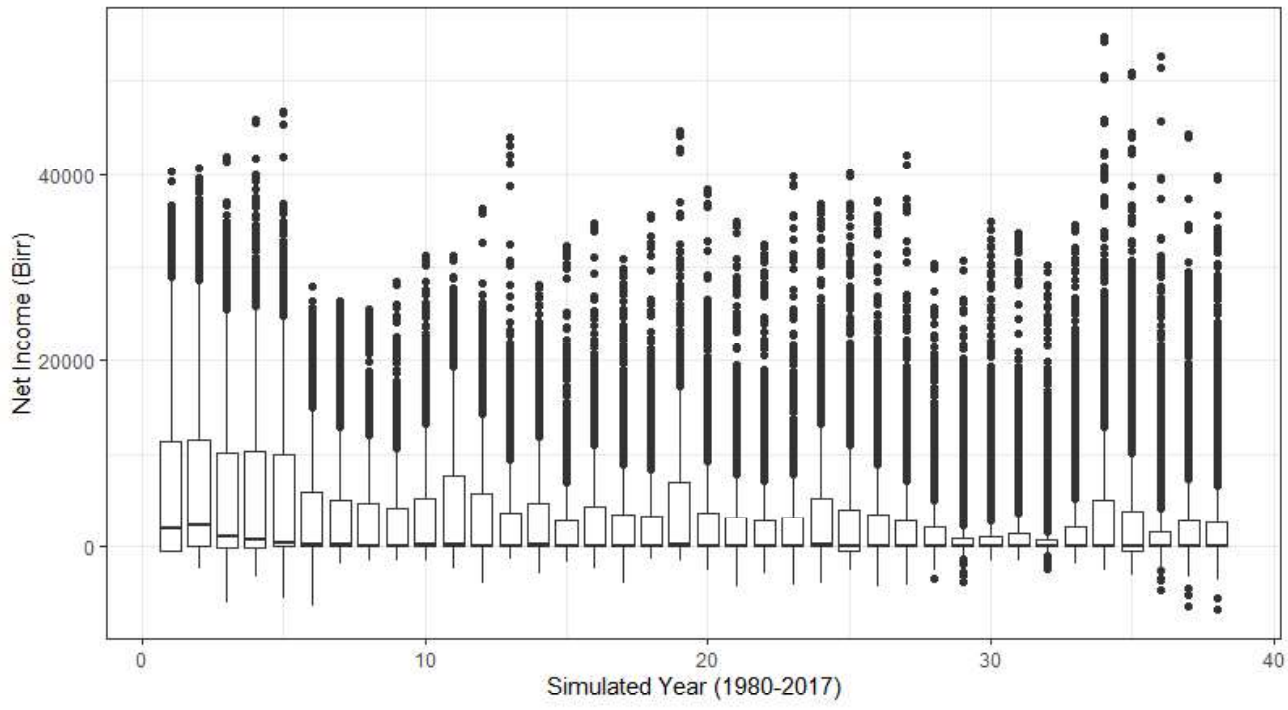

Figure 5.21 DECUMA household Net Income (Birr) for all 250 households for S1

The net income for the households in open all year-round scenario (S1) is highly variable throughout the entire simulation period. In looking at median values across all 250 households, most have low net income, with a few outliers with income in the ranges of 20000 to 40000 Birr. In addition, there are periods where negative net income shows losses due to droughts and animal mortality.

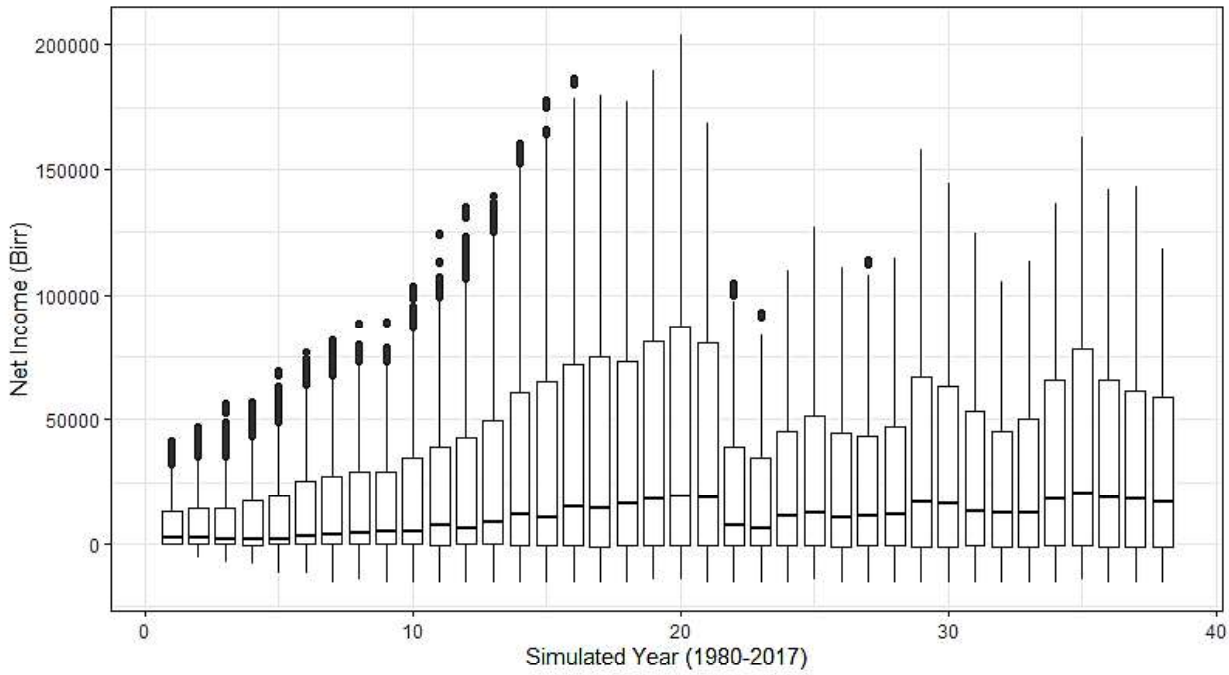

Figure 5.22 DECUMA household Net Income (Birr) for all 250 households for S2

Within the seasonal grazing scenario (S2) Figure 5.21, the net income across households shows steady median and upper percentile progress until the early 2000's drought period where significant contractions are realized. After this drought period, gains are still realized but at a steadier level. This shift is most likely due to increased ecosystem degradation that previous results have highlighted in the post year 2000 simulation period.

Additional household results are presented in Table 5.4 DECUMA-simulated, annual average metrics for the 250 households. show a closer agreement among grazing management scenarios

Table 5.4 DECUMA-simulated, annual average metrics for the 250 households.

	Open all year-round grazing scenario (S1)					Planned grazing scenario (S2)				
	Year 1	**Ten years**	**20 years**	**30 Years**	**Year 38**	**Year 1**	**10years**	**20 years**	**30 Years**	**Year 38**
Meat energy consumed (kCal)	29341.06	27054.92	28676.7	31690.98	31565.97	28921.48	32429.63	35354.71	35637.41	35788.87
Milk energy sold (kCal)	110663.3	70565.01	90195.72	45457.55	63013.72	131402.4	298456	785794.16	541750.5	498697.59
Animal/meat energy Sold (kCal)	10201.83	8745.73	8808.903	18139.78	13699.79	10128.76	4812.16	5027.87	4135.88	3917.07
Milk energy Consumed (kCal)	105175.8	91505.85	88261.78	79530.98	77014.08	106196.9	96073.65	89908.14	90312.98	89803.72
Cash buying Food (Birr)	321722.2	364804.16	504098.56	421199.52	413972.16	341108.3	559166.7	858437.44	876818.9	806849.13
Cash to buy Animals (Birr)	1036.04	531.69	460.33	265.96	415.01	1162.48	2137.81	2754.63	2775.13	2796.19
Running income Per Adult Equivalent (Birr/AE)	1339.42	767.96	786.32	469.65	699.19	1531.68	3948.26	9775.62	6854.97	6246.84

Meat and milk energy consumption within the open all year-round scenario (S1) remained lower than that of the seasonal grazing scenario (S2), but in the last 10 years the difference was becoming smaller than in the first 10 years. For meat energy the differences between the two scenarios were not as wide, although the consumption was somewhat higher in S2. Milk energy consumption is fairly high in both scenarios but declines slightly in the next years although the drop is higher in S1 than in S2. Meat energy consumption increases gradually in both scenarios with S2 rising to a high of 35000kCal while that of S1 is slightly above 30000kCal.

Table 5.4 DECUMA-simulated, annual average metrics for the 250 households. also highlights significant differences in some livelihood in terms of meat and milk energy sales. Milk energy sold started off at around 100000kcal in 1981 for both scenarios. Within the open all year-round grazing scenario (S1), milk energy sales dropped to below this this in the subsequent decades in response to significant drops in livestock condition. On the contrary, for the planned grazing scenario (S2), milk energy sales increase steadily and peaked at around 800000kcal by year 20. By year 30, it dropped to just above 500000kcal and the decline continues to the end of the simulation. Meat energy sales followed a different trajectory. There are more sales in the open all year-round grazing scenario (S1) than in the planned grazing scenario (S2). In the planned grazing scenario (S2), the sales drop from around 6000kcal and remain below 4000kcal in the last 18 years of the simulation. This may be due to some internal decision functions within DECUMA and can be explored further with respect to meat sales and herd levels.

In terms of cash spent for buying food and animals, Table 5.4 shows that in S1, the cash to buy animals slowly diminishes from 1000Birr at the beginning of the simulation to 500Birr and below in the three consecutive decades. On the other hand, in S2, this metric continues to increase gradually from year 1 to year 10. It peaks at year 20 and remains at over 2500Birr in the next three decades. Within planned grazing scenario (S2), a larger amount of money is used to buy food than in the open all year scenario (S1).

Table 5.4 also shows some of the greatest differences in scenario results. Within S1, the running income per adult equivalent (AE) remaining significantly below 2000 Birr throughout the entire simulation. In the planned grazing scenario (S2), running income increased to a peak of 10000 Birr by year 20 before dropping to around 6000Birr in the next years due to drought and range degradation. These results show that household-level metrics

are systematically higher in the planned grazing scenario while the open all year-round scenario S1 shows a stagnation or decrease in most metrics.

5.5 Discussion

Using a coupled human natural system modelling approach, two grazing management scenarios were implemented within the landscape. The chapter pursued questions about what the likely socio-ecological conditions under would be open all year round versus seasonal grazing management in the context of land rights formalization. One of the advantages of the SAVANNA/DECUMA coupled modelling approach is the ability to compare both landscape-scale ecological features (grass/woody biomass and populations) with household-scale livelihood outputs (herd populations, finances and food production). As the communal livestock pressure (communal cattle and shoats) was input through a time series file, the most notable results occur when analyzing the collective household responses to the grazing management scenarios.

Ecological dynamics under the two grazing management scenarios

The simulated vegetation patterns for the different scenarios show that different layers respond differently to the grazing management scenarios. From the herbaceous layer, the unpalatable grass level, rises regardless of grazing management, which is potentially a sign of increased degradation. However, the rise is much higher when grazing is open, all year round, than when there is a functional seasonal grazing management. Yet, for both scenarios this increase is quite visible which suggest that degradation is looming beyond grazing management. Palatable shrubs are becoming fewer, while the unpalatable ones are increasing in both grazing scenarios. The time series of the palatable and unpalatable grasses and shrubs shows a high rise of unpalatable grasses which could imply pervasive ecosystem shifts. In pastoralist communities where mobility takes place on a broad scale and many different camps are used, grazing intensity is usually low (Liao & Clark, 2018a). Such grazing management systems often give rise to multiple vegetation states. This has in some areas contributed to the rangelands being slowly converted into dense thickets, unlike in areas where grazing pressure is high, the rangelands are dominated by sparse shrubs with little

herbaceous cover (Liao et al., 2018). However, when the grazing pressure is moderate, open canopy woodlands can be maintained with lots of grasses and minimal woody cover (Liao & Clark, 2018a). Signs of this same pattern, with low levels of grazing intensity and high levels of grazing intensity each contributing degradation, with the best outcomes resulting from moderate grazing intensity, could be seen in the simulations in this study.

Bush encroachment is one of the major causes for concern for rangeland managers and land users (Liao, 2020). In East Africa common shrubs species are growing at the expense of grasses. In 1975/1976, in southern Ethiopia, there was a nationwide ban on controlled fire. Fires had been traditionally practiced by pastoralists to control undesirable woody plants, promote herbaceous forage production, and reduce the tick load (Desta & Coppock, 2004; Homann et al., 2008). Woody species cover surpassed 50% of the Borana rangelands by the early 2000s whereas it was less than 40% in the 1980s (Homann et al., 2008). The analysis of rangeland vegetation characteristics and grazing patterns in southern Ethiopia by (Liao & Clark, 2018a) suggests that rangeland vegetation follows divergent transition pathways.

It was also found by Liao and Clark (2018a) that both light and heavy grazing pressure in pastoral systems increase bush proliferation. Their findings suggest that the herbaceous cover decreased with increasing grazing intensity. Planned grazing management in pastoral rangelands was found in a study by (Odadi et al., 2017, 2018) to enhance vegetation, and herbivore conditions. This was found after a study conducted five years post implementation of planned grazing. This was said to suggest that these rangelands were actually fairly resilient and responded well to grazing management. Most of the changes in the herbaceous layer were attributed to the changes in the grasses as there wasn't much difference in the forb attributes. The non-responsiveness of forbs to planned grazing was attributed to the higher populations of shoats when grazing was planned (Odadi et al., 2018). From this study simulations the spatial comparisons in Figure 5.16 and Figure 5.17 show that shifting grazing pressure allows some areas to recover from the high stocking rates with the planned grazing scenario having systematically higher grass availability is better than the open grazing scenario in higher rainfall years. The planned grazing scenario does provide more consistent biomass than open all year round but frequent droughts along with the consistently high grazing pressure serves to wear down the grazing system over the longer term. By moving the grazing pressure around good grazing is maintained further into February and also it starts to recover more in October. When it's a very low rainfall year, e.g., the rainfall of 1988-89, the

grazing management does not have as much benefit, as everything becomes dry and stressed, although in October there are some marginal benefits.

Within the coupled simulations of this study, planned grazing preserved the palatable grass but in the longer run the constant degradation overshadows the benefits of planned grazing. Both grazing scenarios had marginal effects on woody biomass or population for palatable species for about half the simulation time when after the early 2000's drought period, the results were effectively the same. Thus, for the palatable woody species, planned grazing helps preserve some palatable species (in this case shrubs) over time, but it does not prevent unpalatable species from increasing. When grazing pressure is high, perennial plants may fail to recover in the consecutive season, and if they may diminish with time, and the area may become degraded and invasive species may take over (Liao & Clark 2018, Odadi et al., 2017). But the question, is whether the is sufficient resting for the vegetation to recover. That could explain the small differences between the two scenarios considering that there are two rainy seasons, a long one and a short one.

Livestock dynamics of grazing management scenarios

Overall vegetation attributes showed some improvements when grazing management was planned, translating to significantly better herbivore populations and condition index, especially at the household herd scale. Within the coupled SAVANNA/DECUMA simulations, all livestock types benefited from the planned seasonal grazing. In the long-term there is a "boom and bust" growth pattern for all grazing scenarios showing there are limits even to what better grazing management can provide. Planned management hedges livestock against drought starvation and mortality. Shoats have higher preference to forbs than larger stock (Odadi et al., 2017). Increased stocking rates even with planned grazing may suppress the growth of forbs. Species like goats that are better at utilising bushes are likely to increase while the grazers decline (Senda 2020b). Changes in the vegetation structure to favour shrubs maybe the cause of the decline of sheep and cattle in favour of goats. Even though shoats are becoming common in pastoral areas, households in the Borana Zone still maintain their cattle herds, as cattle are the main source of wealth and prestige.

In terms of household livestock performance, the seasonal grazing scenario (S2) allows for higher sustained growth and higher levels for all species compared to open access scenario.

It is worth noting that the marginal levels of palatable biomass along with the DECUMA-simulated, herd movements allow households to capitalize on local areas of favorable biomass to sustain increased herds even while overall ecosystem function is steadily degrading.

The condition index (CI) in the coupled model is calculated by dividing the actual weight by the expected weight and is a unitless measure of the state of the overall body condition of the animal. For Borana cattle in semi-arid areas/ pastoral areas, a CI of 0.5 to 0.75 is expected to be the highest possible considering the feed availability and management (Desta and Coppock, 2002, Degen, 2011). As the livestock population increase the biomass drops and in turn the livestock numbers go down. This suggests that when mobility is free all year round, the rangeland becomes degraded faster, fail to regenerate and livestock populations in turn collapse.

Household/pastoralists dynamics under the two grazing management scenarios

The coupled SAVANNA/DECUMA results show some of the largest grazing scenario differences when comparing household level metrics such as household energy consumption, income and expenditure. The simulation shows that while planned grazing management provides significant positive benefits to households, in the long-term both grazing systems may not be the sustainable. For households under the planned grazing scenario, they overall do much better in many attributes than when under the all-year-round grazing scenario. Generally, while some households benefit more from planned grazing, a large majority are not necessarily lifted out of poverty. The simulations show that through planned grazing, households can manage to preserve their herds and even acquire some additional animals, these results are not to be implemented in policy without further scrutiny.

Rules about pastoralist sales, purchases and other households' dynamics have been represented according to the patterns observed in the system (USAID, 2017, Degen, 2011 Homann, 2004). Simulated metrics such as net income are within observed household levels for both scenarios but show that with planned grazing- households are doing systematically better (Homann, 2004, Desta and Coppock, 2004). For those households that have high numbers of animals and can move around, the results show that dheeda level certification may be beneficial as it allows the revival of seasonal grazing (Senda, 2020a). In terms of cash

spent for buying food and animals, the increase may be due to higher expenditures rising with higher total wealth but may also be a function of decreasing yields from household plots of teff and beans (USAID, 2017). This dynamic in the planned grazing scenario needs further scrutiny in subsequent analysis to determine whether higher food purchases are a sign or increased wealth or of decreasing marginal household food production or both.

This study explicitly posed the question of how grazing management affects both the ecology, and livelihoods by capturing long-term ecosystem and household dynamics. Pastoralists are increasingly becoming under pressure as seen by the amount of money spent on food (USAID, 2017, Desta and Coppock, 2004). By evaluating average herd sizes, it was possible to identify which grazing management option would be more beneficial in this particular study site. These insights are important for informing the development of a pastoral oriented communal land formalisation policy. Seasonal grazing may actually be the best way to manage grazing as past researchers (Dressler et al., 2019; Dressler & Mueller, 2012) have shown that both too high and too low mobility are not favourable for the rangeland condition and livestock numbers.

Limitations of the modeling approach and recommendations

The purpose of the simulation was to give the direction and magnitude of potential change to guide policymakers, development practitioners, and the land-livestock based livelihoods-hence the scenario approach. Given the high number of interacting processes and diverse drivers, some human and ecosystem attributes are held constant to create a tractable and stable CHANS modeling environment. The study acknowledges that in the Borana, and other pastoral systems when livestock moves to a different grazing site, there is a proportion that remains behind, mostly the lactating and the weak. For computational efficiency in this study an entirely all-in versus all-out system was assumed when moving livestock around the environment. This assumption could be explored further in future refined simulations to ascertain whether some remaining livestock are kept hedging against movement risks.

Other model assumptions included household size being held constant throughout the entire simulation. Additionally, some parameters such as prices of livestock and other goods (buying and selling) were kept constant throughout the simulation, so as to reduce the amount of variation and be able to track changes that stem from changes in the rangeland condition.

Varying the prices and probably factoring in changes in household sizes could perhaps have shown a different trend and responses to exogenous variables. This is recommended for further simulations to explore how sensitive landscape and household factors are to various exogenous shocks. Given the high variation shown in the box and whisker figures for the TLUs, these results may vary at specific locations within the Dirre region and could be explored further in subsequent analysis of specific reera locations. One of the main advantages of the CHANS modelling approach, especially in this case, was that it was possible to address and track individual households throughout the simulation as well as to evaluate the system from a landscape scale, via ecological feedbacks. The analyses revealed how open all year-round grazing may harm the rangelands and livelihoods in the long run. There is a need to understand how higher- or lower- resource households respond or even increase their resilience under different ecosystem shocks within a heterogeneous landscape. It may also be useful to assess how complete individualization or small-scale certification and restricted mobility may impact rangeland sustainability and human livelihoods.

5.6 Conclusion

Simulation modelling was very useful for exploring implications of grazing management in a pastoral agroecosystem. Planned grazing prolongs the availability of pasture, but the ecosystem continues to be degraded (through increases in bush encroachment), to a point that ultimately nullifies the benefits of planned grazing. Overall, the grazing scenarios only seem to preserve marginal levels of palatable grasses, but do not help protect against the increase of unpalatable species. In a lower rainfall year grazing management has less impact, as everything suffers under the dry conditions. Grazing is key in shaping vegetation dynamics in rangelands hence the need to study the outcomes of the access alterations that come with land certification. Although camels were not simulated, they are known to be browse and would benefit from shrub proliferation.

As the land certification program in pastoral areas move forward, it should aim at enhancing pastoralist livelihoods and their capacity to manage rangeland, halt degradation and allow the rangelands to recover to be able to sustain livestock production for longer. Up to a certain degree, planned grazing allowed the maintenance of pastoral livelihoods. All year-round grazing, however, makes it harder for pastoralists to continue making a living from the animals, and secure their livelihoods. This phenomenon is currently showing within the

medians and averages for the simulated households, but there is a need to disentangle this by looking at implications for different wealth types.

In conclusion, planned/seasonal grazing alone will not be the answer to all problems that pastoralism faces. It is thus recommended from this chapter that this be recommended coupled with intensive rangeland reclamation, and management efforts, and even intensify livestock production through, cattle fattening, and diversification into other livelihood activities. Consequently, to ensure ecologically and economically sustainable resource use in pastoral areas, there is need to also invest in land saving livelihood activities that do not require intensive land use.

CHAPTER 6 GENERAL DISCUSSION, CONCLUSION AND RECOMMENDATIONS

6.1 General discussion and conclusions

Land is undeniably at the center of economic and social development. In pastoral systems land access and availability remains critical for many reasons as it is the main stage for livelihood sourcing. Clearly there has been some issues that threaten the security of tenure in these areas, from both endogenous and exogenous sources. Policies are often made to benefit both the countries' economies and its dwellers, but there is need to carry out assessments as success of policies is dependent on many factors that include geographical location and social norms of an area. There is therefore a need to not assume a one size fits all when it comes to policy implementation. The land registration and certification policy are one such policy that needs to be tailored accordingly, especially for pastoral systems.

How to understand property systems in pastoral areas is long running debate. In an era where land rights have climbed high on the world development agenda, the study sought to understand how this can be implemented in communal pastoral settings. Pastoral communities are faced with many challenges that are compromising their livelihoods. The Ethiopian government has made some strides in securing land rights for its citizens but the question of what scale to consider when strengthening land rights for pastoral communities has been the biggest hurdle. This is further complicated by the unique characteristics of these systems that include legal pluralism, overlapping claims over use of resources, and open but monitored access to resources. These characteristics mean that pastoral systems do not conform to the conventional assumptions about commons and treating them as such when implementing a communal and rights formalization program would produce some complex, unexpected and undesirable outcomes.

This thesis addresses important questions for land governance in pastoral systems: how to recognize 'community' land in pastoral systems, how this interacts with socio-economic drivers that shape land use, and what the implications for rangeland ecology and livelihoods are. It is built on the understanding of the complexities that characterize governance of common pool resources. It sought to find out what the policy makers need to look out for and to consider for successful policy implementation. The study generated empirical data by

applying a mixed methods approach that included participatory scenario development, key informant interviews, focus group discussions, workshops and household surveys. It rounded off by applying a coupled human and natural systems modelling approach to answer questions on what changes to expect in rangeland production, and how pastoralists' livelihoods will be affected.

The findings of this study offer a route into the future of land rights formalization as seen through the lens of pastoralists' own understanding. It captured the pastoralists' perceptions on the biophysical and livelihoods aspects of pastoralism. Pastoralists have shared perceptions about land certification, and they perceive it as an incentive to invest in improved rangeland management and build their herds, and more interestingly to transition into agropastoralism as they become more land secure. From the simulation modelling the findings showed that from the herbaceous layer, the unpalatable grass level rises regardless of grazing management, which is potentially a sign of increased degradation. The time series of the palatable and unpalatable grasses and shrubs shows a high rise of unpalatable grasses which could imply pervasive ecosystem shifts. Planned grazing helps but the constant grazing pressure, along with frequent droughts tend to wear down the system. In very low rainfall years grazing management does not have as much benefit, as everything becomes dry and stressed. Both grazing scenarios had marginal effects on woody biomass or population for palatable species for about half the simulation time for palatable woody species, planned grazing helps preserve some palatable species over time, but it does not prevent unpalatable species from increasing. In terms of household livestock performance, the seasonal grazing scenario allows for higher sustained growth and higher levels for all species compared to open access scenario.

The research concluded that the scale at which certification takes places matters: a small scale has many advantages particularly stronger tenure security. However, pastoralists prefer a larger scale that allows for free and flexible mobility. While strengthening communal tenure for pastoralists is sorely needed, the drivers toward individualization and adoption of crop agriculture are such that implementing a communal tenure framework will not always in itself be sufficient to stem individualization. Land certification alone will not stop fragmentation of rangelands, individualization, and a shift to agropastoralism, but could well facilitate this transition if implemented poorly. Land certification alone is not a solution to the problems that pastoralists face but can be used as an opportunity for strengthening and incentivizing participation in other rangeland, livestock, and livelihood support programs. In

terms of grazing management, overall, planned grazing scenarios only seem to preserve marginal levels of palatable grasses, but do not help protect against the increase of unpalatable species. In a lower rainfall year grazing management has less impact, as everything suffers under the dry conditions.

6.2 Recommendations

The study used a combination of mixed methods approach building, household survey, CHANS modelling to respond to a very pertinent question about the implications of grazing access alterations in the face of communal land rights formalization. This research echoes findings suggesting that indeed pastoral systems are not regular common as seen by the multiple factors that are considered when making a decision about the scale of certification (Robinson, 2019; Behnke, 2018; Moritz, 2016). The tradeoffs clearly show that land rights formalization need to be tailored in a way that is cognizant of this. This work contributes to and is located in a wider and more up-to-date field of debate about pastoral land tenure. This work presents an opportunity for policy makers, researchers and development practitioners to probe further as they work towards developing policies for securing tenure in pastoral systems. This research shows another way that the paradox of pastoral tenure (Fernandez-Gimmenez, 2002) where free and flexible mobility is the key driver of decisions in pastoral areas. It also shows some assumptions that may be made by the policy formulation miss the perceptions of pastoralists about tenure and their livelihoods. For Instance, there is a motivation to strengthen cropping and diversify livelihoods with secure tenure.

It is also an opportunity to understand the uniqueness of these systems, the multiple uncertainties and complexities involved, which suggest need for multi-pronged approaches and support mechanisms built on local realities. This will be important for the sustainability of the policy and for minimizing the unforeseen negative effects of land rights formalization such as fragmentation, as seen in some regions. Findings on the how socio-economic drivers interact with land rights formalisation further contributes to constructively advancing the scholarly debate on tenure reforms in pastoral areas. This is because it provides some of the answers about the future livelihoods of pastoralists with respect to land tenure.

Policymakers seeking to design land governance systems will: seldom be able to choose an option which optimizes all criteria but must craft arrangements that provide the most suitable tradeoffs among different objectives. Understanding that effective tenure implementation is these areas is not just about getting the scale right. The array of objectives for a formal land tenure system in pastoral areas will not be achieved solely by allocating clearly defined property rights over clearly defined territories to clearly defined social groups, as might be inferred from a simplistic reading of commons scholarship. The multiple uncertainties and complexities, suggest that a multi-pronged approach and various support mechanisms will be needed.

An understanding of the dynamics around the perceived causal effects of certification is important for guiding the process, ensuring a smooth implementation, and more so serving as basis for monitoring and evaluation. Such considerations will help ensure that communal land certification in pastoral areas does not turn out to be just another policy that will have undesirable consequences on livelihoods, and the environment, causing pastoralists to fall deeper into poverty. The study suggests that land rights formalization may actually incentivize livelihood diversification and a continuation of the trend toward agropastoral livelihoods. This means there is a need to adjust the narrative around land certification objectives to ensure that it captures local realities and expectations. The focus should be how securing land rights would enhance the pastoralists' capacity to thrive and make livelihood decisions in the face of global and environmental changes. Land certification should thus be crafted in a way that supports pastoralism while enabling other developments and livelihood diversification to take place. The similarities in opinion across different wealth groups should be seen as an opportunity to be taken advantage of for policy implementation as it may make it easier to address the complex challenges with less conflict than might normally be expected when transforming land tenure. A planned approach that allows for some expansion of farming while still protecting key grazing resources and livestock mobility, could be accompanied by agricultural extension and market access support.

As the land certification program in pastoral areas moves forward, it should aim at enhancing pastoralist livelihoods and their capacity to manage rangeland, halt degradation and allow the rangelands to recover to be able to sustain livestock production for longer. Clearly, planned grazing will need to be coupled with intensive rangeland reclamation, and management efforts, and diversification into other livelihood activities.

There is spatial variation in rainfall within the Dirre landscape, but in this study rainfall for the whole of Dirre was simulated with the average rainfall based on the CHIRPS rainfall database. This assumption was used because the research question is more focused on the coarser scale, onto which rangeland processes are being considered. There may however be a need for more refined, localized assessments of rangeland productivity and livestock responses. This heterogeneity would be considered in further research on local rangeland and household effects, especially the need to assess the impacts of further land fragmentation. Also, recommended for further study is a scenario in which there are livestock mobility restrictions to much smaller territories than the dheeda. When mobility is high, there are usually advantages of better herd sizes, but with rangelands becoming scarce the options for mobility are becoming limited, and demarcating rangelands for seasonal grazing/ rotational grazing becomes impossible. This may either be facilitated or hindered by land tenure reforms.

REFERENCES

Abebe, A., Eik, L. O., Holand, Ø., Ådnøy, T., & Tolera, A. (2012). Pastoralists' perceptions of feed scarcity and livestock poisoning in southern rangelands, Ethiopia. *Tropical Animal Health and Production*, *44*(1), 149–157. https://doi.org/10.1007/s11250-011-9902-5

Adriansen, H. K. (2008). Understanding pastoral mobility: The case of Senegalese Fulani. *Geographical Journal*, *174*(3), 207–222. https://doi.org/10.1111/j.1475-4959.2008.00278.x

African Union, African Development Bank, & United Nations Economic Commission for Africa. (2014). *Guiding principles on large scale land based investments in Africa*.

Aklile, Y., & Beyene, F. (2014). Examining drivers of land use change among pastoralists in Eastern Ethiopia. *Journal of Land Use Science*, *9*(4), 402–413. https://doi.org/10.1080/1747423X.2013.807309

Alden-Wily, L. A. (2011). "The Law is to Blame": The Vulnerable Status of Common Property Rights in Sub-Saharan Africa. *Development and Change*. https://doi.org/10.1111/j.1467-7660.2011.01712.x

Alden-Wily, L. A. (2018a). Collective land ownership in the 21st century: Overview of global trends. *Land*. https://doi.org/10.3390/land7020068

Alden-Wily, L. A. (2018b). The community land act in Kenya opportunities and challenges for communities. *Land*, *7*(1). https://doi.org/10.3390/land7010012

Almeida-Gomes, M., Prevedello, J. A., & Crouzeilles, R. (2016). The use of native vegetation as a proxy for habitat may overestimate habitat availability in fragmented landscapes. *Landscape Ecology*, *31*(4). https://doi.org/10.1007/s10980-015-0320-3

Ambaye, D. W. (2012). Land Rights in Ethiopia : Ownership, equity, and liberty in land use rights. *FIG Working Week*, *May*, 6–10. https://www.fig.net/resources/proceedings/fig_proceedings/fig2012/papers/ts02d/TS02D_ambaye_5521.pdf

An, L. (2012). Modeling human decisions in coupled human and natural systems: Review of agent-based models. *Ecological Modelling*. https://doi.org/10.1016/j.ecolmodel.2011.07.010

Anseeuw, W., Wily, L. A., Cotula, L., & Taylor, M. (2011). Land Rights and the Rush for Land. In *ILC Rome report*.

Archambault, C. (2014). *Original Article Young Perspectives on Pastoral Rangeland*

Privatization : Intimate Exclusions at the Intersection of Youth Identities. *26*, 204–218. https://doi.org/10.1057/ejdr.2013.59

Asiama, K. O., Bennett, R. M., & Zevenbergen, J. A. (2017). *Land Consolidation for Sub-Saharan Africa ' s Customary Lands – The Need for Responsible Approaches*. *5*(2), 39–45. https://doi.org/10.12691/ajrd-5-2-2

Ayantunde, A. A., de Leeuw, J., Turner, M. D., & Said, M. (2011). Challenges of assessing the sustainability of (agro)-pastoral systems. *Livestock Science*, *139*(1–2), 30–43. https://doi.org/10.1016/j.livsci.2011.03.019

Baird, T. D., & Gray, C. L. (2014). Livelihood diversification and shifting social networks of exchange: A social network transition? *World Development*. https://doi.org/10.1016/j.worlddev.2014.02.002

Batjes, N.H., 2009. Harmonized soil profile data for applications at global and continental scales: updates to the WISE database. Soil Use and Management25, 124-127(http://dx.doi.org/10.1111/j.1475-2743.2009.00202.x)

Bambio, Y., & Bouayad Agha, S. (2018). Land tenure security and investment: Does strength of land right really matter in rural Burkina Faso? *World Development*, *111*, 130–147. https://doi.org/10.1016/j.worlddev.2018.06.026

Baskent, E. Z., & Keles, S. (2005). Spatial forest planning: A review. In *Ecological Modelling* (Vol. 188, Issues 2–4, pp. 145–173). https://doi.org/10.1016/j.ecolmodel.2005.01.059

Bassett, T. J. (2009). *Geoforum Mobile pastoralism on the brink of land privatization in Northern Côte d ' Ivoire*. *40*, 756–766. https://doi.org/10.1016/j.geoforum.2009.04.005

Basurto, X. (2013). Linking multi-level governance to local common-pool resource theory using fuzzy-set qualitative comparative analysis: Insights from twenty years of biodiversity conservation in Costa Rica. *Global Environmental Change*, *23*(3), 573–587. https://doi.org/10.1016/j.gloenvcha.2013.02.011

Behnke, R. (2018). Land Use Policy Open access and the sovereign commons : A political ecology of pastoral land tenure. *Land Use Policy*, *76*(February), 708–718. https://doi.org/10.1016/j.landusepol.2018.02.054

Behnke, R. H., Fernandez-Giminez, M. E., Turner, M. D., & Stammler, F. (2011). Pastoral migration: mobile systems of livestock husbandry. *Animal Migration: A Synthesis*, 144–171. https://doi.org/10.1093/acprof:oso/9780199568994.003.0010

Behnke, R., & Freudenberger, M. S. (2013). *USAID Issue Brief: Pastoral land rights and resource governance*. 14. http://usaidlandtenure.net/sites/default/files/USAID_Land_Tenure_Pastoral_Land_Right

s_and_Resource_Governance_Brief_0.pdf

Behnke, R.H., 2008. The Drivers of Fragmentation in Arid and Semi-Arid Landscapes. Pp. 305-340 in Fragmentation in Semi-Arid and Arid Landscapes Consequences for Human and Natural Systems, K.A. Galvin, R.S. Reid, R.H. Behnke jr., and N.T. Hobbs, eds. Dordrecht, Netherlands: Springer.

Benjaminsen, T. A., Holden, S., Lund, C., & Sjaastad, E. (2009). *Formalisation of Land Rights : Some Empirical Evidence from Mali , Niger and South Africa Land Use Policy Formalisation of land rights : Some empirical evidence from Mali , Niger and South Africa*. *April 2018*. https://doi.org/10.1016/j.landusepol.2008.07.003

Beyene, F. (2016). Land use change and determinants of land management: Experience of pastoral and agro-pastoral herders in eastern Ethiopia. *Journal of Arid Environments*, *125*, 56–63. https://doi.org/10.1016/j.jaridenv.2015.10.001

Boone, R. B., & Coughenour, M. B. (2001). A system for integrated management and assessment of East African pastoral lands. *US Agency for International Development, Final Report to the Global Livestock Collaborative Research Support Program, University of California, Davis, USA*. http://www.nrel.colostate.edu/~rboone/pubs/GLCRSP_IMAS_2001.pdf%5Cnhttp://files/444/Boone_Coughenour_2001_A system for integrated management and assessment of East African pastoral lands.pdf

Boone, R. B., & Hobbs, N. T. (2004). Lines around fragments: effects of fencing on large herbivores. *African Journal of Range & Forage Science*, *21*(3), 147–158. https://doi.org/10.2989/10220110409485847

Boone, R. B., Coughenour, M. B., Ellis, J. E., Galvin, K. A., Acen, J., Burnsilver, S., & Lynn, S. (2001). *A System for Integrated Management and Assessment of East African Pastoral Lands Balancing Food Security , Wildlife Conservation , and Ecosystem Integrity Edited by :*

Boone, R. B., Galvin, K. A., BurnSilver, S. B., Thornton, P. K., Ojima, D. S., & Jawson, J. R. (2011). Using coupled simulation models to link pastoral decision making and ecosystem services. *Ecology and Society*, *16*(2). https://doi.org/10.5751/ES-04035-160206

Boone, R.B., Lesorogol, C.K., 2016. Modeling coupled human-natural systems of pastoralism in East Africa, in: Building Resilience of Human-Natural Systems of Pastoralism in the Developing World: Interdisciplinary Perspectives. https://doi.org/10.1007/978-3-319-30732-9_7

Brak, B. H., Hilarides, L., Elbersen, B. S., & Wingerden, W. K. R. E. van. (2004). *Extensive livestock systems and biodiversity: the case of Islay*. http://edepot.wur.nl/35382

Brottem, L., Turner, M. D., Butt, B., & Singh, A. (2014). Biophysical Variability and Pastoral Rights to Resources: West African Transhumance Revisited. *Human Ecology*, *42*(3). https://doi.org/10.1007/s10745-014-9640-1

Bruce, J. W., Hoben, A., & Rahmato, D. (1994). *After The Derg : An Assessment of Rural Land Tenure Issues in Ethiopia*. *March*.

Burnsilver, S., Resource, N., Mwangi, E., Tonkei, T., Ndirangu, P., Anduga, L., & Supeet, R. S. (2007). Beyond Group Ranch Subdivision : Collective Action for Livestock Mobility , Ecological Viability , and Livelihoods field research assistants were also critical in this work . Our sincere thank yous to : *Ecology*, *66*.

Butt, B., 2010. Pastoral resource access and utilization: Quantifying the spatial and temporal relationships between livestock mobility, density and biomass availability in southern Kenya. L. Degrad. Dev. 21, 520–539. https://doi.org/10.1002/ldr.989

Campbell, B. M., Gordon, I. J., Luckert, M. K., Petheram, L., & Vetter, S. (2006). In search of optimal stocking regimes in semi-arid grazing lands: One size does not fit all. *Ecological Economics*, *60*(1), 75–85. https://doi.org/10.1016/j.ecolecon.2006.05.010

Campbell, B.M., Gordon, I.J., Luckert, M.K., Petheram, L., Vetter, S., 2006. In search of optimal stocking regimes in semi-arid grazing lands: One size does not fit all. Ecol. Econ. 60, 75–85. https://doi.org/10.1016/j.ecolecon.2006.05.010

Carabine, E., & Wilkinson, E. (2016). *How Can Local Governance Systems Strengthen Community Resilience ? A Social-Ecological Systems Approach*. *4*(4), 62–73. https://doi.org/10.17645/pag.v4i4.746

CGIAR-CSI (2004) SRTM 90m DEM Digital Elevation Database. 2004- 2021, CGIAR - Consortium for Spatial Information (CGIAR-CSI) https://srtm.csi.cgiar.org/

Chimhowu, A. (2018). The 'new' African customary land tenure. Characteristic, features and policy implications of a new paradigm. *Land Use Policy*, *81*(August 2017), 897–903. https://doi.org/10.1016/j.landusepol.2018.04.014

Chimhowu, A., & Woodhouse, P. (2006). Customary vs private property rights? Dynamics and trajectories of vernacular land markets in sub-Saharan Africa. *Journal of Agrarian Change*, *6*(3), 346–371. https://doi.org/10.1111/j.1471-0366.2006.00125.x

CHIRPS v2.0. CHIRPS: Rainfall Estimates from Rain Gauge and Satellite Observations , Climate Hazards Centre, UC Santa Barbra. USAID.*ftp://chg-ftpout.geog.ucsb.edu/pub/org/chg/products/CHIRPS-2.0/global_monthly/bils*

Clavijo, del P. M., Nordenstahl, M., Gundel, P. E., & Jobbágy, E. G. (2005). Poplar Afforestation Effects on Grassland Structure and Composition in the Flooding Pampas. *Rangeland Ecology & Management*, *58*(5), 474–479. https://doi.org/10.2111/1551-5028(2005)58

Clover, J., Eriksen, S., 2009. The effects of land tenure change on sustainability: human security and environmental change in southern African savannas. Environ. Sci. Policy. https://doi.org/10.1016/j.envsci.2008.10.012

Coppolillo, P. B. (2000). The landscape ecology of pastoral herding: spatial analysis of land use and livestock production in East Africa. *Human Ecology*, *28*(4), 527–560. https://doi.org/10.1023/a:1026435714109

Cotula, L., Toulmin, C., & Hesse, C. (2004). Land Tenure and Administration in Africa: Lessons of Experience and Emerging Issues. *International Institute for Environment and Development*, *January*, 50.

Coughenour, M. (2004). The Ellis paradigm — humans, herbivores and rangeland systems. *African Journal of Range & Forage Science*, *21*(March 2014), 191–200. https://doi.org/10.2989/10220110409485851

Coughenour, M.B. *Savanna - Landscape and Regional Ecosystem Model: User Manual*; 430 Colorado State University: Ft. Collins, Colorado 80523 USA. 1993; p. 44.

Crooks, A., Castle, C., & Batty, M. (2008). Computers , Environment and Urban Systems Key challenges in agent-based modelling for geo-spatial simulation. *Computers, Environment and Urban Systems*, *32*(6), 417–430. https://doi.org/10.1016/j.compenvurbsys.2008.09.004

CSA, 1995. Federal Democratic Republic of Ethiopia Central Statistical Agency Agricultural-Sample-Survey-Livestock-Poultry-and-Beehives-1995, Addis Ababa, Ethiopia.

CSA, 1996. Federal Democratic Republic of Ethiopia Central Statistical Agency Agricultural-Sample-Survey-Livestock-Poultry-and-Beehives-1996, Addis Ababa, Ethiopia

CSA, 1997. Federal Democratic Republic of Ethiopia Central Statistical Agency Agricultural-Sample-Survey-Livestock-Poultry-and-Beehives-1997, Addis Ababa, Ethiopia

CSA, 19980/81. Federal Democratic Republic of Ethiopia Central Statistical Agency Agricultural-Sample-Survey-Livestock-Poultry-and-Beehives-1980/81 Addis Ababa, Ethiopia

CSA, 2004. Federal Democratic Republic of Ethiopia Central Statistical Agency. Agricultural Sample Survey Report on Livestock and Livestock Characteristics. Statistical Bulletin 302, Addis Ababa, Ethiopia.

CSA, 2005. Federal Democratic Republic of Ethiopia Central Statistical Agency. Agricultural Sample Survey Report on Livestock and Livestock Characteristics. Statistical Bulletin 331, Addis Ababa, Ethiopia.

CSA, 2006. Federal Democratic Republic of Ethiopia Central Statistical Agency. Agricultural Sample Survey Report on Livestock and Livestock Characteristics. Statistical Bulletin 364, Addis Ababa, Ethiopia.

CSA, 2007. Federal Democratic Republic of Ethiopia Central Statistical Agency. Agricultural Sample Survey Report on Livestock and Livestock Characteristics. Statistical Bulletin 388, Addis Ababa, Ethiopia.

CSA, 2008. Federal Democratic Republic of Ethiopia Central Statistical Agency. Agricultural Sample Survey Report on Livestock and Livestock Characteristics. Statistical Bulletin 417, Addis Ababa, Ethiopia.

CSA, 2009. Federal Democratic Republic of Ethiopia Central Statistical Agency. Agricultural Sample Survey Report On Livestock and Livestock Characteristics. Statistical Bulletin 446, Addis Ababa, Ethiopia.

CSA, 2010. Federal Democratic Republic of Ethiopia Central Statistical Agency. Agricultural Sample Survey Report on Livestock and Livestock Characteristics. Statistical Bulletin 468, Addis Ababa, Ethiopia.

CSA, 2011. Federal Democratic Republic of Ethiopia Central Statistical Agency. Agricultural Sample Survey Report on Livestock and Livestock Characteristics. Statistical Bulletin 505, Addis Ababa, Ethiopia

CSA, 2012. Federal Democratic Republic of Ethiopia Central Statistical Agency. Agricultural Sample Survey Report on Livestock and Livestock Characteristics. Statistical Bulletin 532, Addis Ababa, Ethiopia.

CSA, 2013. Federal Democratic Republic of Ethiopia Central Statistical Agency. Agricultural Sample Survey Report on Livestock and Livestock Characteristics. Statistical Bulletin 570, Addis Ababa, Ethiopia

CSA, 2014. Federal Democratic Republic of Ethiopia Central Statistical Agency. Agricultural Sample Survey Report on Livestock and Livestock Characteristics. Statistical Bulletin 532, Addis Ababa, Ethiopia.

Cumming, G., Peterson, G. D., Carpenter, S. R., Pingali, P. L., Bennett, E. M., & Zurek, M. B. (2005). Ecology in Global Scenarios. *Millennium Ecosystem Assessment : Scenarios*, 45–69. http://books.google.com/books?hl=en&lr=&id=Q6jUX_BgWpIC&oi=fn

d&pg=PA45&dq=Ecology+in+Global+Scenarios&ots=QJptT8P07H&sig=b6TJxAVhmqw8OBXYG4Ug1Ov9fBo

Degen, A. A. (2011). Transformation of Borana from nomadic pastoralists to agropastoralists and shift of livestock from cattle to include more goats, camels and sheep in Southern Ethiopia. *International Journal of Business and Globalisation*, *6*(3–4), 292–312. https://doi.org/10.1504/IJBG.2011.039389

Deininger, K., & Feder, G. (2009). Land registration, governance, and development: Evidence and implications for policy. *World Bank Research Observer*, *24*(2), 233–266. https://doi.org/10.1093/wbro/lkp007

Deininger, K., Ali, D. A., Holden, S., Zevenbergen, J., Bank, W., Dc, W., & Sciences, L. (2007). *WPS4218 Rural land certification in Ethiopia :*

Deininger, K., Ayalew, D., & Tekie, A. (2008). Impacts of Land Certification on Tenure Security , Investment , and Land Markets Evidence from Ethiopia. In *World* (No. 4764; Policy Research Working Paper, Issue October).

Deininger, K., H. Selod and A. Burns (2012). The Land Governance Assessment Framework. Identifying and monitoring good practices in the land sector. Washington D.C.: World Bank.

Deinlnger, K., & Binswanger, H. (1999). The Evolution of the World Bank's Land Policy: Principles, Experience, and Future Challenges. *The World Bank Research Observer*, *14*(2), 247–276. https://doi.org/10.1093/wbro/14.2.247

Deke, L. A. (2016). Soil Physic-chemical Properties in Termite Mounds and Adjacent Control Soil in Miyo and Yabello Districts of Borana Zone, Southern Ethiopia. *American Journal of Agriculture and Forestry*, *4*(4), 69. https://doi.org/10.11648/j.ajaf.20160404.11

Desta, S., & Coppock, D. L. (2002). Cattle population dynamics in the southern Ethiopian rangelands, 1980-97. *Journal of Range Management*, *55*(5), 439–451. https://doi.org/10.2307/4003221

Desta, S., & Coppock, D. L. (2004). Pastoralism under pressure: Tracking system change in Southern Ethiopia. *Human Ecology*, *32*(4), 465–486. https://doi.org/10.1023/B:HUEC.0000043516.56037.6b

Dixit, A. K., Levin, S. A., & Rubenstein, D. I. (2013). Reciprocal insurance among Kenyan pastoralists. *Theoretical Ecology*, *6*(2). https://doi.org/10.1007/s12080-012-0169-x

Dodgson, J. S., Spackman, M., Pearman, A., & Phillips, L. D. (2009). Multi-criteria analysis : a manual. In *Appraisal* (Vol. 11, Issues 1–3). https://doi.org/10.1002/mcda.399

Dressler, G., & Mueller, B. (2012). *Mobility – a panacea for pastoralism ? An ecological-economic modelling approach . International Environmental Modelling and Software Society (iEMSs)2012 International Congress on Environmental Modelling and Software. http://www.iemss.org/society/index.php/iemss-2012-proceedings*

Dressler, G., Groeneveld, J., Buchmann, C. M., Guo, C., Hase, N., Thober, J., Frank, K., & Müller, B. (2019). Implications of behavioral change for the resilience of pastoral systems — Lessons from an agent-based model. *Ecological Complexity*, *40*, 100710. https://doi.org/10.1016/j.ecocom.2018.06.002

Ege, S. (2017). Land tenure insecurity in post-certification Amhara, Ethiopia. *Land Use Policy*. https://doi.org/10.1016/j.landusepol.2017.02.015

Elias, E., & Abdi, F. (2010). *Putting Pastoralists on the Policy Agenda : Land Alienation in Southern Ethiopia*. *July*.

Enemark, S. (2016). Fit-For-Purpose Land Administration. *International Federation of Surveyors (FIG)*, *60*, 118. https://doi.org/https://www.fig.net/resources/publications/figpub/pub60/Figpub60.pdf

ESA (2017) ESA Climate Change Initiative - Land Cover project 2017 CCI LAND COVER – S2 prototype Land Cover 20m map of Africa 2016. *http://2016africalandcover20m.esrin.esa.int/download.php?*

FAO (2002) The State of Food Insecurity in the World Food and Agriculture Organization of the United Nations Viale delle Terme di Caracalla, 00100 Rome, Italy

FAO. (2016). *Governing Tenure Rights to Commons*. https://doi.org/10.1109/TVT.2016.2521703

Fernández-Giménez, M. E. (2002). Spatial and social boundaries and the paradox of pastoral land tenure: A case study from postsocialist Mongolia. *Human Ecology*, *30*(1), 49–78. https://doi.org/10.1023/A:1014562913014

Flintan, F. (2011). The Political Economy of Land Reform in Pastoral Areas: Lessons from Africa, Implications for Ethiopia. *A Paper Presented at the Conference: Future of Pastoralism. 21-23 March, 2011, Addis Ababa*, *March*, 38. http://www.celep.info/wp-content/uploads/downloads/2011/04/Political-economy-of-Land1.pdf

Flintan. (2012). *Participatory rangeland resource mapping as a valuable tool for village land use planning in Tanzania*. 20. http://www.landcoalition.org/sites/default/files/documents/resources/RangelandMappingReportTanzania.pdf

Galaty, J. G. (2016). *Reasserting the commons : Pastoral Contestations of Private and State*

Lands in East Africa 1. *10*(2), 709–727. https://doi.org/10.18352/ijc.720

Galvin, K. A, Thornton, P. K., Boone, R. B., & Sunderland, J. (2004). Climate variability and impacts on east African livestock herders: the Maasai of Ngorongoro Conservation Area, Tanzania. *African Journal of Range & Forage Science*, *21*(3), 183–189. https://doi.org/10.2989/10220110409485850

Galvin, K. A., Thornton, P. K., de Pinho, J. R., Sunderland, J., & Boone, R. B. (2006). Integrated modeling and its potential for resolving conflicts between conservation and people in the rangelands of East Africa. *Human Ecology*, *34*(2), 155–183. https://doi.org/10.1007/s10745-006-9012-6

Gebremeskel, T., Flintan, F., & Bormann, U. (2016). Woreda (District) Participatory Land Use Planning in Pastoral Areas of Ethiopia: Development, Piloting and Opportunities for Scaling-up Paper Prepared for Presentation at the "2016 World Bank Conference on Land and Poverty" The World Bank - Washington. *2016 World Bank Conference on Land and Poverty. The World Bank-Washington DC, March 14-18, 2016.*

GFDRE, 2003 Government of the Federal Democratic Republic of Ethiopia. Republic of Ethiopia rural development policy and strategies. Ministry of Finance and Economic Development Economic Policy and Planning Department Addis Ababa April, 2003

Ghebru, H., & Lambrecht, I. (2017). Drivers of perceived land tenure (in)security: Empirical evidence from Ghana. *Land Use Policy*, *66*. https://doi.org/10.1016/j.landusepol.2017.04.042

Gonin, A., & Gautier, D. (2015). Shift in herders' territorialities from regional to local scale: the political ecology of pastoral herding in western Burkina Faso. *Pastoralism*, *5*(1). https://doi.org/10.1186/s13570-015-0023-z

Greiner, C. (2017). Pastoralism and Land-Tenure Change in Kenya: The Failure of Customary Institutions. *Development and Change*. https://doi.org/10.1111/dech.12284

Greiner, C., Alvarez, M., & Becker, M. (2013). From Cattle to Corn: Attributes of Emerging Farming Systems of Former Pastoral Nomads in East Pokot, Kenya. *Society & Natural Resources*. https://doi.org/10.1080/08941920.2013.791901

Grimm, V., & Railsback, S. F. (2012). Pattern-oriented modelling: A "multi-scope" for predictive systems ecology. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *367*(1586), 298–310. https://doi.org/10.1098/rstb.2011.0180

Grimm, V., Revilla, E., Berger, U., Jeltsch, F., Mooij, W. M., Railsback, S. F., Thulke, H. H., Weiner, J., Wiegand, T., & DeAngelis, D. L. (2005). Pattern-oriented modeling of agent-based complex systems: Lessons from ecology. *Science*, *310*(5750), 987–991.

https://doi.org/10.1126/science.1116681

Groeneveld, J., Müller, B., Buchmann, C. M., Dressler, G., Guo, C., Hase, N., Hoffmann, F., John, F., Klassert, C., Lauf, T., Liebelt, V., Nolzen, H., Pannicke, N., Schulze, J., Weise, H., & Schwarz, N. (2017). Environmental Modelling & Software Theoretical foundations of human decision-making in agent-based land use models e A review. *Environmental Modelling and Software*, *87*, 39–48. https://doi.org/10.1016/j.envsoft.2016.10.008

Herrera; D, J. Ruiz-Mirazo; P. J.; J. Mahomed-Katere; I. Hannam; E. (2016). *Improving governance of pastoral lands*. http://www.fao.org/3/a-i5771e.pdf

Hobbs, N. T., Galvin, K. A., Stokes, C. J., Lackett, J. M., Ash, A. J., Boone, R. B., Reid, R. S., & Thornton, P. K. (2008). Fragmentation of rangelands: Implications for humans, animals, and landscapes. *Global Environmental Change*, *18*(4), 776–785. https://doi.org/10.1016/j.gloenvcha.2008.07.011

Holden, S. T., & Bezu, S. (2016). Preferences for land sales legalization and land values in Ethiopia. *Land Use Policy*, *52*. https://doi.org/10.1016/j.landusepol.2016.01.002

Holden, S. T., & Ghebru, H. (2016). Land tenure reforms, tenure security and food security in poor agrarian economies: Causal linkages and research gaps. *Global Food Security*, *10*, 21–28. https://doi.org/10.1016/j.gfs.2016.07.002

Homann, S. (2004). *Indigenous knowledge of Borana pastoralists in natural resource management : a case study from southern Ethiopia*.

Homann, S., Rischkowsky, B., & Steinbach, J. (2008). The effect of development interventions on the use of indigenous range management strategies in the Borana Lowlands in Ethiopia. *Land Degradation and Development*. https://doi.org/10.1002/ldr.845http://www.post2015hlp.org/wpcontent/uploads/2013/05/UN-Report.pdf

ILC. (2013). Rangelands: Village land use planning in rangelands in Tanzania - good practice and lessons learned. In *International Land Coalition*. http://landportal.info/sites/default/files/rangelandsvillagelanduseplanning.pdf%5Cnpapers2://publication/uuid/6FF346C6-2DDF-4A98-AF3F-B2D565122F30

Kassahun, A., Snyman, H. A., & Smit, G. N. (2008). Impact of rangeland degradation on the pastoral production systems, livelihoods and perceptions of the Somali pastoralists in Eastern Ethiopia. *Journal of Arid Environments*, *72*(7), 1265–1281. https://doi.org/10.1016/j.jaridenv.2008.01.002

Kibugi, R. M. (2011). Governing Land Use in Kenya : From Sectoral Fragmentation to

Sustainable Integration of Law and Policy. *Environmental Protection*.

Kideghesho, J. R., Rija, A. A., Mwamende, K. A., & Selemani, I. S. (2013). Emerging issues and challenges in conservation of biodiversity in the rangelands of Tanzania. *Nature Conservation*, *6*. https://doi.org/10.3897/natureconservation.6.5407

Kiker, G. A., Bridges, T. S., Varghese, A., Seager, T. P., & Linkov, I. (2005). Application of multicriteria decision analysis in environmental decision making. *Integrated Environmental Assessment and Management*, *1*(2), 95–108. https://doi.org/10.1897/IEAM_2004a-015.1

Krantz, L. (2015). *Securing Customary Land Rights in Sub-Saharan Africa Learning from new approaches to land tenure reform*.

Kuusaana, E. D., & Bukari, K. N. (2015). Land conflicts between smallholders and Fulani pastoralists in Ghana: Evidence from the Asante Akim North District (AAND). *Journal of Rural Studies*. https://doi.org/10.1016/j.jrurstud.2015.09.009

Lesorogol, C. K., & Boone, R. B. (2016). Which way forward? Using simulation models and ethnography to understand changing livelihoods among Kenyan pastoralists in a "new commons. *International Journal of the Commons*, *10*(2), 747–770. https://doi.org/10.18352/ijc.656

Liao, C. (2014). *Borana (Pastorlists) Ethiopia Case Study.pdf*. *March*, 1–31. http://www.atkinson.cornell.edu/Assets/ACSF/docs/collaborations/oxfam/Borana%20(Pastorlists)%20Ethiopia%20Case%20Study.pdf

Liao, C., & Clark, P. E. (2018). Rangeland vegetation diversity and transition pathways under indigenous pastoralist management regimes in southern Ethiopia. *Agriculture, Ecosystems & Environment.*, *252*, 105—113. https://doi.org/10.1016/j.agee.2017.10.009

Liao, C., Agrawal, A., Clark, P. E., Levin, S. A., & Rubenstein, D. I. (2020). *Landscape sustainability science in the drylands : mobility , rangelands and livelihoods*. *8*.

Liao, C., Clark, P. E., & Degloria, S. D. (2018b). *Bush encroachment dynamics and rangeland management implications in southern Ethiopia*. *September*, 1–10. https://doi.org/10.1002/ece3.4621

Little, P. D., & Behnke, R. (2010). Policy Options for Pastoral Development in Ethiopia Report Number 3 Pastoral Economic Growth and Development Policy John McPeak. *Development*, *2010*(3), 1991–2008.

Little. P. D, Behnke, R., McPeak, J. G., & Gebru, G. (2010). Future scenarios for pastoral development in Ethiopia, 2010–2025. In *Pastoral Economic Growth and Development*

Policy Assessment, Ethiopia, Addis Ababa, and Department for International Development (DFID), Ethiopia. (Vol. 2, p. 57). www.future-agricultures.org/index.php?option=com_content&view=article&id=7522 :conference-links&catid=1549&Itemid=988

López-i-Gelats, F., Fraser, E. D. G., Morton, J. F., & Rivera-Ferre, M. G. (2016). What drives the vulnerability of pastoralists to global environmental change? A qualitative meta-analysis. *Global Environmental Change*. https://doi.org/10.1016/j.gloenvcha.2016.05.011

Manzano, P. (2018). *Traditional pastoralist governance and the national devolution process in Kenya : challenges and opportunities for action A scoping review for Saferworld*. *March*.

Martin, R., Müller, B., Linstädter, A., & Frank, K. (2014). How much climate change can pastoral livelihoods tolerate? Modelling rangeland use and evaluating risk. *Global Environmental Change*, *24*(1), 183–192. https://doi.org/10.1016/j.gloenvcha.2013.09.009

Martin, R., Müller, B., Linstädter, A., Frank, K., 2014. How much climate change can pastoral livelihoods tolerate? Modelling rangeland use and evaluating risk. Glob. Environ. Chang. 24, 183–192. https://doi.org/10.1016/j.gloenvcha.2013.09.009

McAllister, R. R. J., Gordon, I. J., Janssen, M. A., & Abel, N. (2006). Pastoralists' responses to variation of rangeland resources in time and space. *Ecological Applications*, *16*(2), 572–583. https://doi.org/10.1890/1051-0761(2006)016[0572:PRTVOR]2.0.CO;2

Mcginnis, M. D., & Ostrom, E. (2014 Social-ecological system framework: initial changes and continuing challenges Ecol. Soc., 19 (2) (2014), p. 30, 10.5751/ES-06387-190230

Meur, P. Le, (2005). *Land Tenure Information & Land Policy in Sub-Saharan Africa. Synthesis report (Benin, South Africa. Conclusive expert meeting FAO normative work on land tenure data & policy-making September 22-23, 2005, FAO, Rome*

Molnar, Z. (2014). Perception and Management of Spatio-Temporal Pasture Heterogeneity by Hungarian Herders. *Rangeland Ecology & Management*, *67*(2). https://doi.org/10.2111/rem-d-13-00082.1

Moritz, M. (2010). Crop-livestock interactions in agricultural and pastoral systems in West Africa. *Agriculture and Human Values*, *27*(2), 119–128. https://doi.org/10.1007/s10460-009-9203-z

Moritz, M. (2016). *Open property regimes Linked references are available on JSTOR for this article : International Journal of the Commons 10*(2), 688–708.

https://doi.org/10.18352/ijc.719

Moritz, M., Behnke, R., Beitl, C. M., Bird, R. B., Chiaravalloti, R. M., Clark, J. K., Crabtree, S. A., Downey, S. S., Hamilton, I. M., Phang, S. C., Scholte, P., & Wilson, J. A. (2018). Emergent sustainability in open property regimes. *Proceedings of the National Academy of Sciences of the United States of America*, *115*(51), 12859–12867. https://doi.org/10.1073/pnas.1812028115

Moritz, M., Hamilton, I. M., Chen, Y. J., & Scholte, P. (2014). Mobile pastoralists in the logone floodplain distribute themselves in an ideal free distribution. *Current Anthropology*, *55*(1), 115–122. https://doi.org/10.1086/674717

Moritz, M., Handa, S., Chen, Y. J., & Xiao, N. (2015). Herding contracts and pastoral mobility in the far north region of Cameroon. *Human Ecology*, *43*(1). https://doi.org/10.1007/s10745-015-9732-6

Moritz, M., Larisa Catherine, B., Drent, A. K., Kari, S., Mouhaman, A., & Scholte, P. (2013a). Rangeland governance in an open system: Protecting transhumance corridors in the Far North Province of Cameroon. *Pastoralism: Research, Policy and Practice*, *3*(1). https://doi.org/10.1186/2041-7136-3-26

Moritz, M., Scholte, P., Hamilton, I. M., & Kari, S. (2013b). Open Access, Open Systems: Pastoral Management of Common-Pool Resources in the Chad Basin. *Human Ecology*, *41*(3), 351–365. https://doi.org/10.1007/s10745-012-9550-z

Mwangi, E. (2007). Subdividing the Commons: Distributional Conflict in the Transition from Collective to Individual Property Rights in Kenya's Maasailand. *World Development*. https://doi.org/10.1016/j.worlddev.2006.09.012

Mwangi, E. (2009). Property rights and governance of Africa's rangelands: A policy overview. In *Natural Resources Forum*. https://doi.org/10.1111/j.1477-8947.2009.01219.x

Mwangi, E., & Dohrn, S. (2006). Biting the Bullet: How to Secure Access to Drylands Resources for Multiple Users. In *Food Policy* (CAPRi Working Paper Series No. 47). http://www.capri.cgiar.org/wp/capriwp47.asp

Mwangi, E., & Dohrn, S. (2008). Securing access to drylands resources for multiple users in Africa: A review of recent research. *Land Use Policy*. https://doi.org/10.1016/j.landusepol.2007.07.002

Mwangi, E., & Ostrom, E. (2009). Top-down solutions: Looking up from East Africa's rangelands. *Environment*. https://doi.org/10.3200/ENVT.51.1.34-45

Njuki, J., Poole, J., Johnson, N., Baltenweck, I., Pali, P., & Mburu, S. (2011). *Gender ,*

Livestock and Livelihood Indicators. *October*.

Notenbaert, A. M. O., Davies, J., De Leeuw, J., Said, M., Herrero, M., Manzano, P., Waithaka, M., Aboud, A., & Omondi, S. (2012). Policies in support of pastoralism and biodiversity in the heterogeneous drylands of East Africa. *Pastoralism*, *2*(1), 1–17. https://doi.org/10.1186/2041-7136-2-14

Oba, G. (2012). Harnessing pastoralists' indigenous knowledge for rangeland management: three African case studies. *Pastoralism: Research, Policy and Practice*, *2*(1), 1. https://doi.org/10.1186/2041-7136-2-1

Odadi, W. O., Fargione, J., & Rubenstein, D. I. (2017). Vegetation, Wildlife, and Livestock Responses to Planned Grazing Management in an African Pastoral Landscape. *Land Degradation and Development*. https://doi.org/10.1002/ldr.2725

Odadi, W. O., Riginos, C., & Rubenstein, D. I. (2018). Tightly Bunched Herding Improves Cattle Performance in African Savanna Rangeland. *Rangeland Ecology and Management*. https://doi.org/10.1016/j.rama.2018.03.008

Odadi, W.O., Rubenstein, D.I., 2015. Herd Size-Dependent Effects of Restricted Foraging Time Allowance on Cattle Behavior, Nutrition, and Performance. Rangel. Ecol. Manag. https://doi.org/10.1016/j.rama.2015.05.009

Ostrom, E. (1990). *The Evolution of Institutions for Collective Action*. 280. https://doi.org/10.1017/CBO9780511807763

Pricope, N. G., Husak, G., Lopez-Carr, D., Funk, C., & Michaelsen, J. (2013). The climate-population nexus in the East African Horn: Emerging degradation trends in rangeland and pastoral livelihood zones. *Global Environmental Change*, *23*(6). https://doi.org/10.1016/j.gloenvcha.2013.10.002

Rakotonarivo, O. S., Bredahl, J., Poudyal, M., Rasoamanana, A., & Hockley, N. (2018). *Land Use Policy Estimating welfare impacts where property rights are contested : methodological and policy implications*. *70*(October 2017), 71–83. https://doi.org/10.1016/j.landusepol.2017.09.051

Reid, R., Serneels, S., Nyabenge, M., & Hanson, J. (2005). The changing face of pastoral systems in grass dominated ecosystems of Eastern Africa. *Grasslands of the World*, 19–76.

http://books.google.com/books?hl=en&lr=&id=BBA_HxFizNgC&oi=fnd&pg=PA19&dq=The+changing+face+of+pastoral+systems+in+grass+-+dominated+ecosystems+of+eastern+Africa&ots=t63iOuIbqx&sig=4FF6LXbkGbVDjKWxMy5vxWqOO_M

Ridgewell, A., Mamo, G., & Flintan, F. (2007). *Gender & Pastoralism Volume 1 : Rangeland & Resource Management in Ethiopia* (Vol. 1, Issue September). http://www.sahel.org.uk/pdf/Gender & Pastoralism Vol 1 - ebook.pdf

Roba, H. G., & Oba, G. (2013). Understanding the role of local management in vegetation recovery around pastoral settlements in northern Kenya. *Environmental Management*, *51*(4). https://doi.org/10.1007/s00267-013-0020-1

Robinson, L. W. (2009). A complex-systems approach to pastoral commons. *Human Ecology*, *37*(4), 441–451. https://doi.org/10.1007/s10745-009-9253-2

Robinson, L. W. (2019). Open Property and Complex Mosaics: Variants in Tenure Regimes Across Pastoralist Social-Ecological Systems. *International Journal of the Commons*, *13*(1), 1–23. https://doi.org/10.18352/ijc.903

Robinson, L. W., & Berkes, F. (2010). Applying resilience thinking to questions of policy for pastoralist systems: Lessons from the Gabra of northern Kenya. *Human Ecology*, *38*(3), 335–350. https://doi.org/10.1007/s10745-010-9327-1

Robinson, L. W., Ontiri, E., Alemu, T., & Moiko, S. S. (2017). Transcending Landscapes: Working Across Scales and Levels in Pastoralist Rangeland Governance. *Environmental Management*, *60*(2), 185–199. https://doi.org/10.1007/s00267-017-0870-z

Roe, D., Nelson, F., Blomley, T., & Flintan, F. (2013). *Conservation and "Land Grabbing" in Rangelands: Part of the Problem or Part of the Solution?*

Samuel, G. (2006). Land, Land Policy and Smallholder Agriculture in Ethiopia: Options and Scenarios. *Future Agricultures Consortium Meeting at the Institute of Development Studies 20-22 March 2006*, *March*, 14 pp. http://r4d.dfid.gov.uk/Output/178530/Default.aspx

Samuels, I., Allsopp, N., & Hoffman, M. T. (2013). How could herd mobility be used to manage resources and livestock grazing in semi-arid rangeland commons? *African Journal of Range & Forage Science*, *30*(1–2, SI). https://doi.org/10.2989/10220119.2013.781063

Schmidt, M., & Pearson, O. (2016). Pastoral livelihoods under pressure: Ecological, political and socioeconomic transitions in Afar (Ethiopia). *Journal of Arid Environments*, *124*. https://doi.org/10.1016/j.jaridenv.2015.07.003

Scoones, I. (Ed.), Stirling, A. (Ed.). (2020). The Politics of Uncertainty. London: Routledge, https://doi.org/10.4324/9781003023845

Scoones, I., & Graham, O. (1994). New directions for pastoral development in Africa. *Development in Practice*, *4*(3), 188–198. https://doi.org/10.1080/096145249100077821

Senda, T. S., Robinson, L. W., Gachene, C. K. K., Kironchi, G., & Doyo, J. (2020a). An assessment of the implications of alternative scales of communal land tenure formalization in pastoral systems. *Land Use Policy*, *94*(February), 104535. https://doi.org/10.1016/J.LANDUSEPOL.2020.104535

Senda, T.S.; Kiker, G.A.; Masikati, P.; Chirima, A.; van Niekerk, J.(2020b) Modeling Climate Change Impacts on Rangeland Productivity and Livestock Population Dynamics in Nkayi District, Zimbabwe. *Appl. Sci. 10*, 2330.

Sheffield, J., Wood, E.F., Chaney, N., Guan, K., Sadri, S., Yuan, X., Olang, L., Amani, A., Ali, A., Demuth, S., and Ogallo, L. 2014. A drought monitoring and forecasting system for sub-Sahara African water resources and food security. Bull. Am. Meteorol. Soc. 95 (6), 861–882.

Tache, B., & Sjaastad, E. (2010). Pastoralists' Conceptions of Poverty: An Analysis of Traditional and Conventional Indicators from Borana, Ethiopia. *World Development*, *38*(8), 1168–1178. https://doi.org/10.1016/j.worlddev.2010.01.001

Tefera, S., Enawgaw, C., Loyale, D. T., Eid, A., Olibui, O., LaTosky, S., Detona, M., & Nigatu, A. (2016). *Pastoralists Do Plan! Community-Led Land Use Planning in the Pastoral Areas of Ethiopia*.

Temesgen, H., Nyssen, J., Zenebe, A., Haregeweyn, N., Kindu, M., Lemenih, M., & Haile, M. (2013). Ecological succession and land use changes in a lake retreat area (Main Ethiopian Rift Valley). *Journal of Arid Environments*, *91*, 53–60. https://doi.org/10.1016/j.jaridenv.2012.12.001

Tesfahunegn, G.B., 2018. Farmers' perception on land degradation in northern Ethiopia: Implication for developing sustainable land management. Soc. Sci. J. https://doi.org/10.1016/j.soscij.2018.07.004

Tesfaye Teklu. T, (2004). Land Scarcity , Tenure Change and Public Policy in the African Case of Ethiopia : Evidence on Efficacy and Unmet Demands for Land Rights. *International Conference on African Development*, 1–24.

Tessema, W. K., Ingenbleek, P. T. M., & Van Trijp, H. C. M. (2014). Pastoralism, sustainability, and marketing. A review. In *Agronomy for Sustainable Development*. https://doi.org/10.1007/s13593-013-0167-4

Thornton, P. K. (2010). Livestock production: recent trends, future prospects. *Philosophical Transactions of the Royal Society of London.Series B, Biological Sciences*, *365*(1554), 2853–2867. https://doi.org/10.1098/rstb.2010.0134 [doi]

Thornton, P. K., BurnSilver, S. B., Boone, R. B., & Galvin, K. A. (2006). Modelling the

impacts of group ranch subdivision on agro-pastoral households in Kajiado, Kenya. *Agricultural Systems*, *87*(3), 331–356. https://doi.org/10.1016/j.agsy.2005.03.001

Thornton, P. K., Galvin, K. A., & Boone, R. B. (2003). An agro-pastoral household model for the rangelands of East Africa. *Agricultural Systems*, *76*(2), 601–622. https://doi.org/10.1016/S0308-521X(01)00094-4

Tilahun, M., Angassa, A., Abebe, A., & Mengistu, A. (2016). Perception and attitude of pastoralists on the use and conservation of rangeland resources in Afar Region , Ethiopia. *Ecological Processes*. https://doi.org/10.1186/s13717-016-0062-4

Tilahun, M., Angassa, A., Abebe, A., Mengistu, A., 2016. Perception and attitude of pastoralists on the use and conservation of rangeland resources in Afar Region, Ethiopia. Ecol. Process. https://doi.org/10.1186/s13717-016-0062-4

Tsegaye, D., Vedeld, P., & Moe, S. R. (2013). Pastoralists and livelihoods: A case study from northern Afar, Ethiopia. *Journal of Arid Environments*, *91*, 138–146. https://doi.org/10.1016/j.jaridenv.2013.01.002

Tsegaye, Diress, Moe, S. R., Vedeld, P., & Aynekulu, E. (2010). Land-use/cover dynamics in Northern Afar rangelands, Ethiopia. *Agriculture, Ecosystems and Environment*, *139*(1–2), 174–180. https://doi.org/10.1016/j.agee.2010.07.017

Tura, H. A. (2018). Land rights and land grabbing in Oromia, Ethiopia. *Land Use Policy*, *70*. https://doi.org/10.1016/j.landusepol.2017.10.024

Turner, M. D., & Mcpeak, J. G. (2014). *The Role of Livestock Mobility in the Livelihood Strategies of Rural Peoples in Semi-Arid West Africa*. 231–247. https://doi.org/10.1007/s10745-013-9636-2

UN (2013): A New Global Partnership: Eradicate Poverty and Transform Economies through Sustainable Development. New York. http://www.post2015hlp.org/wpcontent/uploads/2013/05/UN-Report.pdfUN-

UN-HABITAT, IIRR, & G. (2011). Handling Land. In *Tools for land governance and secure tenure*. https://doi.org/ISO 14001:2004

UN-Habitat. (2018). Global Experiences in Land Readjustment. In *Urban Legal Case Studies* (Vol. 7). https://unhabitat.org/books/global-experiences-in-land-readjustment-urban-legal-case-studies-volume-7/

United Nations, Department of Economic and Social Affairs, Population Division (2017). World Population Prospects: The 2017 Revision, Key Findings and Advance Tables. Working Paper No. ESA/P/WP/248

United Nations. Economic Commission for Africa. (2011). *Regional assessment studies on*

land policy in Central, Eastern, North, Southern and West Africa : synthesis report. v, 60 p. http://www.loc.gov/catdir/toc/fy13pdf02/2011349751.html

USAID, (2017). Household Economic Analysis (HEA). Borana Agro-pastoralist Zone 2017. Ethiopia: 2017Livelihood baseline profiles. USAID.

USAID. (2004). *Ethiopia Land Policy and Administration Assessment - Final Report with Appendices*. *4*, 110. http://rmportal.net/library/content/land-tenure-and-property-rights-documents/ethiopia-land-policy-and-administration-assessment/at_download/file

Van de Steeg, J. A., Verburg, P. H., Baltenweck, I., & Staal, S. J. (2010). Characterization of the spatial distribution of farming systems in the Kenyan Highlands. *Applied Geography*, *30*(2), 239–253. https://doi.org/10.1016/j.apgeog.2009.05.005

Veit, B. P. (2011). Rise and Fall of Group Ranches in Kenya, Focus on land in Africa www.focusonland.com

Vetter, S. (2005). Rangelands at equilibrium and non-equilibrium: Recent developments in the debate. *Journal of Arid Environments*, *62*(2), 321–341. https://doi.org/10.1016/j.jaridenv.2004.11.015

Walker, L. R. (2017). *Rangeland Systems*. https://doi.org/10.1007/978-3-319-46709-2

Wario, H. T. (2015). *resource use strategies in the An integrated assessment of resource use strategies in the Borana pastoral system of southern Ethiopia*.

Wario, H. T., Roba, H. G., & Kaufmann, B. (2015). Shaping the Herders' "Mental Maps": Participatory Mapping with Pastoralists' to Understand Their Grazing Area Differentiation and Characterization. *Environmental Management*, *56*(3), 721–737. https://doi.org/10.1007/s00267-015-0532-y

Wario, H. T., Roba, H. G., & Kaufmann, B. (2016). Responding to mobility constraints: Recent shifts in resource use practices and herding strategies in the Borana pastoral system, southern Ethiopia. *Journal of Arid Environments*, *127*. https://doi.org/10.1016/j.jaridenv.2015.12.005

Weisberg, P. J., Coughenour, M. B., & Bugmann, H. (2006). Modelling of large herbivore-vegetation interactions in a landscape context. *Conservation Biology Series-Cambridge-*, *11*, 348.

Woodhouse, P. (2012). New investment, old challenges. Land deals and the water constraint in African agriculture. *Journal of Peasant Studies*, *39*(3–4), 777–794. https://doi.org/10.1080/03066150.2012.660481

Xiao, N., Cai, S., Moritz, M., Garabed, R., & Pomeroy, L. W. (2015). Spatial and Temporal Characteristics of Pastoral Mobility in the Far North Region, Cameroon: Data Analysis and Modeling. *PloS One*, *10*(7), e0131697. https://doi.org/10.1371/journal.pone.0131697

Yamane, T. (2019) 25th edition - STATISTICS ; An Introductory Analysis. A Harper International edition jointly published by Harper & Row, New York, Evanston & London and John Weatherhill, inc., Tokyo

Yatsalo, B., Didenko, V., Gritsyuk, S., & Sullivan, T. (2015). *BNL-107950-2015-JA Decerns : A Framework for Multi-Criteria Decision Analysis Accepted for publication : 19 January 2015*.

APPENDICES

Appendix 1 Checklist for the KII FGDs

Guide for the focus group discussions and key informant interviews in Ethiopia

This discussion is to discuss about land certification in Dirre grazing unit. This has been proposed and is being implemented by the government of Ethiopia. We want to discuss what this means for the future of pastoralism vis a vis the UNIT of Certification- i.e. dheeda vs Kebele vs Reera. In this meeting we want to develop the alternative future scenarios under each certification type.

Why do we need scenarios? This is because Pastoral systems are complex and adaptive. This means that change is them is nonlinear, they can self-organize and hence it's not easy to determine what a policy change means for the future, All the same, for good decision making we need to try and envisage the plausible futures by applying a scenarios approach. This helps all stakeholders to be same, better prepared for the future and we will see things which we otherwise had not thought of.

The scenarios will help stakeholders to visualize the future of pastoralism on the context of changing land use and tenure.

- They also make them think in the longer term as they encompass the practical rationality and hence usable by decision makers.

The process will involve

1. Process of inquiry (to define the questions the scenarios seek to address), thereby guiding the research of complex/dynamic processes, stimulate creative thinking, about the future by all stakeholders
2. Identify uncertainties
3. Accommodate different perspectives
4. An iteration (revisiting and revising the scenarios

Key Guiding question:

1. What is the future of pastoralism in the context of changing land rights?

Background information:

1. How did we get here? Why certification now?
2. For who? Whose idea is it?
3. For how long have is been talked about?

discuss the proposed certification,

1. get more information on the plans for implementation,
2. what scenarios are likely to arise?
3. what are the issues in each scenario?

What do land/land rights/ tenure security affect? What is it linked with? What services are affected?

Show linkages via "spaghetti" diagrams?

Pertinent issues, driving forces and critical uncertainties will be identified. The different variables will be clustered under four broad themes: biophysical, technological, and socio-economic and institutional as shown in Table 1 below

List and evaluate the ecosystem services derived from the rangelands. For each good we put a plus, and for each bad we put a minus. this will be critical for evaluative the trade offs

Further discussion points for the different scenarios:

1. What ecosystem services are there from the rangelands?
2. Discuss the tradeoff that might arise…beyond the rangeland, e.g. other aspects like livelihoods, social relations etc.
3. What are the foreseeable challenges, fears, positives, negatives?
4. What are the likely scenarios (for pastoralism?)? In the future? E.g. by 2030?

5. Map the possible pathways to each scenario, what can help to get there>what can hinder?
6. what are the narratives for each scenario?

Participatory stakeholder workshops will be conducted:

1. to present, discuss and validate the scenarios, the thresholds, the feedbacks involved and key uncertainties, reflect on findings and the process
2. Such activities as visioning will be done to help visualize the impacts of activities in the future.
3. Scenario building will be useful for creating an understanding of complex systems and handling cross scale interactions. What are the ecosystem services from the rangeland? What do we get? What is the value? And how is the values and amount going to be affected by each certification type? What are the tradeoffs involved? Hence the need to do the simulation modelling to quantify how the three key services (range as a feed source, livestock and livelihoods) are going to be affected in the future. Understanding the tradeoffs are critical for achieving/working towards achieving the sustainable development goals.

The magnitude and direction of change will be estimated/quantified and verified/justified through literature and expert knowledge.

1. List the variables (see the ones on questionnaire)
2. Biophysical e.g. herd sizes, area under crop, rangeland health, soil water
3. Institutional
4. Socio economic
5. Technological

For each variable add two other columns to show the magnitude of change and the rationale for that magnitude

(+++ big increase, ++ medium increase, + small increase, 0 no change, --- big decrease, -- medium decrease, - small decrease)

What is the future of pastoralism in the face of changing land policy	**Scenarios**	**Rangeland related issues**	**Institutions and Livelihoods**	**Livestock related issues**	**Other (e.g. food security/gender)**
	Status quo	condition species diversity, degradation, what does it mean for community-based rangeland management	Rules-enforcement Who makes them, investment needed	Herd sizes, species diversity, sales/offtake, mobility	Food security Gender relations Cropping Off farm employment Staying or dropping out pf pastoralism
	***Dheed*a level certification**				
	***Reera* level certification**				
	***Kebele* level certification**				
	***Woreda* level certification**				

Appendix 2 ODK format Questionnaire-

label: English	label:Afaan Oromo
Household ID	lakoobsa abaworra kan addati bassu
Enumerator name:	maqaa qorannaa gaafata
Date of interview:	guyya qorannaa
Reera Name	maqqaa reera
Main Survey	qorannaa
1 Respondents name:	1. maqaa deebi kennata
2 Does this household have livestock?	2. worra keesan hoori hormata qabuu?
3 Please select the respondent's gender:	3. saala deebi kennata filadhuu
4 What is your relationship to the household head	4. firooma maali qabda abba worra wooliin?
5 Please tell me other position	5 gahee kan biraa yo qabaate naa himii
6. Name of the head of the Household	6 maqaan abaa worraa enyuu
7. Year of birth of respondent:	7 ganaa dhalootaa kee
8. How many household members, including household head and respondent, live permanently on the compound?	8 siifi aba manaa wojiin maatiin keesan meeeqa?
9 How many household members are younger than 16 years?	9 miseensoota wojjiin jiraatan kan ganaa 16 gadi taani hagamii?
10.How many household members are 65 years or older?	10 miseensoota wojjiin jiraatan kan ganaa 65 ol taani hagamii?
12Please confirm that your household has a total of " ${hh_members} " members, of which " ${hh_members_16} " are under the age of 16, " ${hh_members_65} " are over 65 years and "	12. mee dhugoomsi maatiin kee hundumni " ${hh_members} " ta'uf isaan keessaa immoo " ${hh_members_16} " gannaa 16 gadi akka ta'an " ${hh_members_65} "immoo akka ganna 65 ol ta'aniif "

${other_hh_members} " are between 16 years and 65 years	${other_hh_members} "illeen gannaa 16 fi 65 gidduu akka ta'an.
13 Gender of the Household Head	13 saala abba worra?
14 Marital status of the Household head	14. Abba/haadha worra fuudhe/fuute jiraa?
15Year of birth of Household head	15. Ganna dhaloota kan abba/haadha woraa yoomii?
16 Highest completed education of the Household head:	16. barnoota ol aansisee kan abbaa/haadha woraa xumure hagamii
17 What is the highest education level of the most educated household member currently living in the household.	17. miseensa woliin jiraatan keesa kan barnoota ol aansise xumuree sadarkaa hagamii?
18 How many housing units does household have?	18. mana hagaam qabdani?
19 Mostly used roofing material	19. irraa caalaa kabaan mana itiin ijaarame maali
20 Please specify other:	20. kan biraa kabaa itin ijaramee yo jiraate ifteessi
21 mostly used wall material	21. irraa caala dhaabaan manaa kan itiin ijaaramee maalii ?
22 Please specify other:	22. kan biraa itiin ijaarame yo jiraate ifteessi
23 do you own a scotch cart	23 isiin gaari harre qabduu?
24 do you own a mobile phone	24 isin moobaayiilii qabduu?
25 do you own a radio	25 isin raadiooni qabduu?
26 do you own a motor bike	26 isin mootor sayikilii qabduu?
27 do you own a wheelbarrow	27 isin gaarii harkaa qabduu
28 What is the main source of water for household use during the dry season?	28 yeroo bonaa madda bishaani kan harka gudda manaaf fayyadamtan kami?
28b Please specify other:	28b kan biraa yo jiraate ifteesi
29 Who owns the dry season household use water source?	29 madda bishaan yeero bona manaf fayyadamtan kan enyuu ?
30 What is the distance of the household water source in the dry season from the homestead?	30 yeroo boona maddii bishaani dhugaatiif ta'uu olaa keessaan irraa hagaam fagataa?
31 What is the main source of water for household use during the wet season?	31 yeroo rooba madda bishaani kan harka gudda manaaf fayyadamtan kami?
31b Please specify other:	31b kan biraa yo jiraate ifteesi

32 Who owns the wet season household use water source?	32 madda bishaan yeero rooba manaf fayyadamtan kan enyuu ?
32b What is the distance of the household water source in the rainy season from the homestead?	32b yeroo roba maddii bishaani dhugaatiif ta'uu olaa keessaan irraa hagaam fagataa?
33 What is the main source of water for Livestock drinking during the dry season?	33 madda bishaan yeero bona harka gudda hooriif fayyadamtan kamii ?
33b. Please specify other:	33b kan biraa yo jiraate ifteesi
34 Who is owns the dry season Livestock drinking water source?	34 madda bishaani kan hooriin dhuugani yeero bona kan eenyuti
35 What is the distance of the livestock drinking source in the dry season from the homestead?	35 yeroo boona maddii bishaani dhugaatiif hooriif ta'uu olaa keessaan irraa hagaam fagataa?
36 What is the main source of water for water for Livestock drinking during the wet season?	36 madda bishaan yeero rooba harka guddahooriif fayyadamtan kamii ?
36b Please specify other:	36b kan biraa yo jiraate ifteesi
37 Who is owns the wet season Livestock drinking water source?	37 madda bishaani kan hooriin dhuugani yeero rooba kan eenyuti
37b What is the distance of the livestock water source in the wet season from the homestead?	37b yeroo roba maddii bishaani dhugaatiif hooriif ta'uu olaa keessaan irraa hagaam fagataa?
38 On average how many cattle do people in this area have?	38 akaa jidugaleesa yo fudhaane abootiin worraa kan ardaa kanaa jiraatan loon hagaam qaban?
39 A person with a lot of cattle in this area has roughly how many?	39 dureessi naannoo kana loon hagaamfaa/meeqa qabani
40 How many adult cattle (not calves) do you currently have?	40 loon kan yabii hin tahiin ammat hagam qabdan
41 How many calves less than one year do you have?	41 jabbiin ganna tokko gaadi ta'uu hagam qabdani?
42 How has your cattle herd changed in the past 5 years	42 ganna shan dabaree keesa yaasuumii loon keeti akkamiti/hagaam jijjiramee
43 What are the reasons for the observed changes in cattle herd sizes	43 sabaabii jijjirama yaasuuma looni irraatti argamsisee maalii
43b.Please specify other:	43b kan biraa yo jiraate ifteesi
44 What is the most important reason you keep cattle?	44 fayyidan gudaan loon horsiistuuf maali?
44b Please specify other:	44b kan biraa yo jiraate ifteesi
45 Where do the cattle graze during the dry season?	45 yeroo bona keessa loon kee eessa dheedani?

45b Please specify other:	45b kan biraa yo jiraate ifteesi
46 Where do the cattle graze during the wet season?	46 yeroo roobaa keessa loon kee eessa dheedani?
46b. Please specify other:	46b kan biraa yo jiraate ifteesi
47 On average how many small livestock (sheep and goats) do people in this area have?	47 akaa jidugaleesa yo fudhaane abootiin worraa kan ardaa kanaa jiraatan re'eefi hoola hagaam qaban?
48 A person with a lot of small livestock (sheep and goats) in this area has roughly how many?	48 dureessi naannoo kana ka re'eefi hoola hagaamfaa/meeqa qabani
49 How many small livestock (sheep and goats) do you currently have	49 amma re'eefi hoola hagam qabda
50 How has your small livestock (sheep and goats) herd changed in the past 5 years	50 ganna shan dabaree keesa yaasuumii re'eefi hoola keeti akkamiti/hagaam jijjiramee
51 What are the reasons for the observed changes in small livestock (sheep and goats) flock sizes	51 sabaabii jijjirama yaasuuma re'eefi hoola irraatti argamsisee maalii
51b Please specify other:	51b kan biraa yo jiraate ifteesi
52 What is the most important reason you keep small livestock (sheep and goats)?	52 fayyidan gudaan re'eefi hoola horsiistuuf maali?
52b. Please specify other:	52b. kan biraa yo jiraate ifteesi
53 Where do the small livestock (sheep and goats) graze during the dry season ?	53. yeroo bona keessa re'eefi hoolan eessa dheedan ?
53b Please specify other:	53b kan biraa yo jiraate ifteesi
54 Where do the small livestock (sheep and goats) graze during the wet season ?	54. yeroo rooba keesa re'eefi hoolan eessa dheedan ?
64 How many camels do you currently have ?	64 yeroo amma Gaala hagam qabda
65 How has your camel herd changed in the past 5 years	65 ganna shan dabaree keesa yaasuumii gaala keeti akkamiti/hagaam jijjiramee
66 What are the reasons for the observed changes in camel herd sizes	66 sabaabii jijjirama yaasuuma gaala irraatti argamsisee maalii
66b Please specify other:	66b kan biraa yo jiraate ifteesi
67 What is the most important reason you keep camels?	67 fayyidan gudaan gaala horsiistuuf maali?

67b Please specify other:	67b kan biraa yo jiraate ifteesi
68 Where do the camels graze during the dry season?	68 yeroo bona keesa gaala eessa dheedan?
69 Please specify other:	69 kan biraa yo jiraate ifteesi
70 Where do the camels graze during the wet season?	70 yeroo rooba keessa gaala eessa dheedan?
70b Please specify other:	70b kan biraa yo jiraate ifteesi
71 Do you move your cattle to other places when there is drought in your area?	71 yeero oola keessa loon kee bakka biraatti kan godaanssifatu ni jira
72 Who decides when to move cattle	72 eenyuutii murtii godaana kennaa?
73 Which months you move away cattle?	73 ji'iootaa kam keessa loon godaanssifataan
74 Which months you move back cattle?	74 ji'ootaa kam keessa loon worraat deebi'an
75 What percentage of the cattle herd moves	75. loon keessaa harkaa hagamituu godaana?
76 Which classes of cattle move?	76 loon akkamituu godaana?
77 How far away from home do you usually move the cattle?	77 loon, olaa irra fageenya hagami itiin godaananii
78 What criteria do you use to decide to move cattle to a different grazing area?	78 bakaa dheeda birraati godaansisuufi ulaagaalee maali kan itiin fayadamuu barbaachisuu
79 which criteria is the most important	79 ulaagaa kami kan caala fayyadduu
80 reason why that criteria is most important when moving cattle	80 yeroo loon godaanssisan ulaagaan kun maaliif chuf cala barbaachisaa.
81 Do you move your small stock (sheep and goats) to other places when there is drought in your area?	81 yeroo oola keessa re'eefi hoola kee bakka biraati kan godaanssifatu ni jira?
82 Who decides when to move smallstock?	82 eenyuutii murtii godaana re'eefi hoola kennaa?
83 Which months you move away smalstock?	83 ji'ootaa kam keessa re,ee godaanssifataan
84 Which months you move back smallstock?	84 ji'ootaa kam keessa re'ee worraat deebi'an?
85 What proportion of the smallstock (sheep and goats) flock moves ?	85 harka hagam kan re'eefi hoola keesaa godaanuu?

86 Which classes of smallstock move?	86 ramaddii kam kan re'eefi hoola keesa godaanuu
87 How far away from home do you move the small stock (sheep and goats)?	87 re'eefi hoola worraa irra fageenya hagami itiin godaantanii?
88 What criteria do you use to decide to move small stock to a different grazing area?	88 reefi hoola bakaa dheedha biraat godansisuufi ulaaga maali kan itiin fayyadamuu isin barbaachisu
89 which criteria is the most important?	89 ulaagaa kami kan caala fayyaddaa qabu?
90 Do you move your camels to other places when there is drought in your area?	90 yeero oola keesat Gaala kanke bak biraati kan godaansifaatu ni qabda
91 Who decides when to move camels	91 eenyuutii murtii kana Gaala godaansisuuf kena
92 Which months you move away camels?	92 jiiootaa kami keesati Gaala godaamsifataan
93 Which months you move back camels?	93 jiiootaa kami keessaati Gaala woorraati galchitaani
94 What proportion of the camels flock moves ?	94 harkaa hagamituu gaala keesaa godaana?
95 Which classes of camels move?	95 gaala akkamituu yaasuuma keessa godaana?
96 How far away from home do you move the camels?	96 gaalli ollaa irra fageenya hagami itiin godaananii
97 What criteria do you use to decide to move camel sto a different grazing area?	97 bakaa dheeda birraati godaansisuufi ulaagaalee maali kan itiin fayadamuu barbaachisaa
98 which criteria is the most important	98 ulaagaalee kamituu cuuf caala barbaachisaa?
99 reason why that criteria is most important when moving camel	99 yeroo gaala godaansisani ulaagaalee kun maaliif chuf chaala ta'e.
100 What land policies are you aware of?	100imammata wa'e lafaatiin wolqabatu kan hubannoo qabadani ni jirra
100b Please specify other:	100b kan biraa yo jiraate ifteesi
101 Do you currently own land privately ?	101 amma Laffa akka dhumfaati horatee qabda ?
102 Do you have title deeds for this land?	102 lafaa kanke ragaa abummaa iti qabdan ?
103 What is your desired land size?	103 aka feedhii keetitii laffaa baayinaa hagaami gau horachuu feeta?
104 Give reason for your answer	104 sababa fedhii baayinaa hagasii isan barbachisee maali
105 How secure do you feel about land ownership/access to land?	105 mirga egamaa/heyyama kan akka lafaa ittiin horatu / fayyadu dandeessisu ni qabdaa?

106 Give reason for you answer	105 deebi kan keef sababa keni
107 Do you own land communally?	107 lafaa akka gummitti horatee jirta?
108 Does the commnunity have a certificate for this communally owned land?	108 lafa akka gummiittii hoorattan kana ragaa abummaa ittii qabdani?
109 How secure do you feel secure about the communal land ownership?	109 Akkaa gummitti lafaa hooratan kana mirgaa egamaa/heyyama ittii qabdu?
110 Do you do any cropping?	110 Midhaan ni obraatu?
111 What is is the area size cultivated?	111 heectaaran obruun kanakee hagaami?
112 For how many years have you been doing cropping?	112 ganaa hagamii obruu facaafate?
113 From the cropping, do you get enough for home consumption?	113 obruu facaafatee irraa midhaan gahaa ni argaata?
114 What ecosystem services do you get from the rangeland?	114 fayyidaan lafaa dheedumsaa irraa argataan maaliffaa?
114b Please specify other:	114b kan biraa yo jiraate ifteesi
115 Please insert how many ecosystem services you selected:	115 mee fayyida lafaa irraa argaatan himii?
116 Ecosystem services	116 tajaajila sirnako
117 Kindly select ecosystem service number ${ecosystemservices_pos}	117 lakoobsa tagaajila sirnakkoo filadhuu
117b Please specify other:	117b kan biraa yo jiraate ifteesi
118 How do you think this service will change in " ${ecosystem_num2} " WITHOUT certification	118 ragaa abbuma lafa jiraachu dhabuun issa fayyida lakobsa lamaffa irrat jijiiram maali ummu danda'aa jetee yaadda
118b Why do you think so?	118b maalif akkas ta'aa jetee?
119 How do you think this service will change in " ${ecosystem_num2} " WITH certification	119 yoos yo ragaan abbuma lafa jiraate fayyida lakobsa lamaffa irrat jijiiram maali ummu danda'aa jetee yaadda
120 Why do you think so?	120 maalif akkas ta'aa jetee?
121 How do you think the rangeland condition wiil change if we continue WITHOUT certification in the future?	121 yeroo ragaan abumma lafaatu **hin jirre** lafti dheedumsaa bif akkamiit jijiiraamti jetee yaada fuul duraat?

122 Why do you think so?	122 maalif akkas ta'aa jetee?
123 How do you think the rangeland condition wiil change if we continue WITH certification in the future?	123 yeroo ragaan abumma lafaatu **jiraate** lafti dheedumsaa bif akkamiit jijiiraamti jetee yaada fuul duraat?
124 Why do you think so?	124 maalif akkas ta'aa jetee?
125 How do you think the soil health wiil change if we continue WITHOUT certification in the future?	125 yeroo ragaa abumma lafaa **hin jirre** haala gabbinna biyyee jijjiramaa isaa akkamitti ilaltaa akka fuul duraat?
126 Why do you think so ?	126 maalif akkas ta'aa jetee ?
127 How do you think the soil health wiil change if we continue WITH certification in the future?	127 yeroo ragaa abumma lafaa **jiraate** haala gabbinna biyyee jijjiramaa isaa akkamitti ilaltaa akka fuul duraat?
128 Why do you think so ?	128 maalif akkas ta'aa jetee ?
129 How do you think the cattle herds sizes wiil change if we continue WITHOUT certification in the future	129 yeroo ragaa abumma lafaa **hin jiirre** yaasummii loon keeti jijjiramaa isaa akkamitti ilaltaa akka fuul duraat?
130 Why do you think so ?	130 maalif akkas ta'aa jetee ?
131 How do you think the cattle herds sizes wiil change if we continue WITH certification in the future	131 yeroo ragaa abumma lafaa **jiraate** yaasummii loon keeti jijjiramaa isaa akkamitti ilaltaa akka fuul duraat?
132 Why do you think so ?	132 maalif akkas ta'aa jetee ?
133 How do you think the small stock (sheep and goats)wiil change if we continue WITHOUT certification in the future	133 yeroo ragaa abumma lafaa **hin jiirre** yaasummii reefi hoola keeti jijjiramaa isaa akkamitti ilaltaa akka fuul duraat?
134 Why do you think so ?	134 maalif akkas ta'aa jetee ?
135 How do you think the small stock (sheep and goats)wiil change if we continue WITHcertification in the future	155 yeroo ragaa abumma lafaa **jiraate** yaasummii reefi hoola keeti jijjiramaa isaa akkamitti ilaltaa akka fuul duraat?
136 Why do you think so ?	136 maalif akkas ta'aa jetee ?
137 How do you think the camel herds sizes wiil change if we continue WITHOUT certification in the future	137 yeroo ragaa abumma lafaa **hin jiirre** yaasummii gaala keeti jijjiramaa isaa akkamitti ilaltaa akka fuul duraat?
138 Why do you think so ?	138 maalif akkas ta'aa jetee ?
139 How do you think the camel herds sizes wiil change if we continue WITH certification in the future?	139 yeroo ragaa abumma lafaa **jiraate** yaasummii gaala keeti jijjiramaa isaa akkamitti ilaltaa akka fuul duraat?
140 Why do you think so?	140 maalif akkas ta'aa jetee ?

141 How do you think access to water for livestock will change if we continue WITHOUT certification in the future	141 yeroo ragaa abumma lafaa **hin jiirre** argataan bishaan dhugaati horii jijjiramaa isaa akkamitti ilaltaa akka ful duraat?
142 Why do you think so ?	142 maalif akkas ta'aa jetee ?
143 How do you think access to water for livestock will change if we continue WITH certification in the future	143 yeroo ragaa abumma lafaa **jiraate** argataan bishaan dhugaati horii jijjiramaa isaa akkamitti ilaltaa akka ful duraat?
144 Why do you think so ?	144 maalif akkas ta'aa jetee ?
145 How do you think livestock diseases prevalance will change if we continue WITHOUT certification in the future	145 yeroo ragaa abumma lafaa **hin jiirre** laf kees gudaachaan dhukuub hoorii jijjiramaa isaa akkamitti ilaltaa akka ful duraat?
146 Why do you think so ?	146 maalif akkas ta'aa jetee ?
147 How do you think livestock diseases prevalance will change if we continue WITH certification in the future	147 yeroo ragaa abumma lafaa **jiraate** laf kees gudaachaan dhukuub hoorii jijjiramaa isaa akkamitti ilaltaa akka ful duraat?
148 Why do you think so?	148 maalif akkas ta'aa jetee ?
149 How do you think strength of traditional institutions will change if we continue WITHOUT certification in the future	149 yeroo ragaa abumma lafaa **hin jiirre** cimiini dhaaataa adaa biyya naano jijjiramaa isaa akkamitti ilaltaa akka ful duraat?
150 Why do you think so ?	150 maalif akkas ta'aa jetee ?
151 How do you think strength of traditional institutions will change if we continue WITH certification in the future	151 yeroo ragaa abumma lafaa **jiraate** cimiini dhaaataa adaa biyya naano jijjiramaa isaa akkamitti ilaltaa akka ful duraat?
152 Why do you think so ?	152 maalif akkas ta'aa jetee ?
153 How do you think livestock mortality wiil change if we continue WITHOUT certification in the future	153 yeroo ragaa abumma lafaa **hin jirre** duaati horiin dhukubaan duan jijjiramaa isaa akkamitti ilaltaa akka ful duraat?
154 Why do you think so?	154 maalif akkas ta'aa jetee ?
155 How do you think livestock mortality wiil change if we continue WITH certification in the future	155 yeroo ragaa abumma lafaa **jiraate** duaati horiin dhukubaan duan jijjiramaa isaa akkamitti ilaltaa akka ful duraat?
156 Why do you think so?	156 maalif akkas ta'aa jetee ?
157 How do you think food security will change if we continue WITHOUT certification in the future ?	157 yeroo ragaa abumma lafaa **hin jirre** haala waabi nyaata jijjiramaa isaa akkamitti ilaltaa akka ful duraat?
158 Why do you think so ?	158 maalif akkas ta'aa jetee ?
159 How do you think food security will change if we continue WITH certification in the future ?	159 yeroo ragaa abumma lafaa **jiraate** haala waabi nyaata jijjiramaa isaa akkamitti ilaltaa akka ful duraat?

160 Why do you think so ?	160 maalif akkas ta'aa jetee ?
161 How do you think land tenure security will change if we continue WITHOUT certification in the future ?	201 yeroo ragaa abumma **hin jirre** lafa horaachuuf itti fayyadamuun isii sodaa womaatu qabdi akka ful duraat?
162 Why do you think so ?	162 maalif akkas ta'aa jetee ?
163 How do you think land tenure security will change if we continue WITH certification in the future ?	163 yeroo ragaa abumma **jiraate** lafa horaachuuf itti fayyadamuun isii sodaa womaatu qabdi akka ful duraat?
164 Why do you think so ?	164 maalif akkas ta'aa jetee ?
165 How do you think rangeland management will change if we continue WITHOUT certification in the future ?	165 yeroo ragaa abumma **hin jirre** too'anoon lafa dheedumsa jijiiramii isaa akkamit ilaalta akkaa fuul duraat?
166 Why do you think so ?	166 maalif akkas ta'aa jetee ?
167 How do you think rangeland management will change if we continue WITH certification in the future ?	167 yeroo ragaa abumma **jiraate** too'anoon lafa dheedumsa jijiiramii isaa akkamit ilaalta akkaa fuul duraat?
168 Why do you think so ?	168 maalif akkas ta'aa jetee ?
169 How do you think growing of fodder crops will change if we continue WITHOUT certification in the future?	169 yeroo ragaa abumma lafa **hin jirre** hujiin fachaafachaa marra hoorii faat**i** jijiiramii isaa akkamit ilaalta akkaa fuul duraat?
170 Why do you think so?	170 maalif akkas ta'aa jetee ?
171 How do you think growing of fodder crops will change if we continue WITH certification in the future?	171 yeroo ragaa abumma lafa **jiraate** hujiin fachaafachaa marra hoorii faat**i** jijiiramii isaa akkamit ilaalta akkaa fuul duraat?
172 Why do you think so?	172 maalif akkas ta'aa jetee ?
173 How do you think size of cultivated land will change if we continue WITHOUT certification in the future? ?	173 yeroo ragaa abumma lafa **hin jirre** lafti baayyinaan qonnaf argamuu isi akkamit ilaalta akkaa fuul duraat?
174 Why do you think so?	174 maalif akkas ta'aa jetee ?
175 How do you think size of cultivated land will change if we continue WITH certification in the future? ?	175 yeroo ragaa abumma lafa **jiraate** lafti baayyinaan qonnaf argamuu isi akkamit ilaalta akkaa fuul duraat?
176 Why do you think so?	176 maalif akkas ta'aa jetee ?
177 How do you think role and participation of women in land/livestock related matters, will change if we continue WITHOUT certification in the future? ?	178 yeroo ragaa abumma lafa **hin jirre** hirmaanafi gahe dubartoota maal fakkata akka ful durat?
178 Why do you think so?	178

179 How do you think role and participation of women in land/livestock related matterswill change if we continue WITH certification in the future? ?	179 yeroo ragaa abumma lafa **hin jirre** hirmaanafi gahe dubartoota maal fakkata akka ful durat?
180 Why do you think so?	180 maalif akkas ta'aa jetee ?
181 How do you get information on Land rights?	181 oddeeffannoo mirgaa abbummaa lafa akkamiin argatta?
181b Please specify other:	191b kan biraa yo jiraate ifteesi
182 How do you get information on Weather forecasts?	182 oddeeffannoo haala qilleenssa akamiin argattan?
182b Please specify other:	182b kan biraa yo jiraate ifteesi
183 How do you get information on New policies?	183 imaammatti haaran ba'uu oduu akkamin argatani?
183b Please specify other:	183b kan biraa yo jiraate ifteesi
184 How do you get information on Rangeland management?	184 akamiin argatani oduu to'annoo lafa dheedumsa?
184b Please specify other:	184b kan biraa yo jiraate ifteesi
185 How do you get information on Livestock diseases?	185 oduu dhukuuboota horii akamiin argatani
185b Please specify other:	185b kan biraa yo jiraate ifteesi
186 How do you get information on Livestock markets?	186 oduu gabaa horii akamiin argatani
186b Please specify other:	186b kan biraa yo jiraate ifteesi
187 What changes have you observed in the dry season grazing area over the last five years?	187 gana shaani kan dabare, jijirama maal argite haala lafa dheedumsaa irra yeroo bonaa keesa.
187b Please specify other:	187b kan biraa yo jiraate ifteesi

188 What changes have you observed in the wet season grazing area over the last five years?	188 gana shaani kan dabare, jijirama maal argite haala lafa dheedumsaa irra yeroo roobaa keesa.
188b Please specify other:	188b kan biraa yo jiraate ifteesi
189 What changes have you observed in the private land a over the last five years?	189 gana shaani kan dabare keesati jijirama maal argitee haala lafa dheedumsa kan dhumfa irra.
189b Please specify other:	189b kan biraa yo jiraate ifteesi
190 What changes have you observed about the amount of grazing around water points over the last five years?	190 jijirama maal argite jirta gana shaani kan dabare keesat haala lafa dhedumsaa iddoo lafa madda bishaanii argamu.
190b Please specify other:	190b kan biraa yo jiraate ifteesi
191 What is the most restricting resource for your livestock production	191 horiisisaa beyylada irra waanti akamalee isaan rakisee maali?
192 Have you ever heard/experienced any land or grazing conflicts?	192 takka dhageete yokiin sirrat dhaqabee waldhabiin waeee lafa dheedumsa irra kae.
193 Give details about the conflict	193 bal'inan waldhaba irra diideesi
194 How often do the conflicts arise in a year?	194 gana keessati waldhaba yeroo hagam jirachu danda'aa?
195 What are the trends about conflicts over the years?	195 gana gudda ture keesa bifi waldhabaa maal fakacha dhu'fe.
196What are the planned changes to your livelihood options if there is no certification?	196 odoo qabiyyi lafa jiraachu baate karori kanke ka mal jireenya maal ta'uu dandaa
197 What are the planned changes to your livelihood options if there is certification?	197 yo ragaan lafaa **jiraate** maali jijirama karrora yaadataan kan jireenya bulti keetii?
198 What is your most preferred land certification level?	198 aka feedhii keeti ragaa lafaa sadarka kami caalisisee aka kenamu feeta.
198b What is your reason for this choice of certification level?	198b sababii si filachise aka ragaan lafaa sadarka kanat kennamu maali .
199 Do you see yourself still able to use the same RESIDENTIAL land in the next 4 Gardas?	199 yo ilaaltu lafa jireenya keesa jirtanu kana, ganna gada 4 iti yaanu keesa itiin fayadamuu ni dandeessisa jechisissu
200 Give your reasons for your decision about use of RESIDENTAL in the next 4 Gardas?	200 kenadhii sababa lafa jireenya ke gana gada 4 iti yaanu keesa itiin fayadamuu ni dandeessisa jechisissu
201 Do you see yourself still able to use the same CROPPPING LAND in the next 4 Gardas?	201 yo ilaaltu lafa qoona kan keesa jirtan gana gada 4 itiyaanu keesa iti fayadamu ni dandeessa.

202 Give your reasons for your decision about use of CROPPING LAND in the next 4 Gardas?	202 kenadhii sababa lafa qoonna ke gana gada 4 iti yaanu keesa itiin fayadamuu ni dandeessisa kan jechisissu
203 Do you see yourself still able to use the same GRAZING LAND in the next 4 Gardas?	203 yo ilaaltu lafa dheedumsa kan, gana gada 4 itiyaanu keesa iti fayadamu ni dandeessa?
204 Give your reasons for your decision about use of GRAIZNG LAND in the next 4 Gardas?	204 kenadhii sababa lafa dheedumsa kan gana gada 4 iti yaanu keesa itiin fayadamuu ni dandeessisa kan jechisissu

Appendix 3 METRICS.DEC

```
6       // Number of human adult equivalent categories
0.52      //  < 5 years - Adult equivalents
0.85      // 6 - 12 years - Adult equivalents
0.96      // 13 - 17 years, males - Adult equivalents
0.96      // 13 - 17 years, females - Adult equivalents
1.00      // > 17 years, males - Adult equivalents
0.86      // > 17 years, females - Adult equivalents
6       // Number of food types with calories
830       // Milk calorie count (kcal/kg)
1720      // Meat calorie count (kcal/kg)
500      // Maize calorie count (kcal/kg)
3360      // Bean calorie count (kcal/kg)            // NOTE CHANGE
3700      // Other calorie count (kcal/kg)           // NOTE CHANGE, TEFF
3950      // Sugar and other rich foods (kcal/kg)
6       // Number of calories (kilo-calories) required by human age/sex class.
1720      // 2 - 6 years - Adult equivalents 1052      //  < 2 years - Adult equivalents
1720      // 7 - 12 years - Adult equivalents
1943      // 13 - 17 years, males - Adult equivalents
1943      // 13 - 17 years, females - Adult equivalents
2024      // > 17 years, males - Adult equivalents
1943      // > 17 years, females - Adult equivalents
 20,  20,  20,  20,  20,  20,  20,  20,  20,  20,  20,  20     //    Milk price sell Birr/kg by month   (unknown; totals only in Non-stock_income.xlsx ... UPDATE.  prices by farmers as of Nov 2018 in Dirre)
 20,  20,  20,  20,  20,  20,  20,  20,  20,  20,  20,  20            //    Milk price buy  Birr/kg by month   (not used presently, they don't buy milk, nor used in energy calculations)
```

100, 100, 100, 100, 100, 100, 100, 100, 100, 100, 100, 100 // coffee/sugar cost Birr/kg by month (this is price for sugar and coffee sourced locally)

5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5 // Maize price sell Birr/kg by month (SET. . Distributed as in Kajiado)

5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5 // MAize price buy Birr/kg by month (Set proportionally higher than sell price, mirroring Kaj-DEC difference; total only in Recurrent_expenditures_2010.xlsx)

10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10 // Beans price sell Birr/kg by month (SET. Units are 50 kg bags, although some vary. Selling price averages 59 Ksh/kg in 2018. Distributed as in Kaj-DEC)

10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10 // Beans price buy Birr/kg by month (Set proportionally higher than sell price, mirroring Kaj-DEC difference; total only in Recurrent_expenditures_2010.xlsx)

10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10 // Other price sell Birr/kg by month (analyses this is the price for Teff 2018, GAK Teff was 2004 300 Birr/100kg

10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10 // Other price buy Birr/kg by month (this is the price for Teff 2018)

750, 750, 750, 750, 750, 750, 750, 750, 750, 750, 750, 750, 750 // Cattle 1 sell Birr by month (Set proportionally to half the value of juv. animals, appoximately)

1500, 1500, 1500, 1500, 1500, 1500, 1500, 1500, 1500, 1500, 1500, 1500 // 2 sell Birr by month (SET using the youngest age class price for female cattle (2 years) sales in 2018)

2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500 // 3 sell Birr by month (SET using the youngest age class price for male cattle (2 years) sales in 2018)

2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500 // 4 sell Birr by month (SET using the adult age classes for female cattle sales in 2018)

3000, 3000, 3000, 3000, 3000, 3000, 3000, 3000, 3000, 3000, 3000, 3000 // 5 sell Birr by month (SET using the adult age classes for male cattle sales in 2018)

750, 750, 750, 750, 750, 750, 750, 750, 750, 750, 750, 750, 750 // Cattle 1 buy Birr by month (Set using proportions drawn from Kaj-DEC relative to sell prices)

1500, 1500, 1500, 1500, 1500, 1500, 1500, 1500, 1500, 1500, 1500, 1500 // 2 buy Birr by month (Set using proportions drawn from Kaj-DEC relative to sell prices)

2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500 // 3 buy Birr by month (Set using proportions drawn from Kaj-DEC relative to sell prices)

2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500, 2500 // 4 buy Birr by month (Set using proportions drawn from Kaj-DEC relative to sell prices)

3000, 3000, 3000, 3000, 3000, 3000, 3000, 3000, 3000, 3000, 3000, 3000 // 5 buy Birr by month (Set using proportions drawn from Kaj-DEC relative to sell prices)

250, 250, 250, 250, 250, 250, 250, 250, 250, 250, 250, 250 // Goats 1 sell Birr by month (Set proportionally to half the value of juv. animals, appoximately)

400, 400, 400, 400, 400, 400, 400, 400, 400, 400, 400, 400 // 2 sell Birr by month (SET using the youngest age class price for female cattle (2 years) sales in 2018)

400, 400, 400, 400, 400, 400, 400, 400, 400, 400, 400, 400 // 3 sell Birr by month (SET using the youngest age class price for male cattle (2 years) sales in 2018)

500, 500, 500, 500, 500, 500, 500, 500, 500, 500, 500, 500 // 4 sell Birr by month (SET using the adult age classes for female cattle sales in 2018)

600, 600, 600, 600, 600, 600, 600, 600, 600, 600, 600, 600 // 5 sell Birrh by month (SET using the adult age classes for male cattle sales in 201812)

```
 250,  250,  250,  250,  250,  250,  250,  250,  250,  250,  250,  250 //  Goats  1   buy  Birr by month  (Set using proportions drawn from Kaj-DEC relative to sell prices)
 400,  400,  400,  400,  400,  400,  400,  400,  400,  400,  400,  400 //        2   buy  Birr by month  (Set using proportions drawn from Kaj-DEC relative to sell prices)
 400,  400,  400,  400,  400,  400,  400,  400,  400,  400,  400,  400 //        3   buy  Birr by month  (Set using proportions drawn from Kaj-DEC relative to sell prices)
500,  500,  500,  500,  500,  500,  500,  500,  500,  500,  500,  500 //        4   buy  Birr by month  (Set using proportions drawn from Kaj-DEC relative to sell prices)
600,  600,  600,  600,  600,  600,  600,  600,  600,  600,  600,  600 //        5   buy  Birr by month  (Set using proportions drawn from Kaj-DEC relative to sell prices)
 250,  250,  250,  250,  250,  250,  250,  250,  250,  250,  250,  250 //  Sheep  1   sell Birr by month  (Set, proportionally to half the value of juv. animals, approx)
 400,  400,  400,  400,  400,  400,  400,  400,  400,  400,  400,  400 //        2   sell Birr by month  (SET using the youngest age class price for female cattle (2 years) sales in 2018)
 400,  400,  400,  400,  400,  400,  400,  400,  400,  400,  400,  400 //        3   sell Birr by month  (SET using the youngest age class price for male cattle (2 years) sales in 2018)
 500,  500,  500,  500,  500,  500,  500,  500,  500,  500,  500,  500 //        4   sell Birr by month  (SET using the adult age classes for female cattle sales in 2018)
 600,  600,  600,  600,  600,  600,  600,  600,  600,  600,  600,  600 //        5   sell Birr by month  (SET using the adult age classes for male cattle sales in 2018)
 250,  250,  250,  250,  250,  250,  250,  250,  250,  250,  250,  250 //  Sheep  1   buy  Birr by month  (Set using proportions drawn from Kaj-DEC relative to sell prices)
 400,  400,  400,  400,  400,  400,  400,  400,  400,  400,  400,  400 //        2   buy  Birr by month  (Set using proportions drawn from Kaj-DEC relative to sell prices)
 400,  400,  400,  400,  400,  400,  400,  400,  400,  400,  400,  400 //        3   buy  Birr by month  (Set using proportions drawn from Kaj-DEC relative to sell prices)
 500,  500,  500,  500,  500,  500,  500,  500,  500,  500,  500,  500 //        4   buy  Birr by month  (Set using proportions drawn from Kaj-DEC relative to sell prices)
 600,  600,  600,  600,  600,  600,  600,  600,  600,  600,  600,  600 //        5   buy  Birr by month  (Set using proportions drawn from Kaj-DEC relative to sell prices)
 0.0, 0.5, 0.5, 1.0              //  Max milk vs condition (CI is different here than in PHEWS.  0.5 is the "baseline" of an average animal)
17.80, 42.40, 42.40, 74.2, 95.9  //  Cattle Max kg meat by class
 3.97,  6.36,  6.36, 10.6, 12.3  //  Goat   Max kg meat by class
 3.97,  6.36,  6.36, 10.6, 12.3  //  Sheep  Max kg meat by class
 0.05                            //  Cattle Prop non-edible deaths
 0.05                            //  Goat   Prop non-edible deaths
 0.05                            //  Sheep  Prop non-edible deaths
 0.0, 0.5,   1.0, 1.0            //  Meat yld vs condition
100.0, 0.0, 250.0, 0.8           //  Mz yield vs ppt mm
100.0, 0.0, 350.0, 0.4           //  Bn yield vs ppt mm
```

100.0, 0.0, 250.0, 0.8 // Other yield vs ppt mm (NOTE CHANGE)

1000, 5500, 5500 // Trigger to sell small stock, Trigger to sell larger stock (Original values were 1200, 6000)

7.0, 4.0 // Trigger multipliers to spur smallstock and largestock livestock purchase. If cash need is much smaller than assets, buy an animal.

0.0, 0.0, 10.0, 140.0 // Cattle Density (km2) of LiveStock TLUs (three species HSIs averaged) (Must be pegged at 0 HSI units, or gradients will be truncated. The upper may be truncated, but that is okay.) Values inferred from Samburu Range Manual.

0.0, 0.0, 10.0, 40.0 // Goat Density (km2) of LiveStock TLUs (three species HSIs averaged) (Must be pegged at 0 HSI units, or gradients will be truncated. The upper may be truncated, but that is okay.) "

0.0, 0.0, 10.0, 50.0 // Sheep Density (km2) of LiveStock TLUs (three species HSIs averaged) (Must be pegged at 0 HSI units, or gradients will be truncated. The upper may be truncated, but that is okay.) "

1,1,3,3,3,1,1,3,3,3,1,1 // Distance to water maps to use, by month (1=Dry, 2=Transition, 3=Wet)

100.0 // Grazing orbit, in km

0.0,0.0,0.2, 0.7,0.7,0.2, 0.0,0.0,0.0, 0.0,0.7,0.2 // ***** Likelihood herders will return to their permanent home. ADDITIVE. Higher, more likely to go home.

20., .5, 150., 1.0 // Cattle short-term HSI density versus Suitability Index

20., .5, 150., 1.0 // Cattle long-term HSI density versus Suitability Index

1., .2, 15., 1.0 // Goat short-term HSI density versus Suitability Index

1., .2, 15., 1.0 // Goat long-term HSI density versus Suitability Index

1., .2, 15., 1.0 // Sheep short-term HSI density versus Suitability Index

1., .2, 15., 1.0 // Sheep long-term HSI density versus Suitability Index
0.0, 1.00 // Coefficient for outside the parcel, and inside the parcel

0., 1.0, 25., 1.0 // TURNED OFF Distance to permanent household (km) versus Suitability Index

0., 1.0, 25., 1.0 // TURNED OFF Distance to current camp (km) versus Suitability Index

0., 1.0, 500., 0.1 // Cattle density (TLUs per km2) versus Suitability Index, used in ALINT as animals are placed during moves.

0., 1.0, 125., 0.1 // Goat density (TLUs per km2) versus Suitability Index, used in ALINT as animals are placed during moves.

0., 1.0, 125., 0.1 // Sheep density (TLUs per km2) versus Suitability Index, used in ALINT as animals are placed during moves.

1,1,1, 1,1,1, 1,1,1, 1,1,1 // STATEV 4,4,3, 2,1,3, 3,3,4, 2,2,4 // 4,4,2, 1,1,2, 2,2,3, 1,1,3 // Integers showing which force map to use each month

0.0 // TURNED OFF Desire to stay at their current location (coefficient of correlated moving). ADDITITVE. Higher, more likely to stay put.

1 // 3 // Flag: 1 = Move camps within study area, 2 = Move household herds outside study area, 3 = Do neither, stay at the permanent residence

160.,165.,165. // 120.,155.,155. // 9999., 9999., 9999. // 160.,142.,143. // Short-term HSI that causes household herds to move out of the system, by species (If movement flag = 2)

30, 25, 25 // Standard deviation of random normal deviate assigned to short-term HSI for each household. This value adds variability to movements.

50., 35., 35. // Tendency for people to stay in their current location, that is, inside or outside the study area (If movement flag = 2)