

**Deconstructing a pastoralists’
network to evaluate climate
adaptation in the sector:
A case study of Narok, Kenya**

Small Grants Programme
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PRISE

Pathways to resilience
in semi-arid economies

Research for climate-resilient futures

Deconstructing a pastoralists' network to evaluate climate adaptation in the sector: A case study of Narok, Kenya

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Grace W. Ngaruiya

Lucy W. Muithui

This report is based on field research carried out in Narok county, Kenya, between September and November 2014, and has been produced as part of a series of preliminary papers to guide the long-term research agenda of the Pathways to Resilience in Semi-arid Economies (PRISE) project. PRISE is a five-year, multi-country research project that generates new knowledge about how economic development in semi-arid regions can be made more equitable and resilient to climate change.

Front cover image:

Cattle drive – Lukenya, Kenya

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Acronyms

AMCEN	African Ministerial Conference on the Environment
ASALs	Arid and Semi-Arid Lands
CAO	County Agricultural Office
ASDSP	Agricultural Sector Development Support Programme
CBD	Convention on Biological Diversity
CLO	County Livestock Office
CMDRR	Community Management Disaster Risk Reduction
ESG	Ecosystem Service Governance
GDP	Gross Domestic Product
ILRI	International Livestock Research Institute
IPCC	Intergovernmental Panel on Climate Change
LTA	Livestock Traders Association
KWS	Kenya Wildlife Service
NDMA	National Drought Management Authority
NPC	Narok Pastoral Centre
SNA	Social Network Analysis
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
WEF	Women Enterprise Fund
WRMA	Water Resource Management Authority

Executive summary

This study seeks to deconstruct the pastoralist network of Narok County in Kenya to clearly identify the role of each actor and document inherent challenges in relation to adaptation knowledge transmission. To accomplish this, we use the Ecosystem Service Governance (ESG) approach, which primarily uses mathematical indices based on social network theory to analyse Narok's pastoral resource governance. In particular, we chose centralisation and structural hole indices to reveal major network actors and missing links that are hindering information flows across the network. To strengthen the analytical aspect of this approach, additional secondary data such as monetary value may be included.

Social network analysis (SNA) revealed eight key actors responsible for linking most of the actors in Narok. All identified actors have introduced diverse adaptation measures across four main arenas, of livestock management, capacity-building, environmental conservation and disaster management. However, most actors are government agencies based in urban centres; they are also too few in number to efficiently cover the extensive county. Fortunately, high brokerage values indicate potential in the formation of new actor linkages in the network as opportune interventions to insulate pastoralism further against the negative impacts associated with unpredictable climatic conditions.

Accurate socioeconomic analysis of Narok's pastoral sector is hindered by lack of consistent data on livestock diversity, products and population trends across the four major districts. These constraints call for intensified efforts to build a comprehensive county database to facilitate effective management in face of advancing climate change.

In conclusion, this study confirms that the government through its agencies – the National Drought Management Authority and the Agricultural Sector Development Support Programme – is actively involved in addressing challenges facing the pastoralism sector in Kenya. However, the county disaster management strategy needs to be enhanced through strengthening policy and diversifying current prevention and recovery strategies to reduce the probability of a poverty increase among pastoralists in Kenya.

1. Background

We set out to deconstruct the pastoral network in the newly formed Narok County in order to be able to understand the actual impacts of climate variability on pastoralism and identify challenges in the transmission of adaptation knowledge across the social networks involved. This is because a system's response to change depends on its capacity to cope and adapt, which in turn depends on the diversity of the social networks that govern a particular sector or resource (Bodin and Prell, 2011).

1.1 Pastoralism in Kenya

East African pastoralists have engaged in livestock mobility for millennia as a natural resource management strategy to exploit resources in their arid and semi-arid environments (Galvin et al., 2014). Pastoralism is considered the most economically, culturally and socially appropriate strategy for maintaining the well-being of communities in dryland landscapes because it is the only activity that can simultaneously provide secure livelihoods, conserve ecosystem services and promote wildlife conservation (ILRI, 2006; Neely et al., 2009).

In Kenya, livestock production contributes an estimated over 12% of gross domestic product (GDP) and about 47% of agricultural GDP (Silvestri et al., 2012). The livestock sector in the drylands accounts for 90% of employment and more than 95% of family incomes and livelihood security (Davies, 2007). Of concern is that slightly over 50% of these livestock (worth about \$6 billion) are found in arid and semi-arid lands (ASALs) that are now experiencing frequent and intensified drought periods as a result of unpredictable climatic conditions (Galvin et al., 2014).

Furthermore, climate-driven epidemics, cattle raids, degraded pastures and loss of transit paths, owing to irregular land subdivision and infrastructure development, have affected the sector (Niamir-Fuller, 1999; Schilling et al., 2012; El Vilaly et al., 2013).

In addition, pastoral systems support a wide range of services and products, especially in the tourism sector; any decline in pastoralism will have far-reaching impacts in terms of the wider economic ecosystem (Cheung, 2012).

1.2 Vulnerability of pastoralism to climate change

Climate change is arguably the greatest emerging threat to global biodiversity and functioning of local ecosystems (IPCC, 2014), and this is no less the case for the pastoralism sector in the sub-Saharan (Davies, 2007; Elmi and Birch, 2013). Observational records show that a 0.7°C warming over most of the African continent has occurred at a rate of about 0.05°C per decade, with a slightly larger warming in the June–November season than in December–May (Hulme et al., 2001). With regard to changes in precipitation, an average 25% decrease in rainfall has occurred over the African Sahel during the past 30 years. This change has been characterised by a decrease in the number of rainfall events (UNFCCC, 2007).

Of particular concern is the issue of drought, defined in general terms as a 50% shortfall in rainfall over three months (Lim et al., 2005). Droughts have affected the Sahel, the Horn of Africa and Southern Africa in particular since the end of the 1960s. Estimates suggest that a third of African people live in

drought-prone areas and around 220 million people are annually exposed to drought (UNFCCC, 2007).

Kenya has since the early 1960s seen increasing temperature trends that depict a general warming with time in inland areas (Government of Kenya, 2010). Impacts of such variable and harsh climatic conditions are projected to affect livestock production through change in quantity and quality of fodder, heat stress, livestock diseases, water availability and loss of indigenous genetic biodiversity (World Bank, 2013; IPCC, 2014). For example, Rift Valley fever afflicts people and livestock and is closely related to heavy rainfall events, which are predicted to increase with climate change (UNFCCC, 2007). Such negative impacts lower livestock productivity, significantly upset economic growth and worsen local food insecurity. Furthermore, cumulative impacts from climate change on the socioeconomic status of pastoralists open up various avenues for the subsequent irregular immigration by other communities that are perceived to disrupt local norms. This clash in cultures and livelihood practices is seen as a main source of resource conflicts among resource-dependent rural communities with low adaptive capacity (AMCEN, 2011).

Increased climate variability also has an indirect impact on pastoralism through increased human–wildlife conflicts. Otiang'a-Owiti et al. (2011) note that climate change will alter geographical environments and, as a natural adaptation mechanism, wildlife will be forced to migrate to new areas; however, diminishing natural areas will bring wildlife to human

settlements, leading to conflict. Moreover, prolonged drought greatly affects the quality of wildlife habitats, forcing wildlife, in the absence of well-managed protected areas, to retreat to farmlands to access water and fodder (Ladan, 2014). Since incidence of conflicts varies with the season, pastoralists must be able to access specific strategies to mitigate conflicts and regulate their interactions with wildlife (Government of Kenya, 2013).

1.3 Adaptation interventions

Adaptation measures involve making adjustments in social and environmental processes in response to or anticipation of climate change, to reduce potential damages or to take advantage of new opportunities (Adger et al., 2007). These also include *coping mechanisms*, defined as temporary reactive responses that aim to restore a system to a previous state. Coping is a more reactive action, whereas adaptation implies preparing and planning for climate change.

In Kenya, the adaptation strategy was developed by means of the National Climate Change Response Strategy in 2010 and further formulated into the five-year (2013–2017) National Climate Change Action Plan in 2013 under the Ministry of Environment (Government of Kenya, 2010). The Kenyan Climate change Secretariat recognises the domino effect of climate change on livestock keepers: ‘impacts will potentially result *inter alia* in community conflicts, loss of lives and livelihoods as well as migration’

(Government of Kenya, 2010: 51). Proposed measures include adaptable livestock breeds, insurance schemes, capacity-building of communities, fodder storage, inventories of indigenous knowledge, economic diversification, water provision and stocking rate balancing. These measures correspond with those in Silvestri et al. (2012), which entail improving pastoralists’ capacities to cope with degradation and drought and promoting sustainable and integrated management of croplands, rangelands and water.

Literature documents diverse adaptation measures, some of which are geared towards the pastoralism sector (Lim et al., 2005; Adger et al., 2007; Silvestri et al., 2012). Hence, we propose pastoralism adaptation strategies that entail measures categorised into four main pillars that holistically address adverse climatic-driven impacts on the sector (Table 1). *Technological* interventions focus on improving livestock and fodder/forage quality to sustain sector productivity. *Behavioural* aspects in adaptation entail changing pastoralists’ attitudes towards embracing modern pastoral concepts and techniques. *Managerial* strategies strive to integrate sustainability objectives into the sector, and *policy* seeks to develop ideas and proposals into implementable rules and regulations to guide stakeholder actions for enhanced sector productivity.

Given perceived high levels of vulnerability in developing countries, much-publicised adaptation programmes have been implemented, with large amounts of

global funds invested in adaptation measures (Madzwamuse, 2010; Brooks et al., 2011). However, there has been no satisfactory explanation of the slow adoption of adaptation activities among people in the southern sub-Saharan (SSA) (Madzwamuse, 2010). In Kenya, drought episodes continue to devastate the pastoralism sector even in the face of multiple and diverse collaborative activities by stakeholders (Government of Kenya, 2013). However, it can also be argued that climate change is a long-term phenomenon, so it is not feasible for researchers to effectively monitor impacts of adaptation programmes and for the funding to have addressed the negative climatic impacts over a short timeframe.

Nevertheless, inclusivity with regard to climate governance remains a major challenge for rural actors in Africa (Agrawal, 2010). Pastoral communities are known to hold valuable indigenous knowledge that supports their key livelihood activity (Elmi and Birch, 2013). Not incorporating them in governance thus results in poor adaptation; this is also precipitated by poor coordination and by sectoral divisions among adaptation actors, which lower programme efficiency at the grassroots (Madzwamuse, 2010). To overcome these challenges, good resource governance practice advocates for a strong participatory element: the needs and perspectives of different actors regarding a specific issue must be integrated (Greiber and Schiele, 2011).

Table 1: Suggested adaptation measures for efficient livestock management

Adaptation pillar	Target	Suggested activities
Technological	Livestock breed and fodder	<ul style="list-style-type: none"> • Reintroduction of ASAL indigenous livestock breeds • Hybrid animals resistant to certain parasites and diseases • Improvement of climate models
Behavioural	Pastoralist attitude	<ul style="list-style-type: none"> • Sale of healthy livestock before drought periods • Diversification of livestock types and agro activities • Intensification in livestock production • Migration and mobility
Managerial	Capacity-building and enhanced productivity	<ul style="list-style-type: none"> • Regular training on new methods in pastoralism • Hay storage • Grazing programmes • Formulation of crisis management strategy • Effective early warning campaigns • Splitting herds to reduce risk • Increased participation of pastoralists in decision-making • Infrastructure development, i.e. sale yards and good roads • Enhanced market information
Policy	Sustainable sectorial practices	<ul style="list-style-type: none"> • Regular vaccination programmes • Strict animal movement regulations • Removal of subsidies • Introduction of insurance packages • Access to credit • Appropriate land tenure regulations • Efficient livestock marketing boards • Cash and asset-based assistance after drought • Strengthening resource institutions

Source: Authors' compilation

1.4 Social networks

Social structure is a pattern of relations (i.e. networks) between social units or actors (i.e. individuals, organisations or countries) (Prell, 2012). These social structures influence the actions of individuals just as the actions can influence social structures. In this study, we introduce social network analysis (SNA) as a tool to reveal how pastoralism governance unfolds in a community setting. This is because successful adaptation practices are to be seen in a system that gives greater attention to ‘the multiple actors with multiple interests, the processes through which these actors interrelate, and, especially, the institutional arrangements that structure their interactions’ (Agrawal and Gibson, 1999).

Over time, effective pastoral social relations have culminated in sets of agreements among several clans, communities and regions that have facilitated efficient livestock movements. In particular, informal institutions such as councils of elders have been instituted to regulate use of and access to resources among pastoralists (Galvin et al., 2014). However, political, social, economic and ecological transformations have made traditional pastoralism unviable in many locations (ibid.). Environmental and socio-political changes are undermining traditional coping strategies, hence creating a need for (appropriate) external interventions. Subsequent introduction of new diverse actors has enhanced traditional pastoral networks from being simple inter-clan entities at the grassroots to become regional, national or even international entities, especially with regard to research (Ngaruiya, 2014a). Among the actors involved are government agencies that seek to improve resource governance at the grassroots, humanitarian actors focused on improving the well-being of ASAL communities and

wildlife tourism stakeholders who seek to promote conservation and human–wildlife conflict resolution for mutual community benefits (ibid.).

At the same time, lack of understanding and negative perceptions of pastoral systems have resulted in unfavourable policies in the pastoralism sector (Elmi and Birch, 2013). In addition, decades of neglect by government have led to a misrepresentation of the actual profitability of the sector to the community and country (ILRI, 2006). As a result, there are stakeholders introducing diverse economic activities like fish-farming and bee-keeping, turning pastoralists into agro-pastoralists, which is gradually expanding the traditional ‘livestock-keepers’ network (Ngaruiya, 2014a).

Poverty reduction schemes initiated by the Kenyan government give monetary incentives to promote self-employment among youth and marginalised groups. In pastoral areas, individuals have formed diverse livestock-based community groups for business purposes but unfortunately, these are not involved in local livestock governance (Ngaruiya and Scheffran, 2013). Consequently, rural areas have a high density of community interest groups with little or no diversity, where everyone in the cluster knows what everyone else knows and no one knows what is going on in other clusters (Krebs and Holley, 2004).

Given the threats of climate change, interactions for the efficient exchange of information between these diverse actors are of paramount importance (Prell et al., 2010; Silvestri et al., 2012). Yet, although climate change interventions are increasing in number, there is a lack of evidence as to whether they are effective in building adaptive capacity and whether the ‘climate-vulnerable’ poor, such as pastoralists, are aware of ways to manage climate

risks that affect their development (Madzwamuse, 2010; Brooks et al., 2011). This partially explains why severe drought episodes dramatically decimate livestock numbers, especially in remote parts of Narok County. Our research contributes to addressing this by looking at dissemination gaps and opportunities using SNA.

Discovery of the role of social relationships in shaping environmental outcomes has rejuvenated studies in natural resource management (Bodin and Prell, 2011). SNA is guided by formal theory organised in mathematical terms and grounded in the systematic analysis of empirical data (ibid.). These relational data consist of at least one structural variable measured for a set of actors (Hennig et al., 2012). We selected two indices – centralisation and structural holes – to quantify patterns of interactions and indicate levels of synergy among rural community actors.

Centralisation values reveal the most prominent actor assumed to be a major channel for information, since they are connected to many others (Prell et al., 2010). By contrast, structural holes are potential opportunities that exist between two people or groups when either party is unaware of the value that would be available if they were to coordinate on some point in a network (Burt, 2000). These ‘holes’ occur whenever an actor 1) has a relationship with someone who is connected to a separate cluster of actors and 2) has no other direct or indirect connections with the people in that cluster (Ehrlich and Carboni, 2005). Networks with high numbers of structural holes may be deemed poor in terms of information diffusion between actors and between different sets of actors.

Application of SNA obliges resource managers to understand how actors are connected to each other, how they influence each

other's behaviour and how their interactions influence the overall network structure (Hennig et al., 2012). In relation to pastoralism, understanding the flow of information and identifying the missing links enables effective introduction of adaptive knowledge as well as prompt resolution of conflicts within the network.

1.5 Research objectives and questions

Our study covers two thematic areas – namely, climate change impacts and adaptation – and actor linkages in the pastoralism network.

In particular, our main objective is to analyse how adaptation and coping strategies are disseminated across the pastoralist network of Narok. Consequently, our research questions are:

1. Who are the major actors in the network?
2. What are the implemented adaptation and coping measures?
3. How does the network structure facilitate or hinder information flow?

4. Are there potential entry points for actors to enhance adaptation performance?

In answering these questions, we first assist with the documentation of conventional and indigenous adaptation measures, thus increasing the regional and national database for scaling up implemented adaptation measures in the sector. Second, visualisation of the pastoralism network will aid in the identification of challenges in relation to adaptation knowledge transmission in the community.

2. Narok county context

This study focuses on Narok county, an area commonly referred to as the bread basket of the country, given its relatively high production of wheat and barley. The county lies between latitudes 0° 50' and 1° 50' South and longitudes 35° 28' and 36° 25' East and is located on the south-western side of the country along the border of Kenya and Tanzania (Figure 1). Narok is about 17, 933.1 km², representing approximately 3.1% of the total area in Kenya (Government of Kenya, 2013).

2.1 Ecological and climatic setting

About two thirds of Narok county is classified as semi-arid (Government of Kenya, 2013). It consists of two main ecological zones: the highlands of Mau, rising to an altitude of 3,100 m above sea level,

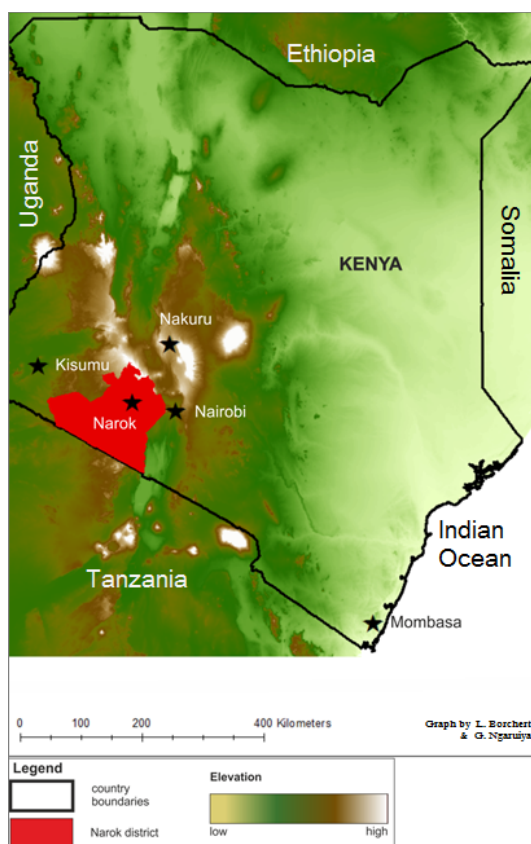
found mainly on the western side of the county; and the remaining area, comprising lowlands made up of bushlands, grasslands and shrubs. The highlands are the source of many rivers, such as the Mara, Mogor and Narok Enkare, which cut across the county. The county's altitude and physical features strongly influence its climatic conditions (Government of Kenya, 2013).

The temperature ranges from 20°C (January–March) to 10°C (June–September) with an average of 18°C. Narok experiences a bimodal rainfall pattern, whereby long rains fall between February and June and short rains between August and November. Rainfall amounts range from 2,500 mm in the wet season to about 450 mm during the dry season, with an annual average of

771 mm (Figure 2) (Government of Kenya, 2013).

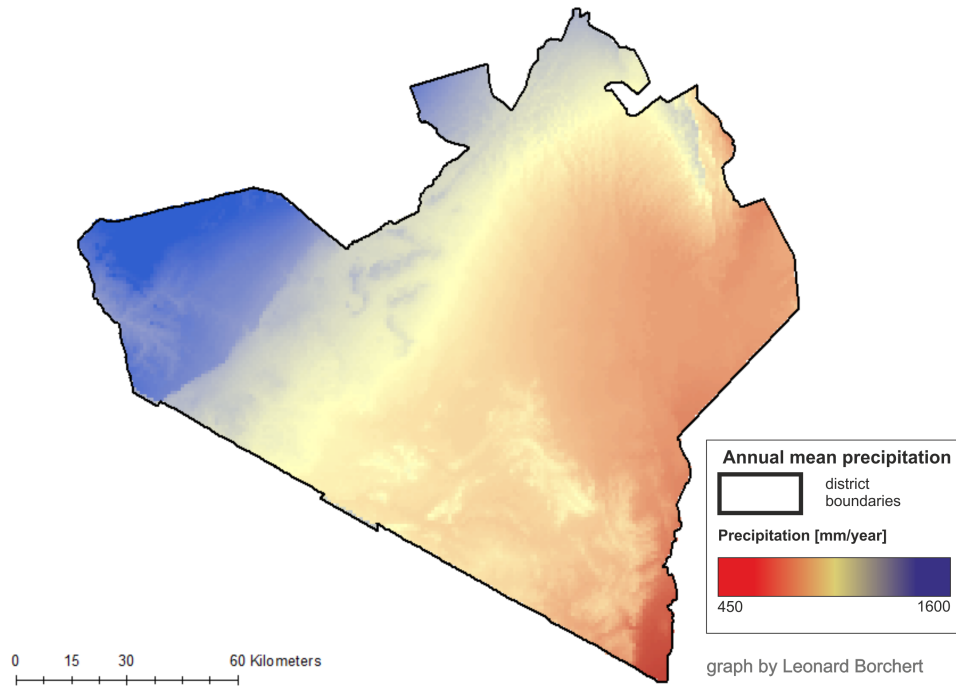
Studies on climate variability reveal that, during 1989–2003, an extreme drought occurred in 1999/00, severe droughts in 1993 and 1997, moderate droughts in 1991 and 1994, normal years in 1989/90, 1992 and 1995/96, a wet year in 2002, a very wet year in 2003 and extremely wet years in 1998 and 2001 (Government of Kenya, 2010, 2013). More specifically, the 1999/00 drought was caused by failure of the wet season rainfall in both years, whereas the 1993 drought owed to failure of the dry season rainfall in Narok (Ogutu et al., 2008). This reflects the county's high inter-annual variability in rainfall, which has implications for water resources and pasture.

Figure 1: Location of Narok County in Kenya



Source: GADM- Global Administrative Maps Database (<http://www.gadm.org/>)

Figure 2: The annual mean precipitation in Narok



Source: WorldClim (Global climate data) (<http://www.worldclim.org/>)

2.2 Socioeconomic status

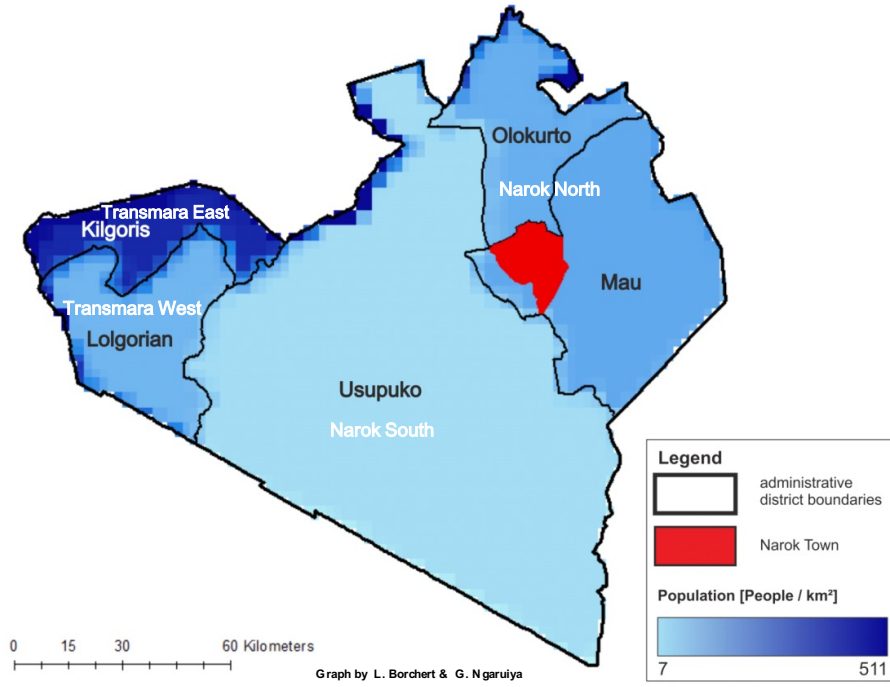
The county capital is also called Narok. The county is divided into four administrative units: Narok South (10,412.1 km²), Narok North (4,663.7 km²), Transmara West (2,583.9 km²) and Transmara East (275.4 km²). It is a cosmopolitan area, hosting diverse ethnic groups such as Maasai, Kipsigis, Kikuyu, Kisii, Luo, Luhya and Kamba. Narok has an estimated human population of 850,920, of whom 429,026 are male and 421,894 are female; the livestock population is at 1,416,886 cattle and 1,650,029 sheep (Government of Kenya, 2013). Figure 3 shows how the population is distributed across the county and also the common names of the administrative units.

The major livelihood activities in Narok and their estimated populations are mixed farming (60.8%), agro-pastoral (8.7%), pastoral (23.8%) and trade (6.7%) (Gicheru et al., 2012). The diverse soils and altitudes support a vibrant agriculture sector, whose crops include wheat, barley, maize, Irish potatoes, sugarcane and horticultural crops. It is estimated that the county has about 1,436 ground water sources, including dams, rivers, water pans and springs (Figure 4) (Government of Kenya, 2013).

In terms of tourism, Narok has several attributes that make it one of the most toured sites in Kenya. First, it hosts the Maasai Mara game reserve, renowned for the annual wildebeest migration across

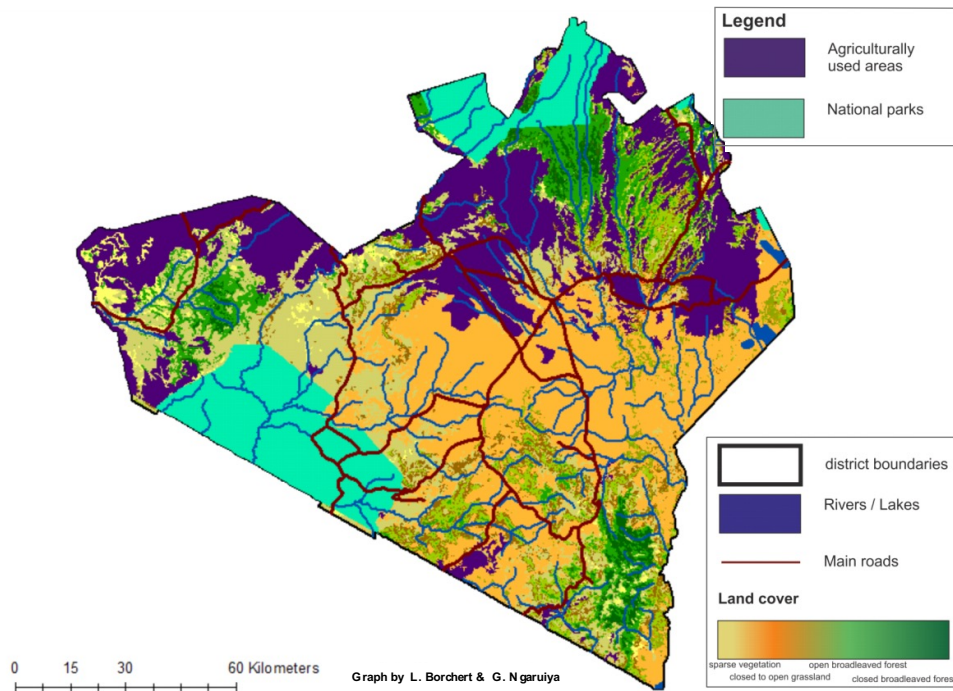
the Mara River every dry season, and in particular July. Second, the forested Mau highlands offer scenic sites for hikers. Third, the 95 species of resident wildlife enable daily game drives across the different private and government-managed protected areas (Figure 4). Of concern for this study are the increased human-wildlife conflict cases brought about by predators such as lions, leopards, cheetahs and hyenas. In particular, natural availability or provision of prey by stakeholders to wildlife predator populations may be a key measure in reducing depredation rates as pastoralists move closer or deeper into protected areas to access pasture during drought periods.

Figure 3: Population distribution in Narok



Source: GADM- Global Administrative Maps Database (<http://www.gadm.org/>) and Narok population data from the County.

Figure 4: Location of the major economic resources in Narok



Source of data: GLAC (Global Land Cover 2000 project) (<http://www.diva-gis.org/Data>)

2.3 Pastoralism and livestock management in Narok

In Narok county, most of the pastoralists are indigenous Maasai people. The common livestock kept are cattle (*Bos primigenius*), goats (*Capra aegagrus hircus*), sheep (*Ovis aries*), pigs (*Sus scrofa*), donkeys (*Equus asinus*), camels (*Camelus dromedarius*) and rabbits (*Oryctolagus cuniculus*), with beehives to supplement household income. Figure 5 shows a profile of the approximately 4,155,000 head of livestock found in Narok county (Government of Kenya, 2013).

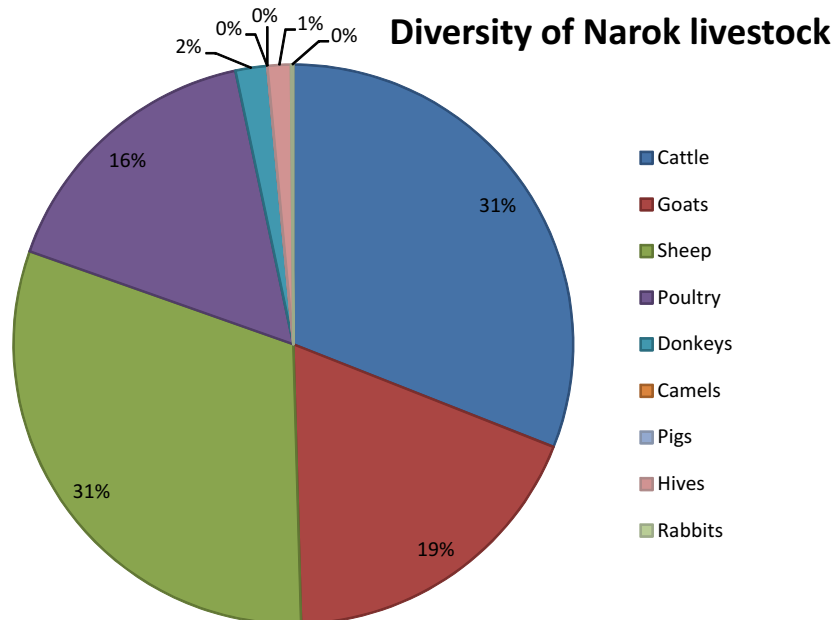
A rapid increase in the human population of Narok from the 1960s onwards is attributed to immigration from the surrounding highlands through legal acquisition of land created by means of the subdivision of Maasai land (Gicheru

et al. 2012). Sindiga (1984) explains this situation clearly: 'Under the Kenyan adjudication program, lands that were previously under the colonial government were administered by the government but held in trust by the respective county councils.' From the late 1960s, these lands were later surveyed and then assigned to various registered groups of Maasai to improve pasture management by developing such facilities as water and dips for their livestock on a communal basis. This was done using the land legislation of 1968 (the Land Group Representatives and Land Adjudication Act), which enabled the conferral of land titles to groups of people where land ownership was identified with groups. However, failure of the group ranch system to deliver improved livelihoods and security of tenure to the group ranch members set in motion the subdivision of group ranches.

This subdivision has produced many private land parcels in many areas of Kenya, including Narok (Gicheru et al., 2012; Government of Kenya, 2013). Many of these communities are indigenous farmers, and subsequent expansion of crop farming reduces grazing land and access to water and increases land use conflicts (between farmers and pastoralists, and wildlife and pastoralists (Gicheru et al., 2012).

Apart from the variable climate, continuing deforestation and degradation of the Mau complex have reduced river flow across the county and neighbouring counties. In addition, livestock suffer from malignant catarrh fever, *Trypanosomiasis*, tick-borne diseases, *Helminthiasis*, Mange, foot and mouth disease, contagious bovine pneumonia and the Rift Valley fever whose prevalence rates are highly influenced by climate conditions.

Figure 5: Diversity of livestock in Narok in 2014



Source: Government of Kenya (2013)

Depredation by carnivores is also a major problem given the open nature of protected areas, which allows for movement of both livestock and wildlife in Kenya (Okello, 2005).

There has been increasing interest in ASALs in Kenya at the national level in the policy context. Key in this is work by the former Ministry for Northern Kenya and Other Arid Lands, as well as the Sessional Paper on National Policy for ASALs

(Elmi and Birch, 2013). Moreover, Kenya adopted a new constitution in 2010, which introduced devolution of governance down to the county level. In this, natural resource management moved fully from central to county governments hosting their own sub-ministry committees. Implementation of devolution in 2013 saw the integration of four former districts to form the current Narok county. Hence, obtaining pastoral

information from the newly installed administration at its infancy becomes difficult, as it is synchronising its data records. Now that the county assembly has the power to formulate its own policies and regulations concerning livestock management, we think it is prudent to investigate how pastoralism can be enhanced and how associated resource conflicts are resolved at the grassroots.

3. Methodology

Understanding the context in which an adaptation intervention takes place requires practitioners to explore a site-specific relationship between the development status of the intervention's beneficiaries and their vulnerability to climate change (Spearman et al., 2011). This has successfully been analysed in a multi-resource sector community using the Ecosystem Service Governance (ESG) approach (Ngaruiya 2014a), which is based on the ecosystem approach developed by Convention of Biological Diversity (CBD, 2004).

3.1 The Ecosystem Service Governance approach

The ESG approach attempts to reveal precisely *who* and *how* climate adaptation and resource conflict resolution are implemented in rural communities of Africa (Ngaruiya, 2014a). It incorporates two notions into ecosystem management. First, monetary valuation of pastoralism is a useful tool to explore the full range of costs and benefits emanating from pastoralism, by giving contextual information on the perceived local significance of livestock at the community level. SNA systematically identifies local actors and their activities for efficient appraisal of the rural pastoralism governance. These datasets enable realistic performance assessment of a given sector, community or ecosystem.

The ESG framework consists of four main phases (Figure 6).

1. The core is the specific natural resource (ecosystem service) that supports livelihoods and economic growth in the community, for example livestock. If possible, the ecosystem service is given in

monetary value. These values help put local resources on the agenda of economic planners and policy-makers, who make their decisions based on the monetary returns of resource, land and investment options (Boyd and Banzhaf, 2007).

2. The resource determinants (challenges) that negatively influence ecosystem services, for example climate change impacts and conflicts.
3. The social network structure that either manages the challenges or utilises ecosystem services, for example pastoralism networks.
4. The perceived outcomes of effective resource governance as guided by the ESG approach, for example holistic pastoralism governance.

The ESG is an iterative framework therefore; the implemented outcomes feed back into their respective phases to create a cycle that can be systematically analysed and readjusted for successful conservation (Ngaruiya, 2014b).

3.2 Data collection

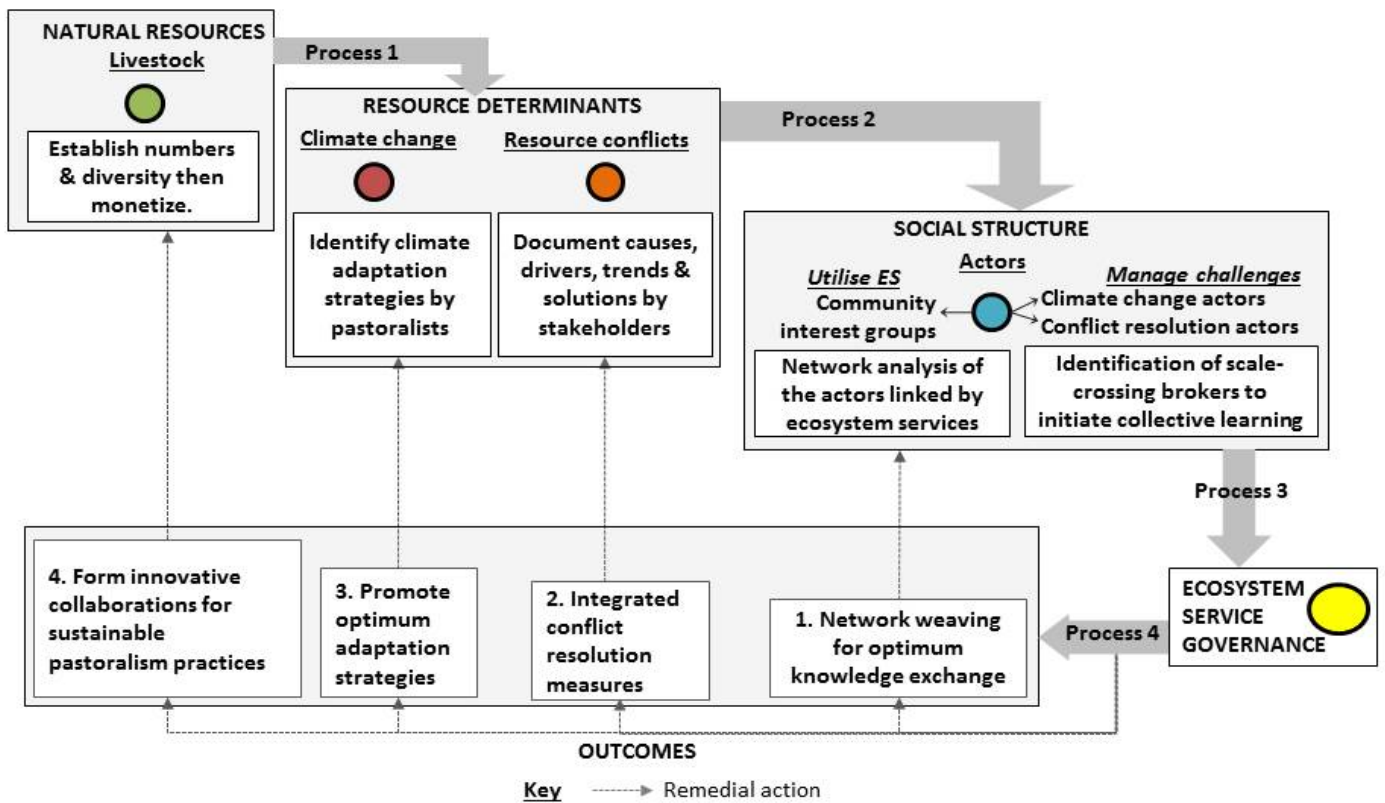
We conducted the empirical component of this research during two field visits to Narok county, in September and November 2014. We administered the questionnaire randomly with assistance from livestock extension officers to 41 pastoralists across the county (16 in Narok South, 13 in Narok North, eight in Transmara West and four in Transmara East) and used it to guide four group discussions in Narok North. Also, we held interviews with 15 experts (some via telephone), who provided technical information concerning the sector (Appendix 2).

A structured questionnaire divided into three sections was used to collect the following data (Appendix 1).

- **Climate change:** The first section collects information from community members about climate impacts, perceived threats, adaptation strategies and hindrances to effective adaptation in the pastoralism sector.
- **Resource conflicts and resolution:** The second section queries the trends of conflict, causes, underlying drivers (political or socioeconomic) and resolutions adopted in the pastoralism sector.
- **Governance collaborations:** The final section collects relational (network) data using questions about the personal contacts pastoralists gain adaptation knowledge. This uses the saturation sampling technique, whereby a respondent is asked to name a maximum of five actors they have collaborated with in terms of adaptation financial support; research and training; and project implementation to enhance their livelihoods. This actors' list is to be compiled and, where possible, mentioned actors are to be located and asked about their partners in resource governance, to go on until no new actors in the community are mentioned. A clear interaction relation/tie between the actors is defined as entailing exchanges involving economic, technological and/or social (humanitarian and cultural) adaptation resources according to the social resources concept.

Figure 6: Conceptual framework of the ecosystem service governance approach

Theoretical ESG framework



Source: adapted from Ngaruiya (2014b)

In addition, we sought secondary data from the County Livestock Office (CLO) on numbers, breeds and types of livestock, livestock trade trends and costs of livestock products in the county. However, as Narok county became operational as an administrative unit only in 2013, obtaining consistent comprehensive livestock-related data from the newly appointed officers was difficult. Part of the challenge here relates to the poor quality of livestock population data in Kenya and the fact that livestock population censuses are not equipped to cope with the dynamic nature of pastoral systems and the rapid rates of herd growth and shrinkage according to climatic conditions (Davies, 2007). Also, fluctuations in livestock numbers in the immediate aftermath of climatic shocks (increases and decreases of around 50%) make it difficult to

measure livestock populations in pastoral areas (ibid.).

3.3 Data analysis

Data collected were analysed following the systematic framework of the proposed ESG approach.

- **Monetary valuation of livestock:** The value of pastoralism is often considered to equate to the value of livestock sales, perhaps sometimes also including the sale of certain by-products, such as dairy and hides (Davies, 2007). Hence, monetary value of livestock was calculated using current market prices for live animals, which gave the total value of the estimated annual livestock population. Livestock products were similarly valued using market prices and their trade values for

import and export confirmed using extension officers' data. The monetary value of crops and livestock in Loitokitok district was calculated using the 2013 base exchange rate (\$1 = KES0.85).

- **Resource determinants:** The choices selected by the respondents concerning climate adaptation and resource conflict issues were ranked into percentiles as a representation of respondents' perceptions and activities.
- **SNA:** Actor relation data were analysed for centrality (level of involvement) and structural holes (potential control of an actor) using the UCINET program. Thereafter, data consisting of actors (nodes) and relations (links) were visualised using the Netdraw program.

Centralisation values are calculated using

$$C_D(i) = \sum_{j=1}^n x_{ij} = \sum_{i=1}^n x_{ji}$$

Where:

x_{ij} = the sum of all ties from actor i to actor j

n = the number of nodes in the network

The structural holes index is calculated using

$$C_B(k) = \sum_{i \neq j \neq k} \frac{\partial_{ikj}}{\partial_{ij}}$$

Where:

∂_{ikj} = the number of paths linking actors i and j that pass through actor k

∂_{ij} = the number of paths linking actors i and j

4. Preliminary results

4.1 Monetary value of pastoralism

As of 2012, milk was the product with the highest production, at 63.6 million litres per year, followed by beef, eggs, mutton, poultry and pork, at 2.77 million kg, 1.10 million trays, 629,390 kg, 106,270 kg and 160 kg per year, respectively. Surprisingly, honey production is also high, through the use of 48,111 hives across the county. The estimated annual monetary value of the livestock population and associated products is \$808 million (Table 2).

Lack of sufficient and consistent livestock data (blamed on devolution teething problems) hindered us from carrying out a comprehensive monetary valuation that would have enabled us to detect the tangible temporal impacts of drought on the sector. However, the field survey confirmed that pastoralists had suffered high losses through the death of their livestock and through unfair market practices entailing the cheap purchase of livestock during drought periods.

4.2 Actors involved in pastoralism governance

The 55 identified Narok pastoralism actors (Appendix 2) can be grouped into four sectors: livestock management, covering animal breeding, animal health and value addition programmes; capacity-building, entailing training activities and fund provision; environmental conservation, comprising resource management and water governance; and disaster management, with an emphasis on flood and drought mitigation (Figure 7). These are actors in the public and private sectors, civil society and non-governmental and faith-based organisations. Interestingly, the Council of Elders was not seen as a critical actor in pastoralism governance, indicating that other external support actors, such as conservancy investors, may have replaced traditional actors.

The calculated network centralisation is 49.02%, a high value that implies the presence of two main actors in the network. These are CLO, with a score of 57.4, and the National Drought Management Authority (NDMA), at

38.9. The other smaller but central areas of power in the community are the Agricultural Sector Development Support Programme (ASDSP), the Livestock Traders Association (LTA), Kenya Wildlife Service (KWS), the Water Resource Management Authority (WRMA), the Women Enterprise Fund (WEF), livestock groups, Narok Pastoral Centre (NPC) and pastoralists, with centrality values of 37, 31.5, 31.5, 24.1, 22.2, 20.4, 18.5 and 16.7, respectively. Appendix 3 gives a full description of the actor labels and their centrality values .

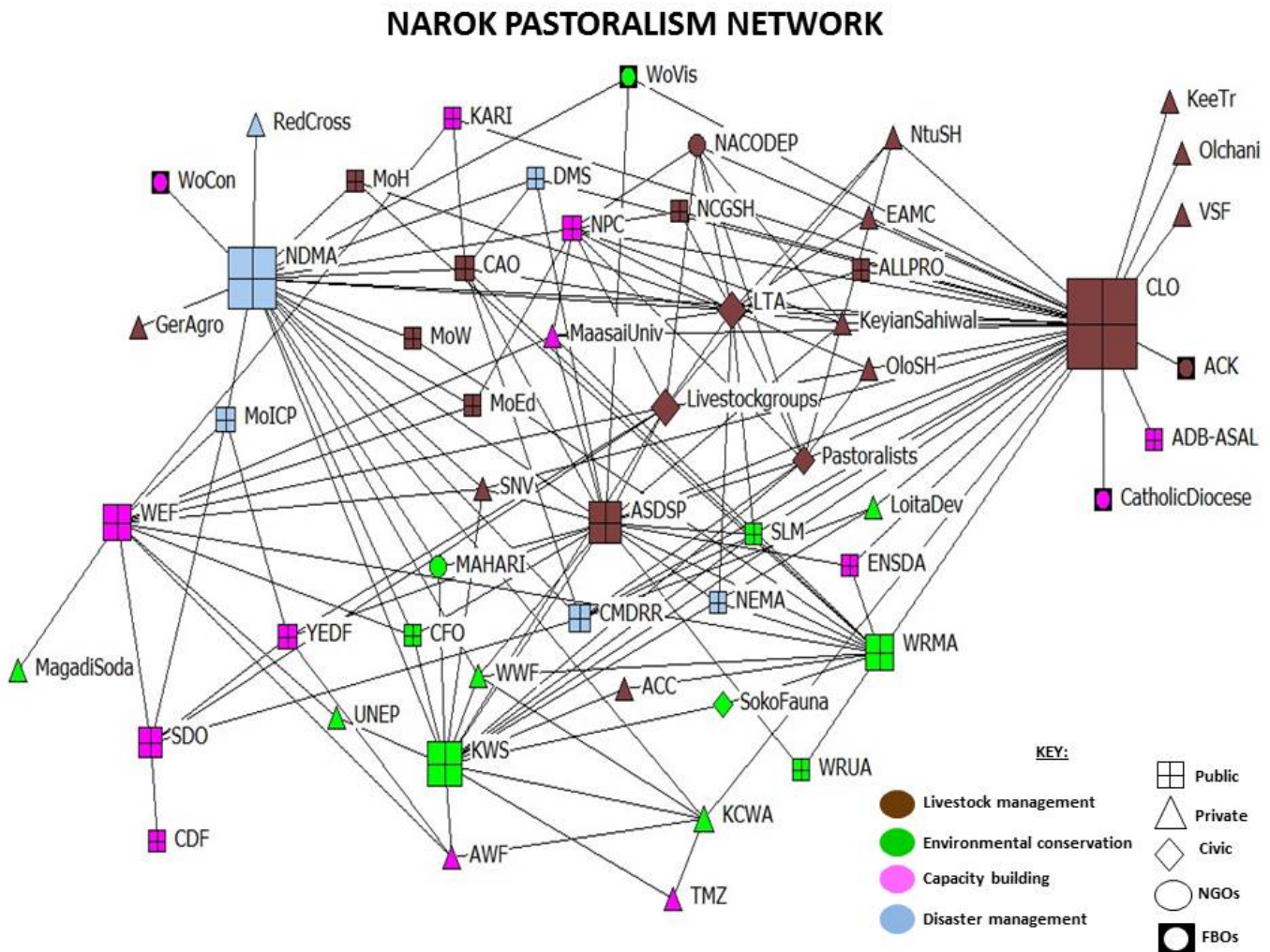
In terms of structural holes, the actors with the most 'spaces' in their linkages are CLO, NDMA, ASDSP, KWS, LTA, WRMA, WEF, livestock groups, NPC, Community Management Disaster Risk Reduction (CMDRR), the County Agriculture Office (CAO) and pastoralists. These actors have an ego betweenness score of 646, 295, 196, 169, 136, 115, 114, 61, 26, 23, 23 and 20, respectively. These scores denote potential opportunities for the actors in creating new linkages with other actors in the network. The rest of the actors and their respective betweenness scores are found in Appendix 4.

Table 2: Estimated monetary value of livestock in Narok

Livestock (2008-2014)	Gross value (mKES/year)	Gross value (mS/year)
Livestock population	66,563	783
Associated products	2,125	25

Source: Author's compilation

Figure 7: The Pastoralism management network in Narok County



Source: Authors' compilation

4.3 Implemented adaptation activities

Preferred responses to drought and related issues, such as climate-driven human-wildlife conflicts, in the questionnaire are given in brackets to guide this section. Results (given in percentage of persons interviewed) indicate that participants in Narok perceived drought episodes (51.7%) as the major inhibiting factor, over and

above irregular precipitation (34.5%), elevated temperatures (11.5%) and loss of biodiversity (0.02%).

Nevertheless, the community revealed several adaptation and coping measures in relation to drought impacts, which mainly included diversifying their livestock portfolio to maintain income generation (Table 3). Mobility remains the most widely practised

measure, based on indigenous knowledge that informs pastoralists when and where to shift. On the wider scale, the Maasai are aware of the relationship between climatic conditions and livestock attacks, thus, to reduce their losses, they employ tact in identifying and killing dominant problematic predators. Minor cases have involved carcass poisoning.

Table 3: List of implemented strategies in Narok

Actor arena	Adaptation and coping strategies	Actor responsible
Livestock management	Pasture bailing and improvement through reseeded (hay storage)	German Agro Action, SNV, KARI
	Water provision	World Vision, CMDRR, WRMA, WRUA, ASDSP, ENSDA
	Dairy value chain addition	German Agro Action, SNV, ASDSP
	Rehabilitation of sale and stock yards	LTA, VSF
	Regular vaccination and disease control programmes	NDMA, CLO, Olchani, VSF, Keekonyokei Trust
	Beef value chain addition	ASDSP, slaughter houses, ALLPRO
	Animal breeding services	NACODEP, Olchani, CLO
	Grazing programmes	KWCA, KWS, Loita Development
	Purchase of commercial feeds	Pastoralists, livestock groups
	Targeted killing of predators	Pastoralists, livestock groups
Capacity-building	Pasture bailing and improvement through reseeded (hay storage)	German Agro Action, SNV, KARI
	Water provision	World Vision, CMDRR, WRMA, WRUA, ASDSP, ENSDA
	Dairy value chain addition	German Agro Action, SNV, ASDSP
	Rehabilitation of sale and stock yards	LTA, VSF
	Regular vaccination and disease control programmes	NDMA, CLO, Olchani, VSF, Keekonyokei Trust
	Beef value chain addition	ASDSP, slaughter houses, ALLPRO
Environmental conservation	Translocation of problematic animals	KWS
	Construction of fences	KWS, investors, SLM,
	Establishment of tree nurseries	MAHARI, SLM
	Reforestation	Community groups, ASDSP, WEF, UNEP, Magadi Soda, CFO, ACC, ENSDA, NEMA, WWF, Soko Fauna
Disaster management	Flood mitigation around Suswa area	Red Cross
	Early warning system	NDMA, ASDSP
	Drought monitoring system	NDMA, NEMA

Source: Authors' compilation

The respondents identified several hindrances to the efficiency of these measures, including low capacity of extension workers (24.2%), poorly advertised value addition opportunities (20.4%), poor coordination in the sector (16.1%), high cost of veterinary medicines (13.7%), inadequate vaccination programmes (8.1%) and lack of finances in government agencies (3.8%).

Interestingly, one would expect conflicts to be higher during the dry season when food resources are less available but incidences of pastoralist–wildlife conflicts were most common in the wet season.

This is because predators follow the foraging herbivores out of the protected area and increases carnivore encounters with grazing livestock, leading to high numbers of depredation cases (20.4%) and disease transmission (17.9%) particularly near protected areas. Although predator numbers have declined, land sub-division (12.2%) and infrastructure development (12.2%) have led to pastoralists and wildlife competing for the few open spaces with sufficient water (19.4%), which has resulted in the targeted killing of predator offspring such as lion cubs. Moreover, the community is known to poison

problematic predators, which unfortunately causes the death of other species, especially scavengers in the area. Solutions involve negotiation over land use and sometimes compensation of the aggrieved party by a conservation investor so as to avoid the targeted revenge killings of predators. The participants agree that the long bureaucratic compensation procedure (ineffective institutions) by KWS, together with the low finances allocated for this purpose, acts as a key conflict driver.

5. Discussion on the social network structure

Evaluation of the proposed adaptation strategy against the measures documented in Table 1 reveals that the technological and managerial aspects are well represented in Narok County. The policy aspect is clearly seen in the establishment of several institutions charged with consolidating and equipping the community with information concerning climate change – namely, NDMA, CMDRR, Sustainable Land Management and NPC. However, the behavioural

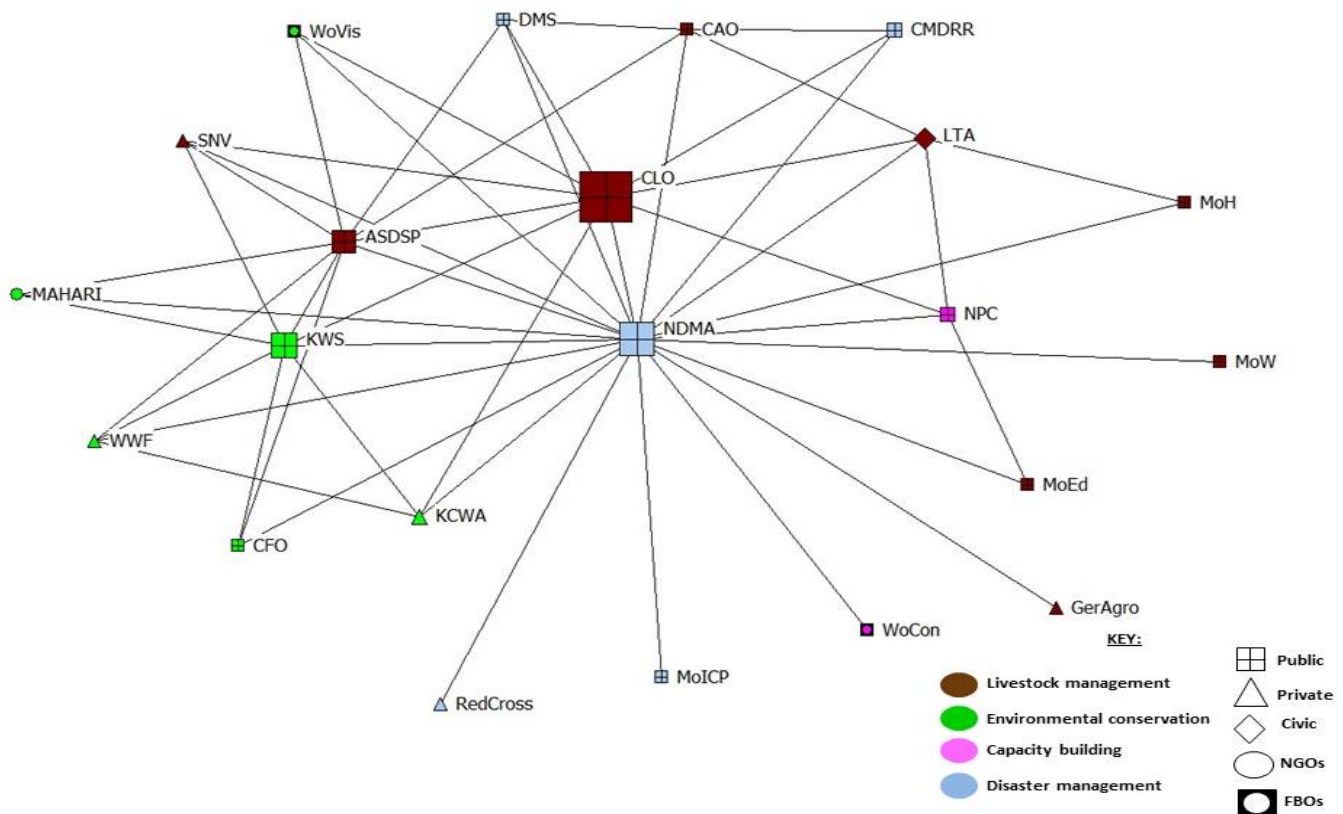
aspect, which relies heavily on regular and site-specific capacity-building initiatives, is not well established in the community, despite having many knowledgeable actors. To make this prognosis clear, we briefly deconstruct the pastoral network below.

5.1 Strengths

Generally, the actors are well linked across the four main action arenas. As a result, the community has

many diverse and practical livestock management measures that can be classified as technological aspects of the previously mentioned pastoralism adaptation strategy. A closer look at ego networks reveals that the key players (NDMA and CLO) are connected to actors introducing the different management approaches, such as improved indigenous animal breeds, value chain programmes, disease management and water provision (Figure 8).

Figure 8: Sociograph of key managerial actors in the pastoral network



Note: Actor size is determined using their betweenness values

Source: Authors' compilation

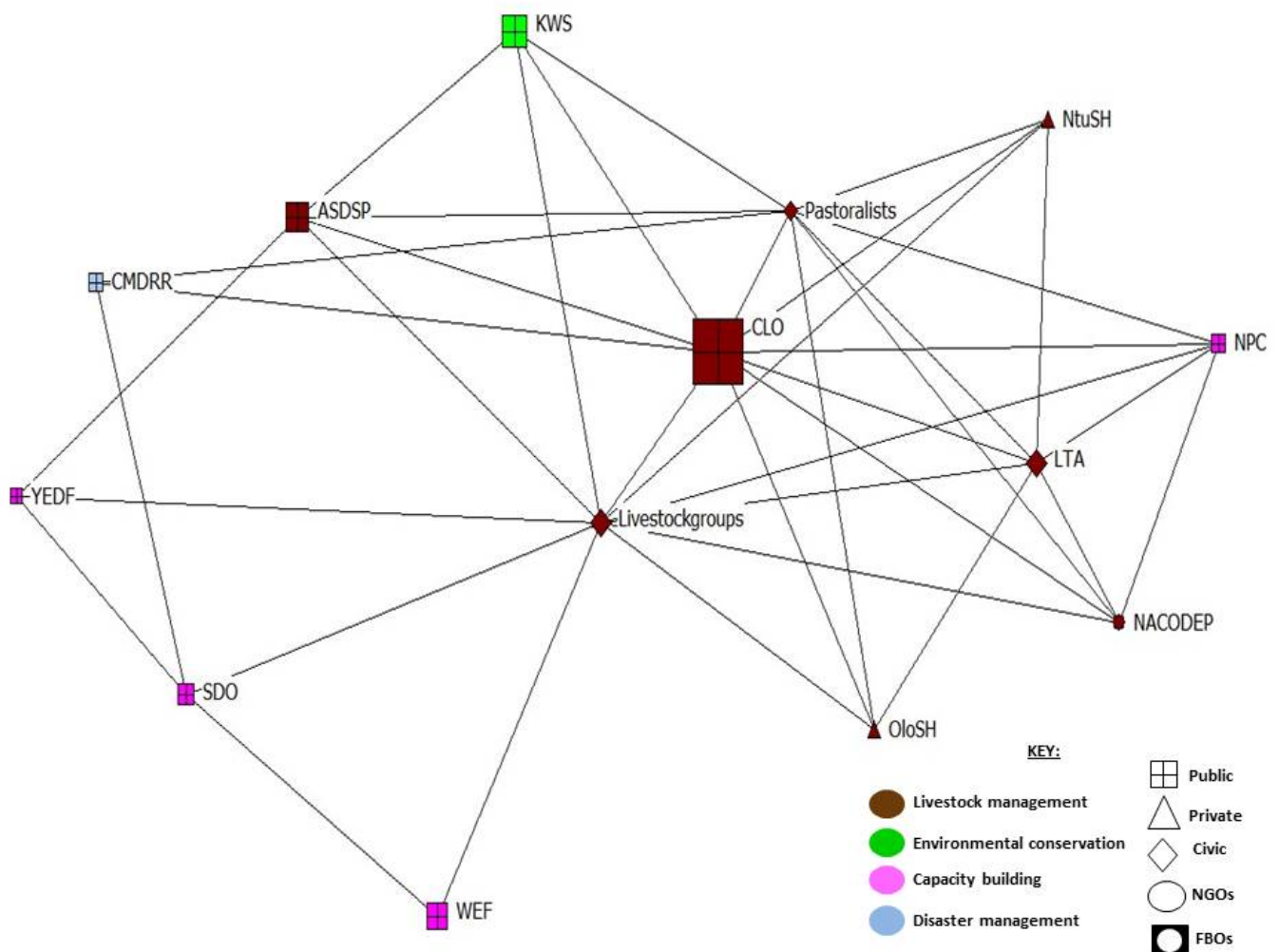
5.2 Weaknesses

Similar analysis of pastoralists and livestock-keeping ego networks confirms what the field survey discovered – lack of involvement of the community in decision-making and poor dissemination of information to the grassroots. Most of the interviewed community members openly stated that they managed livestock in harsh

environmental conditions using traditional or self-researched information. Figure 9 shows the missing links between these two actors and ‘adaptation managers’ in the sector. This network displays a business-as-usual scenario, whereby the community is linked to business actors such as slaughter houses, agrovets, traders and fund providers to expand the sector. Poor linkages to ‘adaptation’

experts like NDMA or other capacity-building actors lead to lack of information. This is evidenced by slow behavioural change in the adoption of coping and adaptation measures, such as the immediate sale of healthy animals before the commencement of a drought, lack of change in livestock mobility and negative perceptions of pastoralism by the young generation.

Figure 9: Linkages among civic actors in the pastoral network



Note: Actor size determined using their betweenness values

Source: Authors' compilation

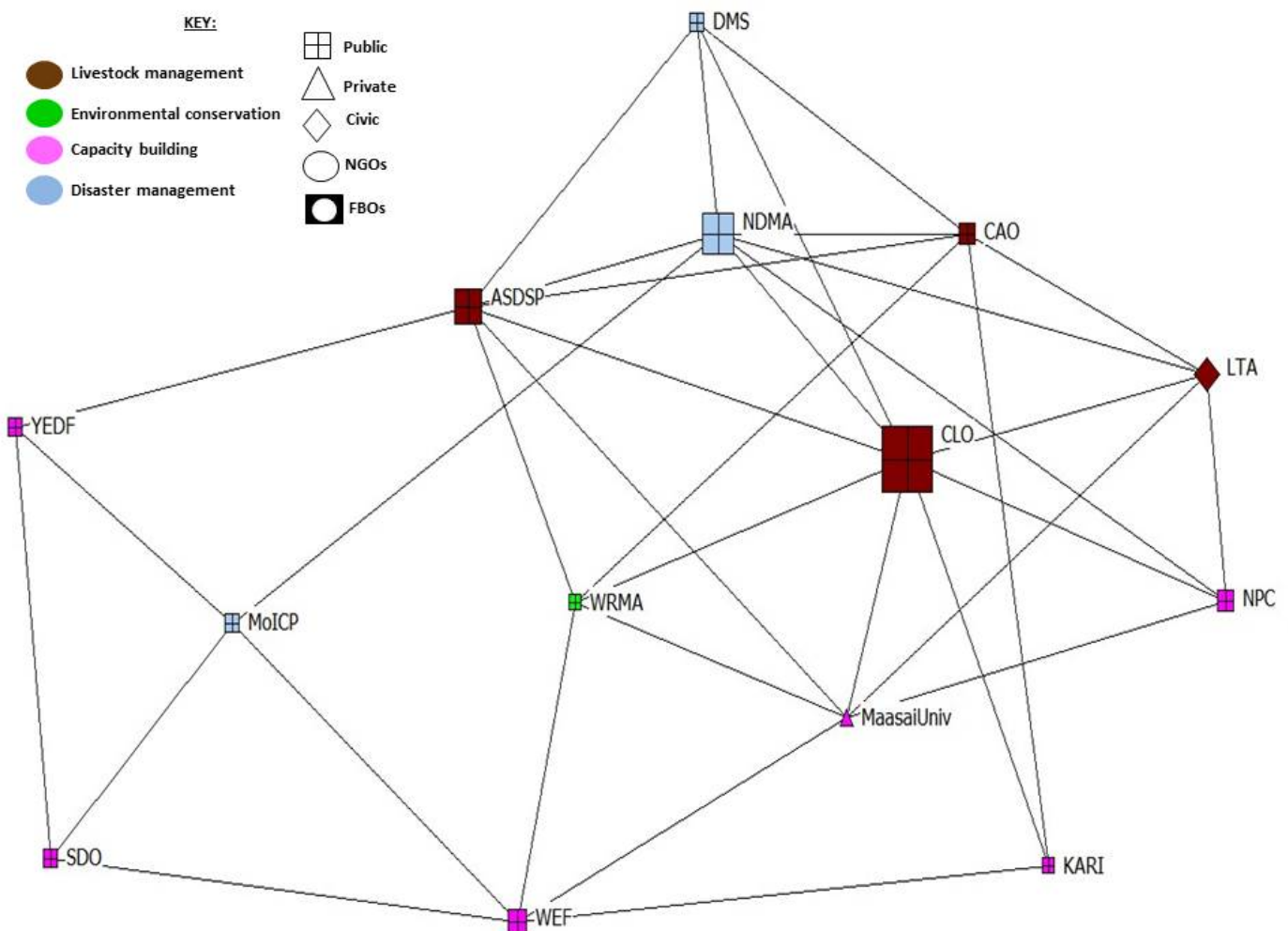
5.3 Opportunities

Local actors should use the active presence of research institutes such as Maasai Mara University, Kenya Agricultural Research Institute and the Ministry of Devolution and Planning in formulating site-specific pastoralism policies (Figure 10). In addition, researchers may also need to get better at engaging and

communicating with stakeholders. These policies could provide the framework for initiating much-needed adaptation measures, such as credit facilities, disaster-related insurance policies, land management, regulation of livestock marketing boards and introduction of a positive pastoralism culture in community education programmes. In addition,

these three actors can bring in other critical actors, such as the Department of Meteorological Services, in developing local climate models that can enhance the early warning systems strategy to be used in formulating policy to oversee cash-based disaster assistance.

Figure 10: The ego network of key policy and research actors in Narok



Note: Actor size determined using their betweenness values

Source: Authors' compilation

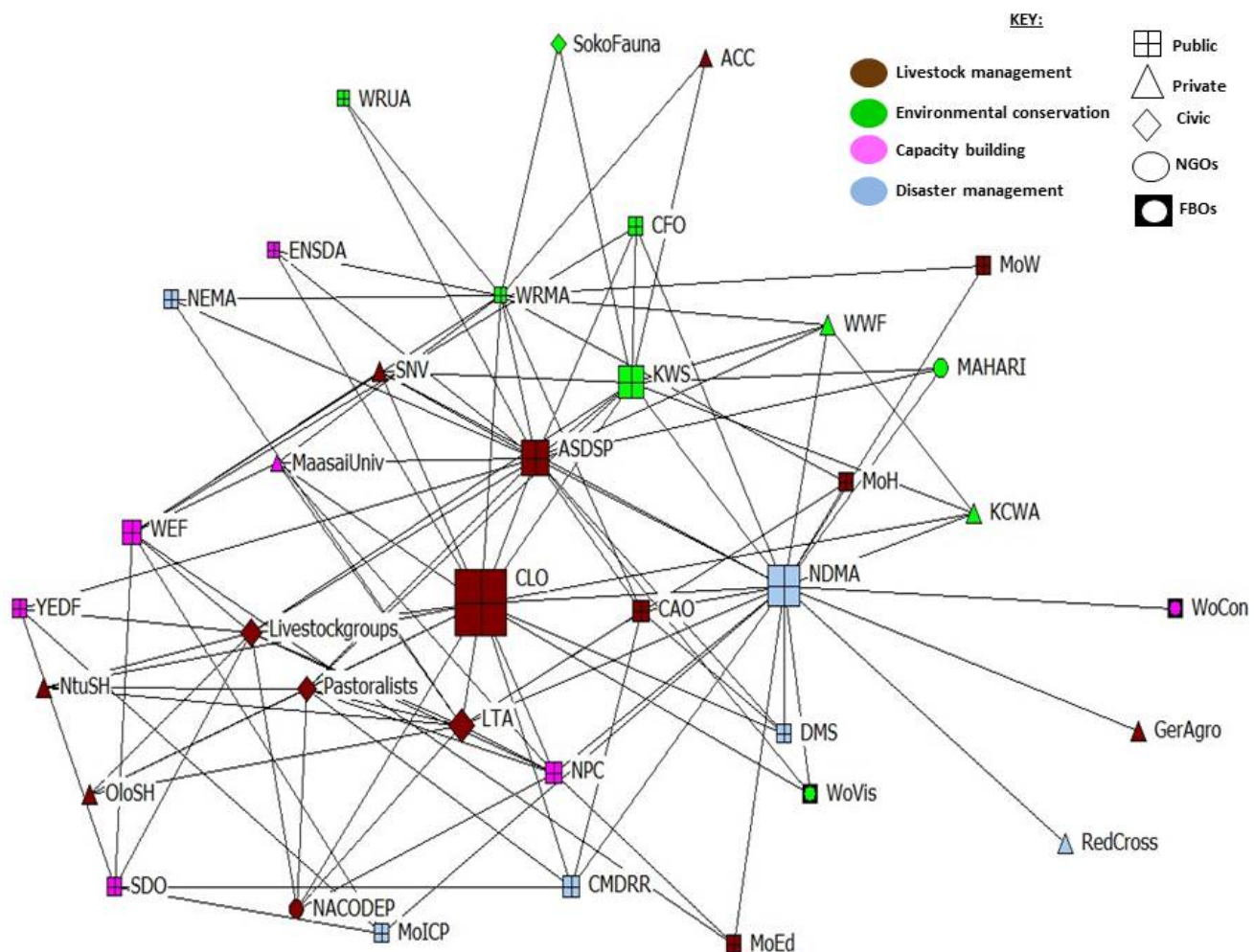
5.4 Challenges

As revealed earlier, there is no strong link between the 'adaptation experts and resource managers' and the community at the grassroots. Hence, the community may not be well prepared to face climate change as it escalates. This scenario can be reversed if certain actors become proactive in creating linkages among existing actors, in a

process known as network-weaving. Figure 11 shows how seven actors (CLO, NDMA, ASDSP, KWS, LTA, WRMA and WEF), termed 'brokers', have the greatest opportunities to create new linkages in the entire pastoral network. If this action is implemented, then it will be easy for the grassroots to disseminate and adopt managerial decisions. This

issue also concerns integrating adaptation planning in the wildlife sector with livestock management in ASALs. Such changes will lead to a rapid change in pastoralists' attitudes towards proposed adaptation measures, thanks to their participation in widespread capacity-building events.

Figure 11: Ego networks of potential key brokers in Narok



Note: Actor size determined using their betweenness values

Source: Authors' compilation

6. Conclusion

We set out to deconstruct the pastoral network in the newly formed Narok county in order to be able to understand the actual impacts of climate variability on the sector and to identify challenges in the transmission of adaptation knowledge across the network. This study used the ESG approach framework to guide data collection on the actors involved in pastoralism governance and subsequent SNA. This analysis revealed 55 active actors and identified diverse adaptation and coping measures, which we divided into four main thematic areas: livestock management, capacity-building, environmental conservation and disaster management. In terms of conflict resolution, there were few non-governmental conservation organisation actors who were directly involved in negotiations with the community to resolve human-wildlife conflicts in Kenya.

Analysing the identified measures against our proposed pastoralism adaptation strategy, we found that the Narok network has the following attributes.

First, the presence of diverse actors provides the network with a range of technological expertise and resources, including improved breeds, fodder and disease control.

Second, lack of linkages between the community groups and adaptation knowledge actors has resulted in slow behavioural change among pastoralists. It has promoted a business-as-usual scenario covering value addition programmes and livestock trade, despite the urgent need for adaptation knowledge in the community. Moreover, capacity-building actors are seen more as being management-based in urban centres than as being engaged in practical action at the grassroots level.

Third, it is evident that, although the network has several knowledgeable adaptation actors, these are not fully connected to the grassroots. This has resulted in a weak managerial pillar. Fortunately, analysis of the network reveals that *only* seven actors have the highest structural holes values. Thus it could be easy to increase linkages across the network and increase transmission of adaptation knowledge to resource users at the grassroots.

Finally, poorly linked actors (Maasai Mara University, Kenya Agricultural Research Institute and the Ministry of Devolution and Planning) in the research sector reflect unutilised opportunities to boost the very weak policy pillar and introduce much-needed disaster-related insurance policies to enhance the resilience of the community in the face of increasing climate variability.

7. Recommendations

The importance of equipping the pastoral community with relevant adaptation and coping knowledge in this region cannot be downplayed. We would like to put forward the following areas of actions based on our study so as to help safeguard the future of this sector.

1. The network's strong technological pillar urgently needs to be upgraded through the development of a comprehensive county database that is easily accessible by the community and researchers. These data should be compiled frequently from the lowest administrative

level from the earliest possible time period and cumulated up to the regional level so as to facilitate accurate and seasonal trend analysis of the impacts of climate change, urban development, land tenure changes, wildlife populations and epidemics on the livestock and pastoralist community.

2. The number of linkages between actors implementing capacity-building and the community should be increased across the network, especially through community *barazas*, to boost the ability to disseminate adaptation information in the county.

3. Reduction of the high structural hole values of the seven identified actors should be implemented through focused network-weaving to improve the quality of adaptation knowledge in the region.

Local disaster management would benefit from improved cooperation and linkages between research organisations, which would result in the development of effective prevention and recovery policy and strategies to reduce the probability of a poverty increase among pastoralists.

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Appendix 1: Questionnaire used in the field survey

QUESTIONNAIRE No _____ DATE _____

NAME OF ADMINISTRATOR _____ LOCATION _____

RESPONDENT CHARACTERISTICS NAME _____ AGE ____ SEX ____

ORGANIZATION _____ YEAR OF ESTABLISHMENT _____

Area of action	International <input type="checkbox"/>	National <input type="checkbox"/>	Regional <input type="checkbox"/>	Local <input type="checkbox"/>
Type of organization	Public <input type="checkbox"/>	Private <input type="checkbox"/>	Civil <input type="checkbox"/>	

Section A: CLIMATE CHANGE CONCERNS IN THE PASTORALISM SECTOR

CC Parameter	Precipitation <input type="checkbox"/>	Temperature <input type="checkbox"/>	Biodiversity <input type="checkbox"/>	Natural disasters <input type="checkbox"/>
CC Threat to pastoralism	Low/ lack of fodder <input type="checkbox"/>	Pasture degradation <input type="checkbox"/>	Reduced water and water points <input type="checkbox"/>	Disease outbreaks <input type="checkbox"/>
Adaptation strategies (specific to pastoralism)	Soil & Nutrient management <input type="checkbox"/>	Diversified agricultural activities <input type="checkbox"/>	Improved breeds <input type="checkbox"/>	Frequent training of pastoralists <input type="checkbox"/>
	Rehabilitation of pasture land <input type="checkbox"/>	Enhanced pest and disease control <input type="checkbox"/>	Hay storage <input type="checkbox"/>	Water harvest & Use <input type="checkbox"/>
Drawbacks	Poor coordination <input type="checkbox"/>	Lack of finances <input type="checkbox"/>	Low capacity for extension services <input type="checkbox"/>	Low value addition opportunities <input type="checkbox"/>
	Poor quality breeds <input type="checkbox"/>	Poor fodder preservation method <input type="checkbox"/>	High cost of vet. medicines <input type="checkbox"/>	Inadequate vaccination events <input type="checkbox"/>

SECTION B: RESOURCE CONFLICTS & RESOLUTION

Trend of conflict	Increasing <input type="checkbox"/>	Seasonal <input type="checkbox"/>	Decreasing <input type="checkbox"/>	
Cause of conflict	Pasture loss <input type="checkbox"/>	Wildlife attacks <input type="checkbox"/>	Access to water <input type="checkbox"/>	Development/ infrastructure <input type="checkbox"/>
	Water scarcity/ shortage <input type="checkbox"/>	Rustling <input type="checkbox"/>	Land use Competition <input type="checkbox"/>	Size of individual herds <input type="checkbox"/>
Conflict driver	Ineffective institutions <input type="checkbox"/>	Low finances <input type="checkbox"/>	Cultural information <input type="checkbox"/>	Lack of policy <input type="checkbox"/>
Outcome	Community tension <input type="checkbox"/>	Targeted violence <input type="checkbox"/>	Poor or no collaboration <input type="checkbox"/>	Project/Program sabotage <input type="checkbox"/>
Conflict arbitrator	Council of Elders <input type="checkbox"/>	Government officials <input type="checkbox"/>	Investor or Coordinator <input type="checkbox"/>	NGO/FBO <input type="checkbox"/>
Solutions	Resource use negotiations <input type="checkbox"/>	Fines/Jail term <input type="checkbox"/>	Compensation <input type="checkbox"/>	Reallocation of land <input type="checkbox"/>
Public awareness	Barazas <input type="checkbox"/>	Posters/fliers <input type="checkbox"/>	Workshops <input type="checkbox"/>	Media <input type="checkbox"/>

SECTION C: ADAPTATION KNOWLEDGE TRANSMISSION NETWORKS

Funding partners	1.	2.	3.	4.	5.
Research & training partners	1.	2.	3.	4.	5.
Project Partners (implementation)	1.	2.	3.	4.	5.

Appendix 2: List of actors involved in governance of pastoralism in Narok

No.	Full Name	Acronym	Type	Sector
1	National Drought Management Authority	NDMA	Public	Disaster_management
2	World Vision	WoVis	FBO	Environmental_conservation
3	Red Cross	RedCross	Private	Disaster_management
4	World Concern	WoCon	FBO	Capacity_building
5	German Agroaction	GerAgro	Private	Livestock_management
6	Netherlands Development Organisation	SNV	Private	Livestock_management
7	Livestock Traders Association	LTA	Civic	Livestock_management
8	Community Managed Disaster Risk Reduction	CMDRR	Public	Disaster_management
9	Maa Habitat Restoration Initiative	MAHARI	NGO	Environmental_conservation
10	World Wildlife Fund	WWF	Private	Environmental_conservation
11	Department of Meteorological Services	DMS	Public	Disaster_management
12	National Environmental Management Authority	NEMA	Public	Disaster_management
13	Water Resources management Authority	WRMA	Public	Environmental_conservation
14	Agricultural Sector Development Support Program	ASDSP	Public	Livestock_management
15	Ntulele Slaughter House	NtuSH	Private	Livestock_management
16	Olokurto Slaughter House	OloSH	Private	Livestock_management
17	Namukonyi Community Development Project	NACODEP	NGO	Livestock_management
18	Olchani Agrovet	Olchani	Private	Livestock_management
19	ASAL-Based Livestock and Rural Development Programmes	ALLPRO	Public	Livestock_management
20	Vétérinaires Sans Frontières	VSF	Private	Livestock_management
21	Keekonyokei Trust	KeeTr	Private	Livestock_management
22	African Development Bank programs for ASAL regions	ADB-ASAL	Public	Capacity_building
23	Narok Pastoral Centre	NPC	Public	Capacity_building
24	Social development Office	SDO	Public	Capacity_building
25	African Wildlife Foundation	AWF	Private	Capacity_building
26	Nature Conservancy	TMZ	Private	Capacity_building
27	Livestock keeping community groups	Livestockgroups	Civic	Livestock_management

No.	Full Name	Acronym	Type	Sector
28	Pastoralists (Individual)	Pastoralists	Civic	Livestock_management
29	Ewaso Nyiro South Development Authority	ENSDA	Public	Capacity_building
30	Sustainable Land Management	SLM	Public	Environmental_conservation
31	Maasai Mara University	MaasaiUniv	Private	Capacity_building
32	Constituency Development Fund	CDF	Public	Capacity_building
33	Loita Development Organisation	LoitaDev	Private	Environmental_conservation
34	Catholic Diocese of Narok	CatholicDiocese	FBO	Capacity_building
35	Anglican Church of Kenya	ACK	FBO	Livestock_management
36	Keyian Sahiwal Organisation	KeyianSahiwal	Private	Livestock_management
37	Kenya Agricultural Research Institute	KARI	Public	Capacity_building
38	County Livestock Office	CLO	Public	Livestock_management
39	County Agricultural Office	CAO	Public	Livestock_management
40	Ministry of Water	MoW	Public	Livestock_management
41	Ministry of Health	MoH	Public	Livestock_management
42	Ministry of Education	MoEd	Public	Livestock_management
43	Kenya Wildlife Service	KWS	Public	Environmental_conservation
44	County Forest Office	CFO	Public	Environmental_conservation
45	Ministry of Integration, Devolution and Planning	MoICP	Public	Disaster_management
46	East Africa Meat Company	EAMC	Private	Livestock_management
47	Narok County Government Slaughter House	NCGSH	Public	Livestock_management
48	Kenya Conservancies for Wildlife Association	KCWA	Private	Environmental_conservation
49	Women Enterprise Funds	WEF	Public	Capacity_building
50	Youth Enterprise Development Funds	YEDF	Public	Capacity_building
51	United Nations Environmental Program	UNEP	Private	Environmental_conservation
52	Magadi Soda Company	MagadiSoda	Private	Environmental_conservation
53	Water Resources Users Association	WRUA	Public	Environmental_conservation
54	African Conservation Centre	ACC	Private	Livestock_management
55	Soko Fauna Organisation	SokoFauna	Civic	Environmental_conservation

Appendix 3: Degree centrality values for the pastoralism actors

No.	Actor	NrmDegree
1	CLO	57.41
2	NDMA	38.89
3	ASDSP	37.04
4	LTA	31.48
5	KWS	31.48
6	WRMA	24.07
7	WEF	22.22
8	Livestockgroups	20.37
9	NPC	18.52
10	Pastoralists	16.67
11	CMDRR	12.96
12	CAO	12.96
13	NACODEP	11.11
14	SDO	11.11
15	MaasaiUniv	11.11
16	KCWA	11.11
17	SNV	9.26
18	WWF	9.26
19	SLM	9.26
20	KeyianSahiwal	9.26
21	YEDF	9.26
22	DMS	7.41
23	NtuSH	7.41
24	OloSH	7.41
25	AWF	7.41
26	CFO	7.41
27	MolCP	7.41
28	WoVis	5.56

No.	Actor	NrmDegree
29	MAHARI	5.56
30	NEMA	5.56
31	ENSDA	5.56
32	LoitaDev	5.56
33	KARI	5.56
34	MoH	5.56
35	MoEd	5.56
36	NCGSH	5.56
37	ALLPRO	3.70
38	TMZ	3.70
39	MoW	3.70
40	EAMC	3.70
41	UNEP	3.70
42	WRUA	3.70
43	ACC	3.70
44	SokoFauna	3.70
45	RedCross	1.85
46	WoCon	1.85
47	GerAgro	1.85
48	Olchani	1.85
49	VSF	1.85
50	KeeTr	1.85
51	ADB-ASAL	1.85
52	CDF	1.85
53	CatholicDiocese	1.85
54	ACK	1.85
55	MagadiSoda	1.85

Appendix 4: Structural holes and brokerage values for pastoralism actors

No	Actor	Ego Betweenness	Actor	Brokerage potential
1	CLO	646	CLO	820
2	NDMA	295	NDMA	362
3	ASDSP	196	ASDSP	310
4	KWS	169	KWS	224
5	LTA	136	LTA	215
6	WRMA	115	WRMA	136
7	WEF	114	WEF	107
8	Livestockgroups	61	Livestockgroups	80
9	NPC	26	NPC	53
10	CMDRR	23	Pastoralists	44
11	CAO	23	CAO	30
12	Pastoralists	20	CMDRR	27
13	SDO	19	SDO	16
14	MaasaiUniv	10	MaasaiUniv	16
15	MoICP	10	KCWA	16
16	SNV	8	MoICP	10
17	KCWA	8	YEDF	9
18	YEDF	8	SNV	8
19	KARI	6	WWF	8
20	CFO	6	SLM	7
21	WWF	5	KARI	6
22	NEMA	4	CFO	6
23	AWF	4	KeyianSahiwal	5
24	MoH	4	NEMA	4
25	MoEd	4	NACODEP	4
26	SLM	4	AWF	4
27	KeyianSahiwal	3	MoH	4
28	MoW	2	MoEd	4
29	UNEP	2	DMS	2
30	ACC	2	NtuSH	2
31	SokoFauna	2	OloSH	2
32	NACODEP	1	LoitaDev	2
33	LoitaDev	1	MoW	2

No	Actor	Ego Betweenness	Actor	Brokerage potential
34	DMS	1	UNEP	2
35	NtuSH	1	ACC	2
36	OloSH	1	SokoFauna	2
37-55	WoVis, RedCross, WoCon, WRUA GerAgro, MAHARI, Olchani, VSF, ALLPRO, KeeTr, ADB-ASAL, TMZ, ENSDA, ACK, CDF, CatholicDiocese, EAMC, NCGSH, MagadiSoda,	0	WoVis, RedCross, WoCon, GerAgro, MAHARI, Olchani, ALLPRO, VSF, KeeTr, ADB-ASAL, TMZ, ENSDA, CDF, CatholicDiocese, ACK, EAMC, NCGSH, MagadiSoda, WRUA	0

PRISE

Overseas Development Institute
203 Blackfriars Road
London SE1 8NJ
United Kingdom

Tel. +44 (0)20 7922 0438

www.prise.odi.org

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