THE ECONOMICS OF LAND DEGRADATION

UNIVERSITY OF NAIROBI

Kenya Rangeland Study

COSTS AND BENEFITS OF SUSTAINABLE RANGELAND MANAGEMENT PRACTICES IN NORTHERN KENYA

An Economics of Land Degradation study carried out in the framework of the "Reversing Land Degradation in Africa through Scaling-up Evergreen Agriculture" project

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Economics of Land Degradation Initiative:

Kenya Rangeland Study: Cost and Benefits of Sustainable Rangeland Management Practices in Northern Kenya

An Economics of Land Degradation (ELD) Initiative study carried out in the framework of the project "Reversing Land Degradation in Africa through Scaling-up Evergreen Agriculture"

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Executive Summary

The degradation of rangeland ecosystems has rapidly increased in Kenya, posing daunting challenges to achieving sustainable development and poverty reduction in pastoral communities. This has led to environmental challenges including the loss of land productivity, which is resulting in deteriorating livelihoods for the majority of the rural poor who heavily depend on natural resources. The resulting scarcities further prohibits and dispossesses pastoral communities from access to land, water and grazing resources, which is particularly severe for pastoralists whose main livelihood is livestock production.

Pastoral systems are characterised by low external input subsistence livestock production that is grounded on strategic exploitation of resources that are non-uniformly distributed in space and time. The spatio-temporal variability in water and pasture availability necessitates mobility to exploit the heterogeneous rangeland resources, leading to the development of nomadic pastoralism as the most suitable livelihood activity in the arid and semi-arid areas.

Sound grazing management practices are necessary in achieving sustainable rangeland environments and livelihoods, especially in the face of climate change and a myriad of ecological dynamics. As part of the Evergreening Africa initiative, an ELD study was conducted to analyse the costs and benefits of two rangeland management models: community wildlife conservancy and the traditional rangeland management system known as the Dedha system among the pastoral community of Northern Kenya.

Key scientific findings

- **Weak governance due to dysfunctional traditional /customary laws and institutions and poorly or non-functioning modern laws and institutions, lead to the proliferation of unsustainable management practices**. Land degradation is a negative process which lowers the value of land, its utility and thus impacts on livelihoods. The main cause of rangeland degradation was found to be poor rangeland governance. Pastoral land in the study area is communally owned and increasingly faces many complex challenges, including climate change; rapid urbanization; increased demand for natural resources; food, water and energy insecurity; natural disasters; and violent conflict. Many of these challenges have a clear land dimension: unequal access to land; insecurity of tenure; unsustainable land use; weak institutions for dispute and conflict resolution. The weak statutory and customary institutions that govern land result in unsustainable use of rangeland.
- **The broader institutional environment plays a major role in determining the sustainability of the SLM practices especially those aimed at conservation of communally owned resources**. The results of the study showed that equitable access to conservation's economic benefits both assets and incomes, gender inclusion particularly

women in decision making, accountability of resources and inclusivity and participation of the sustainability of all practices in communally owned land.

- **Proper coordination of sustainable land management practices is needed in arid and semi-arid counties**. There is little coordination or interaction of the actors, ideas or utilization of the lessons learnt from various SLM projects implemented by different actors which has led to duplication of efforts and inefficient use of resources, as well as gaps that should not have existed. There is need to complement each other and learn from the projects implemented by other players to ensure successful implementation of SLM practices.
- **There is lack of incentive mechanisms for SLM adoption and income generation at the local level:** The results show that payment schemes for services outside traditional markets were typically absent. As a result, cost-benefit analyses are biased toward development over conservation, and planning efforts miss potential win-win areas and associated opportunities to finance conservation in innovative ways.
- **The cost of taking action to rehabilitate rangelands was much lower than the cost of inaction over a 30-year period**. The results show that the Net Present Value per hectare for Dedha and conservancy was positive irrespective of the discount rate. NPV per hectare for Dedha was £22,356, £64,911 and £9,680 using 8%, 3.5% and 12% discount rates respectively while for the conservancy the NPV was £38, 597, £78,297 and £23,792 using the 8%, 3.5% and 12% discount rates respectively.

Recommendations

Key recommendations to pastoral communities

Land improvement and mitigation of land degradation can come about through behavioural change of pastoralists and following their re-allocation of resources to land-improving practices.

- Destruction of natural vegetation through activities such as overgrazing, encroachment and haphazard illegal tree felling for fuel use and timber was found to have caused increased runoff, flash flooding, soil erosion and siltation in the water pans and other water reservoirs.
- The research presented here shows that investments in Dedha and conservancy land management practices which address land degradation have significant economic payoffs through improved rangeland productivity.
- Sustainable rangeland management and responsible land governance such as conservancy and Dedha have great potential for becoming one of the cornerstones of achieving the sustainability of pastoral livelihoods and peaceful coexistence in these areas.

There is need for a holistic approach to achieving productive and healthy ecosystems by integrating social, economic, physical and biological needs and values.

- This can be embraced through proper land governance such as soil and water conservation, natural resource management and integrated landscape management.
- Weak governance due to dysfunctional traditional/customary laws and institutions and poorly or non-functioning modern laws and institutions lead to the proliferation of unsustainable management practices.
- There is more economic value in sustainable rangeland management due to the reduced cost of the loss of ecosystem functioning as found in the study.

Key recommendations to NGOs and the private sector

Rangeland rehabilitation and improvement should be an iterative process based on strong dialogue amongst all stakeholders. The process should enable stakeholders to negotiate and decide on a sustainable form of land use in rural areas as well as initiate and monitor implementation. This should be based on:

- Targeted policy and institutional support, including the development of incentive mechanisms for SLM adoption and income generation at the local level;
- Land-user-driven and participatory approaches;
- The integrated use of natural resources on farms and at the ecosystem scale; and
- Multi-level, multi-stakeholder involvement and partnerships at all levels – land users, technical experts and policy-makers.

The results of planning and the implementation of measures can only be sustainable if plans are made with and by the local community, not behind them or even against them. Sustainable land-use planning is therefore not just a matter for experts but should be carried out together with those affected by it. To ensure a feeling of ownership concerning self-help activities, the local community who are affected need to be involved in the planning process from the beginning.

Capacity building should be undertaken for communities and their leaders to enable them manage rangelands and their resources effectively.

- Capacity building should include sustainable rangeland management practices, financial management, dispute resolution, security operations and data collection and analysis, and documentation.

It is equally important that social institutions and regulatory mechanisms are structured in such a way to enable data on ecosystem services and assessments to become the actual basis for decisions and actions with the goal of achieving sustainable social and economic development that promote ecosystem service conservation.

- This will ensure that the various assessments and data on economic value of rangeland ecosystem services and assessments are helpful and enable the pastoral society to be more efficient and successful in sustaining their livelihoods.

Gender equality and equity is key to rangeland rehabilitation, conservation effectiveness and sustainability.

- Given gender-differentiated roles and responsibilities in natural resource management, sustainable rangeland management must address the specific needs and opportunities of women and men in order to reduce inequalities, stimulate growth and reverse environmental degradation.

- The recognition of women's land and resource rights would reinforce their social and economic empowerment resulting in financial security and decision-making power.
- One of the requirements for reaching and maintaining land degradation neutrality and advancing land restoration and rehabilitation is the achievement of a more equitable balance in workloads and in the sharing of economic and social benefits between rural women and men.
- Women's unique knowledge on natural resources management, their influence on youth and their role in stewarding ecosystems makes them an important stakeholder group in determining and developing sustainable rural economies.

Benefits are the most important and usually complicated aspects of the conservancy development.

- It should be made clear to the community that not only monetary benefits should be regarded as benefits but rather the health of the environment such as biodiversity is also an imperative benefit, although the ultimate goal of the conservancy concept is poverty alleviation.
- Realizing the benefits associated with conservancy is entirely dependent on the conservancy members' awareness of conservancy, the conservancy development stage and effectiveness. Therefore, the community should be informed about what conservancy could offer them, the conservancy concept and a general understanding of its associated benefits. This should be done by the Northern Rangeland Trust in charge of the conservancies.

Key policy recommendations

- Strengthen customary rangeland resource access and use rights through legal statutes
- Enhance mechanisms for integrated land use planning.
- Implement policies that incentivize Sustainable Land Management (SLM) such as climate change fund
- Develop market-based instruments to incentivize the environmental benefits such as mechanisms for payment of ecosystem services
- Introduction of innovative community-based natural resources governance frameworks that integrate customary practices into modern local government natural resource management systems
- Multi-stakeholder platforms and frameworks at county, and national levels to collaborate in planning, implementing, monitoring and evaluating LDN interventions.
- Build the capacity of communities and their leaders to enable them manage rangelands and their resources effectively. Capacity building should include sustainable rangeland management practices, financial management, dispute resolution, security operations and data collection and analysing, and documentation.
- Ensure gender equality and equity in rangeland rehabilitation, conservation effectiveness and sustainability.

About the ELD Initiative and the "Reversing Land Degradation in Africa through Scaling-up Evergreen Agriculture" project

Land degradation, desertification, and drought are widespread global issues that increasingly threaten the future of our environment. They lead to a loss of services from land and land-based ecosystems that are necessary for human livelihoods and economic development. Food production, water availability, energy security, and other services provided by intact ecosystems are jeopardised by the ongoing loss of land and soil productivity.

Desertification already affects around 45 % of the African continent (ELD Initiative 2017), indicating an urgent need for action. Failure to act on this threat would have serious negative impacts on the economies and sustainable development opportunities.

The Economics of Land Degradation (ELD) Initiative is a global initiative established in 2011 by the European Union (EU), the German Federal Ministry for Economic Cooperation and Development (BMZ) and the United Nations Convention to Combat Desertification (UNCCD). The Initiative provides specific scientific support to decision makers on national and international level. A broad network of partner experts and institutions supports the Initiative, which aims at transforming the global understanding of the economic value of productive land and improving stakeholder awareness of socio-economic arguments to promote sustainable land management.

The ELD Initiative provides ground-truthed tools and assessments that allow stakeholders to undertake cost-benefit analyses of land and land uses through total economic valuation and include this information in decision-making. The Initiative is coordinated by the ELD Secretariat, hosted by the Sector Project Soil Protection, Desertification and Sustainable Land Management within the German International Cooperation (GIZ) in Bonn, Germany.

Land degradation is explicitly included in objective 15 of the United Nations' sustainable development goals (SDGs), which have been adopted in 2015. SDG 15 aims at *"protecting, restoring and promoting sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss".*

The objectives 15.3. and 15.9. aim at achieving land degradation neutrality as well as at the integration of ecosystems and biodiversity values into national and local planning. On international level, the United Nations Convention to Combat Desertification (UNCCD) has been appointed as custodian agency for SDG 15.3 and, by developing economic arguments, the ELD Initiative complements the work of the scientific and technical committee of the Convention.

Land degradation is a complex and detrimental problem, affecting many aspects of human life, which means that it cannot simply be eliminated by implementing some technical or technological measures. The fight against degradation rather requires holistic measures, which will then simultaneously enable to reduce poverty (SDG 1), improve food security (SDG 2), sustainably manage water and waste water (SDG 6), enhance economic development (SDG 8), encourage sustainable consumption and production (SDG 12), improve adaptation to climate change (SDG 13), and to contribute to freedom and justice (SDG 16).

The Project *Reversing Land Degradation in Africa by Scaling-up EverGreen Agriculture* started in 2017, and aims to improve livelihoods, food security and climate change resilience by restoring ecosystem services. The project target countries are Ethiopia, Ghana, Kenya, Mali, Niger, Rwanda, Senegal, and Somalia. The action is financed by the European Union (EU) and co-financed by the Federal German Ministry for Economic Cooperation and Development (BMZ). It is carried out jointly by the ELD Initiative and the World Agroforestry Centre (ICRAF).

The role of the ELD Initiative within this project is to raise awareness on the threats and opportunities of different land use options by supporting and communicating cost-benefit analyses in each target country. At the same time, the Initiative extends the capacity of national institutions and experts to assess the economic benefits of investments in sustainable land management in consideration of the costs of land degradation.

The present report has been developed in the framework of such a process on national level. It provides decision-makers and administrators with scientific information on the economic consequences of land degradation and optional pathways to rural growth.

Acronyms and abbreviations

AEZ	Agro-ecological zones
ASAL	Arid and Semi-arid Lands
CBA	Cost Benefit analysis
CWC	Community Wildlife conservancies
DM	Dry matter
ELD	Economics of Land Degradation
EU	European Union
FAO	Food and Agricultural Organization
FGD	Focus Group Discussions
GoK	Government of Kenya
Ha	Hectares
HWC	Human Wildlife Conflicts
IGO	Intergovernmental Organization
IIED	International Institute for Environment and Development
IRR	Internal Rate of Return
LDN	Land Degradation Neutrality
NAP	National Action Plan
NGO	Non-governmental Organizations
NPV	Net Present Value
NDMA	National Drought Management Authority
NRM	Natural Resource Management
NRT	Northern Rangeland Trust
PSA	Participatory Scenario Analysis
SD	Standard Deviation
SLM	Sustainable Land Management
TLU	Tropical Livestock Unit
UNCCD	United Nation Convention for Combating Desertification
WRMA	Water Resource Management Authority

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1. INTRODUCTION

Drylands make about 40 per cent of the global land surface (Sutie et al., 2005) and constitute approximately 69 per cent of the world's agricultural land (FAO, 2009). They are important habitats for wild flora and fauna as well as for domestic livestock (Osano et al., 2013). Drylands are predominantly used for pastoralism, which is a low external input subsistence system characterised by extensive livestock production (Galvin, 2009). The system is grounded on a strategic exploitation of resources that are non-uniformly distributed in space and time (Wasonga et al., 2003). The spatio-temporal variability in water and pasture availability influences mobility and settlement patterns of pastoral communities leading to the development of pastoralism as the most suitable livelihood in the arid and semi-arid areas (Galvin, 2009).

In Kenya, pastoral production systems are confronted with a variety of risks that constantly disrupt pastoralists' livelihoods and devastate assets. These risks, coupled with limited and increasingly ineffective risk management options, underlie the vulnerability of drylands. Some of the challenges facing the pastoral communities include land degradation, land tenure changes, diminishing grazing resource base and frequent droughts which undermine pasture and livestock productivity (Gao et al., 2009). Movement of livestock herds to track pasture and water is a central component of rangeland management (Galvin, 2009). However, it has been compromised due to declining access to rangeland resources occasioned by, among others, degradation of grazing land, loss of grazing land to crop agriculture, poor watering point management, conflicts and insecurity arising due to the breakdown of traditional institutions and social change necessitated by changing human aspirations and economic needs (De Jode, 2009; Gao et al., 2009). These challenges undermine rangeland productivity and therefore the ability of pastoral communities to cope with the challenges of complex and dynamic ecosystems (Kassahun et al., 2008).

For a long time, pastoralists have used various adaptive and flexible risk management strategies and resilience enhancement mechanisms to maintain their lifestyle (Barrow et al., 2007). These strategies include: pasture deferral, which includes grazing bans near water points during the wet season by having wet and dry season grazing areas; maximizing stocking densities to ensure a biomass threshold below which grazing is not allowed to avoid overgrazing; livestock species diversity, which involves keeping mixed species of animals such as browsers and grazers to maximise the use of scarce resources; splitting of herds into satellite herds that graze and browse far away from the homesteads, and home-based herds which comprising lactating animals and young ones that graze around homesteads; and livestock redistribution among friends and relatives as a social insurance against shocks (Oba, 2012; Wasonga et al., 2003). Unfortunately, due to changes in policies, increases in human population and changing lifestyles, a number of these strategies are becoming increasingly constrained, thus affecting pastoral production systems (Barrow et al., 2007).

Although there are a number of emerging land governance systems, customary natural resource management institutions have traditionally formed the basis of managing land and land-based resources in Africa's drylands. In northern Kenya for example, the Borana community traditionally used the Dedha system to regulate use of grazing resources in their territory. However, Community Wildlife Conservancies (CWCs) are increasingly gaining popularity as community-based natural resource management (NRM) options for achieving sustainable co-existence and complementarity between wildlife conservation and livestock production in the

region. Kenya's *Wildlife Conservation and Management Act 2013* defines conservancy as 'land use system where land is set aside by an individual land-owner, corporate body, group of owners or a community for the purposes of conservation' (Gok, 2013). The CWCs are based on the premise that communities and land-owners can be the stewards of wildlife conservation working together with government agencies to protect, and benefit from, a healthy and productive environment.

Conservancies therefore, serve as the main NRM institutions in areas where the traditional governance systems are either weak or absent. The conservancies have increased since the 1990s and by 2015, there were over 140 Private and Community Conservancies covering 7.5 million acres (30,300 km^2) of land and located in 24 Counties in Kenya (King et al., 2015). They are managed by a board selected by members of the communities. The community conservancy board is the primary decision-making institution of a Community made up of democratically elected representatives with equitable representation from the community and ethnic groups as well as women and youth. Working under the board are various committees including grazing committees whose role is to enforce regulations on grazing based on the by-laws (GoK, 2013).

Notwithstanding the popularity of conservancies in northern Kenya, not all the communities have fully embraced them. The Borana community in Isiolo County for example, have responded to recurrent droughts, associated perennial pasture scarcity and increasing demand for forage and water by reviving and strengthening the Dedha system of governance to help regulate use of grazing resources and ensure regeneration of the deteriorating land (Wasonga et al., 2016). The Dedha system comprises opinion and religious leaders selected by the community. The leaders of Dedha are guided by customary laws derived from the gada, the supreme Borana governance structure that preserves traditional laws and codes of conduct with amendments and additions based on the evolving environmental, social and cultural context (Tari and Pattison, 2014).

Using the Dedha system, the communities in Kinna, Cherab and Garbatulla wards in Isiolo County have distinctly partitioned their grazing land into wet and dry season grazing units and drought grazing reserves. This zoning is designed to cater for pastoralists' needs in different seasons of the year and ensures that the resources are used sustainably. Despite increasing interest and adoption of conservancies in Isiolo county and studies on the value of products (King-Okumu, 2018; Mulinge et al., 2015) there has been no study that examines both costs and benefits through a cost-benefit analysis. In addition, despite the positive results reported from the revival of the Dedha system, no attempt has been made to attach value to the approach. This study therefore seeks to undertake a cost-benefit analysis of conservancy and Dedha systems so as to provide information about their potential out- and up-scaling in the drylands of Kenya for sustainable rangeland management.

1.1. Relevance of the study

The arid and semi-arid lands (ASALs) in northern Kenya are affected by inherently unpredictable rainfall and frequent droughts, which are exacerbated by climate change. This has resulted in deterioration of land resources, leading to forage and water shortages that negatively impact livestock productivity. The situation is made worse by the rising demand for products from rangelands and a shrinking grazing resource base, which results from factors such as land tenure and land use changes and conflicts that restrict access to critical grazing areas especially during dry seasons. The result is land degradation that is made worse by climate change. Any attempt aimed at enhancing resilience of the dryland environments and their livelihoods should therefore give priority to promoting sustainable rangeland management practices.

Some of these practices have not been able to produce the desired levels of productivity and thus have failed to improve the welfare of the pastoral communities or prevent rangelands from deteriorating (Macleod and Brown, 2014; Torell et al., 2013). Besides, the economic valuation of these rangeland management practices has not been done (Costanza et al., 2016). Valuing rangeland services requires understanding of two main things: the rangeland components, functions and processes that produce valuable services; and how these services translate into particular benefits (Westerberg, 2016). Therefore, valuing various approaches of sustainable rangeland management not only helps to reveal the benefits from particular sustainable land management (SLM) practices, but is also crucial in guiding policies, decisions on development

intervention, as well as resource allocation. Valuing SLM in the drylands will provide information on the sustainable practices that support pasture production and livestock productivity, which both have a direct bearing on the livelihoods of the populations living in these areas (Keeler et al., 2012).

Precise appraisal of rangeland goods and service values permits the integration of unquantified values into principal decision-making frameworks, such as cost-benefit analysis and impact assessments along with the costs and benefits that are easily quantifiable financially (Lambert, 2013). The findings of this study will therefore make it easier to discern the value of various practices by determining their total costs and benefits which can improve the effectiveness of decisions about the proper use of rangelands (Favretto et al., 2016).

Information on the economic value of rangeland practices will not only provide incentives for these values to be incorporated into decision-making processes but also assist in generating additional financing for conservation by identifying significant beneficiaries of rangeland conservation (Pagiola et al., 2005). Incorporating cost-benefit analyses into local and watershed-level decision-making could therefore improve decision-making and management to enhance ecosystem services from rangelands.

The general objective of the study is therefore to determine the economic value of selected sustainable rangeland management practices so as to inform their up-scaling and policies on sustainable rangeland management in the drylands of Kenya.

2. POLICY AND LEGAL FRAMEWORK

2.1 Land Degradation Neutrality

Land degradation and soil fertility losses are considered to be the main challenges that hinder the government of Kenya to achieve its food production goals (Dallimer et al., 2019; Vlek et al., 2010). Land degradation is the loss in arid, semi-arid and dry sub-humid areas of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including those arising from human activities and habitation patterns (UNCCD,2019).

Land Degradation Neutrality (LDN) calls for securing enough healthy and productive natural resources by avoiding degradation wherever possible and restoring land that has already been degraded (Cowie et al., 2018). Better management practices and land-use planning can improve economic, social and ecological sustainability for present and future generations. According to Kust el al. (2017), the implementation of specific measures to achieve LDN can be differentiated across the following three states of land: (i) in land that is not degrading, avoiding land degradation involves the use of proactive measures such as appropriate regulation and planning; (ii) in land that is degrading, measures to reduce land degradation can be achieved by incorporating SLM practices; and (iii) in land that is already degraded, interventions are required to reverse degradation through restoration or rehabilitation, which actively assist in the recovery of ecosystem functions.

Kenya is rich with specific legal provisions and measures to address LDN, with a number of relevant institutions and structures across governance levels. As a tool for implementing the provisions of the UNCCD, Kenya prepared a National Action Programme (NAP) in 2002 to address the following issues (GoK, 2002):

- inadequate policies and regulatory frameworks;
- sectoral approaches to programming;
- uncoordinated and frequent shifts of mandate of dryland issues from one institution to another;
- low and uncoordinated funding;
- inadequate involvement of local communities in programming and decision making; and
- inadequate capacity for implementation, monitoring and evaluation.

However, according to Gichenje (2019), the implementation of the NAP was hampered by weak coordination between the various implementing institutions and the absence of an overarching monitoring and evaluation framework to guide the scaling-up of activities. After the promulgation of the Constitution in 2010, the *Environmental Management and Coordination Act of 1999* (EMCA) was revised in 2012 to harmonise legal requirements to address the LDN responses contained in a number of laws. EMCA with its subsidiary legislation and regulatory institutions is now the legislation for environmental management that takes precedence and has the potential to coordinate other horizontal and sectoral laws and policies with mandates relevant to the management and protection of soil and land.

2.2 The Constitution of Kenya, 2010

Kenya has a strong legal foundation to address LDN that is anchored in the Constitution. Entrenched within the Constitution are the environmental rights of citizens, the obligations of the state for sustainable environmental management, as well as guiding norms and principles with respect to public participation and safeguarding of indigenous knowledge. The Constitution devolves to county governments' specific land related functions, such as county planning and development, including land survey and mapping, boundaries and fencing, and housing. County governments hold unregistered community land and some categories of public land in trust for residents of the counties.

The principles of land policy articulated in Article 60 of the Constitution now constitute the core values that inform land administration in Kenya. The Article stipulate that:

> "*land in Kenya shall be held, used and managed in a manner that is equitable, efficient, productive and sustainable, and with due regard to the imperatives of equitable access; security of land rights; sustainable and productive management of land resources; transparent and cost effective administration of land; sound conservation and protection of ecologically sensitive areas; elimination of gender discrimination over land and property rights; and settlement of land disputes through recognized local community initiatives consistent with the Constitution.*"

The Constitution classifies land in Kenya as:

- Public;
- Community; and
- Private.

In the study areas of this research, most land is still held communally, and rights thereto should be determined on the basis of customary norms and practices.

2.3 Community Land Act, 2016

The Community Land Act was enacted in September 2016 as the legal framework for implementation of the community land provisions of the Constitution. It has nine parts with Parts III, IV and VI being important for SLM. In Part III of the Act, section 15 provides for all adult members of the community to constitute themselves into a community assembly who will elect between seven and fifteen of its members to constitute the community land management committee, one of the functions of which is to coordinate the development of community land use plans in collaboration with the relevant authorities.

In Part IV, section 19 provides for land use planning and development of community land. It provides that a registered community may submit to the county government a plan for the development, management and use of community land for approval. Such a plan shall, among other things, consider any relevant conservation, environmental or heritage issues; comply with environmental impact assessment requirements of the EMCA, comply with values and principles of the Constitution; and be bound by any approved relevant physical development plan. Once

approved, the plan becomes the basis for development, management and use of the community land. Registered communities are required by section 20 of the Act to put in place measures for conservation of land-based natural resources found on community land.

In Part VI, section 28 makes specific provisions regarding grazing rights. It stipulates that customs and practices of pastoral communities relating to land shall be taken into consideration by a registered community as long as they are not inconsistent with Act and other applicable law. Community land of a pastoral community shall be available for use by members of the community to graze their livestock, subject to such conditions as the community may impose based on an agreed grazing plan. Such a community may grant grazing rights to a non-member on terms and conditions, and may withdraw such a grazing right if, due to drought or any other reasonable cause, it considers such withdrawal to be in the interests of the community.

2.4 National Land Use Policy, 2017

The policy commits government to plan and develop rangelands according to their potential for livestock production, tourism, mining and energy; discourage open access to grazing land by promoting development of communal grazing management plans; and set policies that optimise the long-term productivity, efficiency, equity and sustainability of rangelands use. It requires the county government to identify and map land degradation hotspots and plan for all transboundary natural resources; to develop transboundary conflict prevention and resolution mechanisms; and to promote the use of bilateral agreements and other instruments to facilitate sustainable transboundary resource use. County planning, including land survey and mapping is the mandate of the county governments under the Fourth Schedule of the Constitution, and counties may formulate laws to regulate zoning of land for different uses. The responsibility for reducing and avoiding land degradation is vested in the county government under the Fourth Schedule to the Constitution of Kenya 2010.

2.5 County spatial plans

The County Governments Act provides for county spatial plans as an integral part of the county development planning framework. The strategic objective of the Ministry of Lands, Energy, Housing and Urban Area Management is to develop spatial plans that will provide a spatial framework to guide, coordinate development activities and manage resources according to the concerns of pastoralists and agro-pastoralists in the use of rural land within the county.

2.6. Synthesis of policy and legal framework

With the above policy and legal framework for LDN in Kenya, there remains some shortcoming in the disjointed approach that is scattered across policy areas. According to Gichenje (2019), some of the key policy improvements needed to support effective implementation of LDN in Kenya include: a national soil policy on the management and protection of soil and land; a systematic and coordinated data collection strategy on soils; mobilisation of adequate and sustained financial resources; streamlined responsibilities and governance structures across national, regional and county levels.

According to the Kenya Strategic Investment Framework on SLM 2017-2027, efforts have been made to promote SLM but there is no dedicated policy for SLM in Kenya. Policy issues touching on SLM are addressed in the context of other developmental priority areas like agriculture, water, environment and soils. Under such circumstances, priority setting with regard to effective implementation of SLM is limited by competition for resources between SLM priorities and other sectoral priorities. In this regard, there is need to raise the profile and publicity of SLM issues in order for it to be accorded the requisite consideration and weight for a dedicated policy.

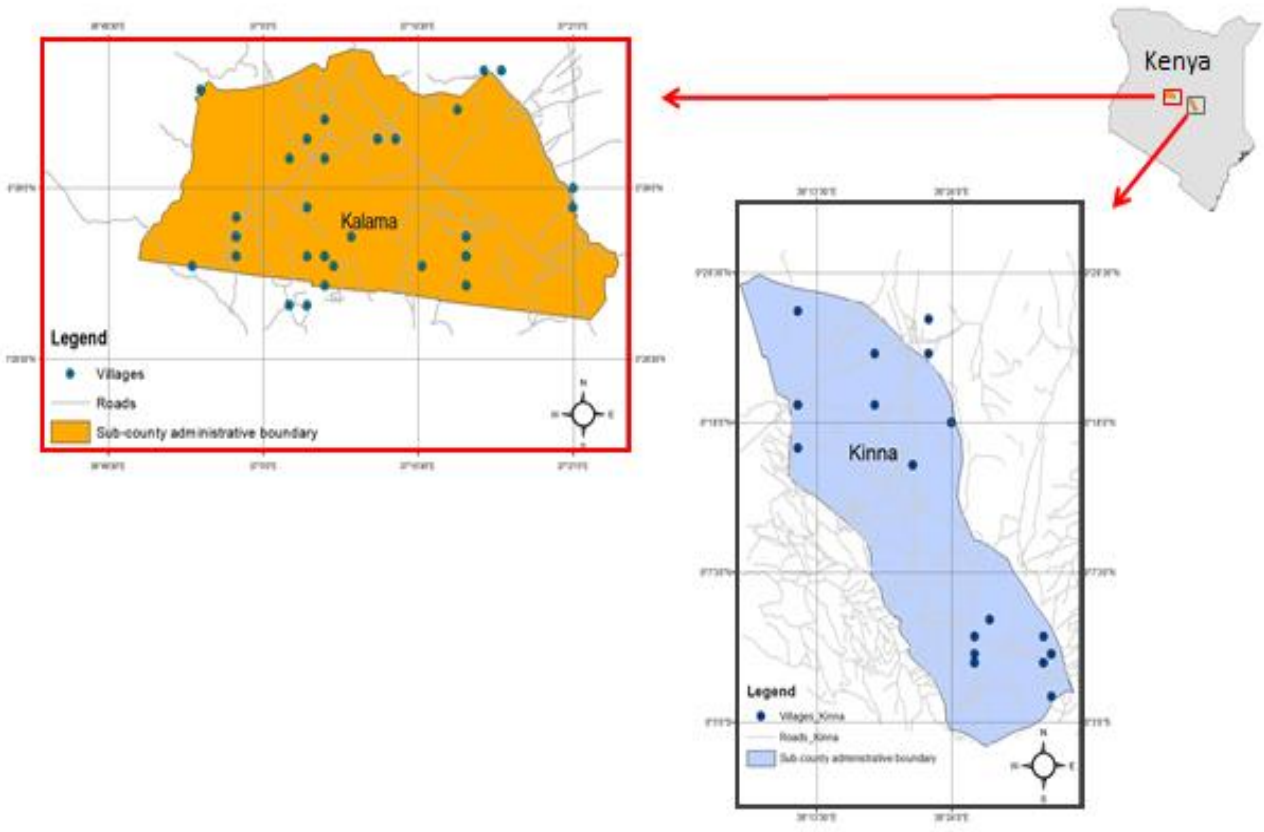
There is little coordination or interaction of the actors, ideas or utilisation of the lessons learnt from various SLM projects implemented by different ministries which has led to duplication of efforts and inefficient use of resources, as well as gaps that should not have existed.

3. METHODS

3.1 Study area

The study was conducted in Kalama conservancy Samburu County and Kinna in Isiolo County (Figure 1). The area is hot and dry in most months in the year with two rainy seasons. The rainfall is usually scarce and unreliable, posting an annual average of 580.2 mm. The wettest months are November with an average of 143 mm of rainfall and April with an average of 149 mm of rainfall. The short rain seasons occur in October and November, while the long rain season is between March and May. The mean annual temperature in the counties is 290C (Noor et al., 2013). The main economic activity in the counties is livestock production, with over 80 per cent of the inhabitants relying on livestock for their livelihoods (Kagunyu, 2014).

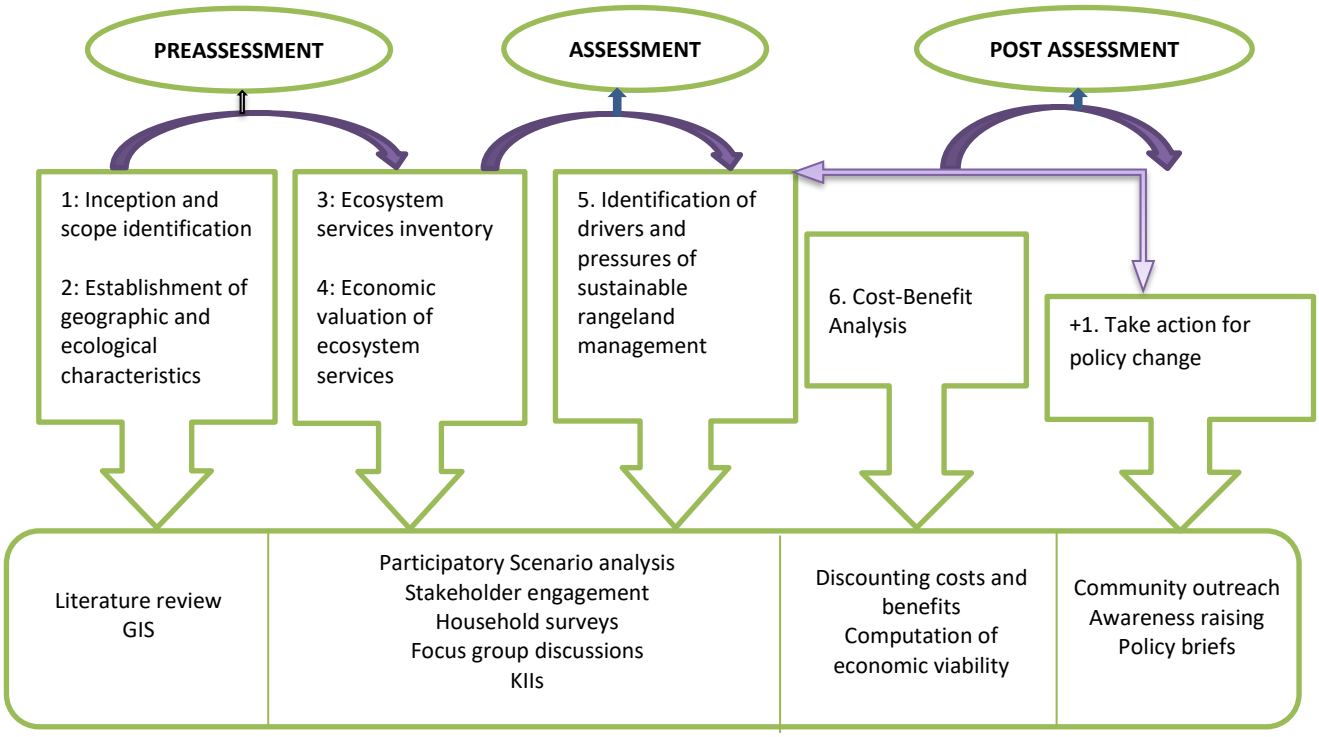
Figure 1: Map of case study area



3.2 The 6+1 step approach of the ELD Initiative

In this study, we used the 6+1 step approach (ELD, 2015) that was adopted by the ELD Initiative to guide through the process of establishing scientifically sound cost-benefit analyses of the rangeland management practices to inform decision-making processes as shown below.

Figure 2: The 6+1 step approach of the ELD Initiative



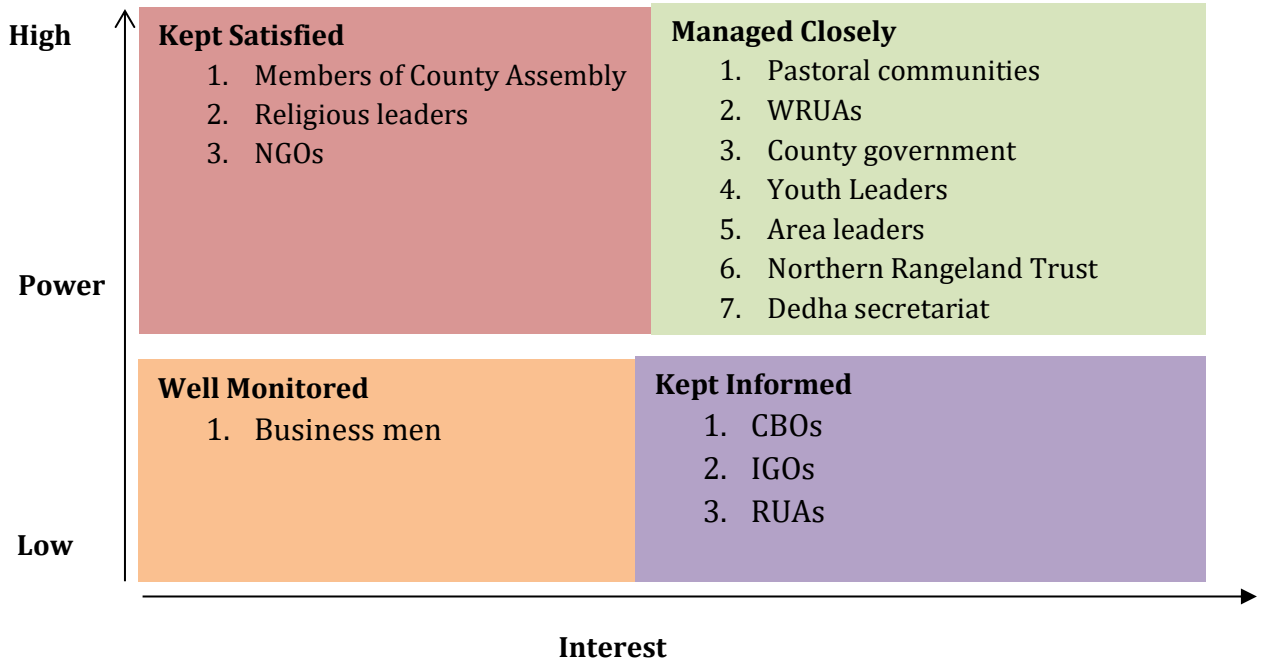
Step 1: Inception and scope identification

An understanding of the local context, including stakeholder mapping and analysis was done at this stage. Key stakeholders in the management of land resources within the study areas were identified in the inception phase. Any individual, group or institution who has vested interest in the natural resource management and livelihoods of communities living in Isiolo and Samburu counties and/or who potentially can be affected by land-use planning process and has something to gain or lose if conditions change or stay the same was considered a stakeholder. In this case, all those who needed to be considered in achieving sustainable rangeland management and whose participation and support was crucial to its success was considered. Table 1 shows the key stakeholders who were identified according to their level of influence and interest in sustainable rangeland management in the study area.

The scope, rationale, spatial scale, and strategic purpose of the study was outlined and agreed upon with all stakeholders. The scope of the study included:

1. Characterising the governance system of the conservancies and Dedha land management systems.
2. Conducting a CBA of Kalama conservancy and Dedha system of resource governance.
3. Analysing communities' perception on sustainability of the preferred range management practices under changing climate and environment.

Table 1: Stakeholders identified in the study area



Step 2: Establishment of geographic and ecological characteristics

A Geographic Information System (GIS)-based approach was used to assess land cover and the respective categorisation of the study areas into agro-ecological zones. Extensive review of existing information was done to assess the vegetation characteristics, quantity, spatial distribution and ecological characteristics of the two study sites. The study sites in Kinna and Kalama are all in northern Kenya. The two study sites are hot and dry in most months of the year with two rainy seasons. The short rains season occurs in October and November while the long rains season occurs between March and May. The scarce rainfall in the two sites amounts to an average of 580.2 mm per annum with November and April being the wettest months receiving 149 and 143 mm respectively. The erratic and unreliable rainfall cannot support crop farming, which partly explains the high food insecurity and poverty levels in the county (GoK, 2013).

Kinna ward is predominantly inhabited by the Borana Community. The ward is classified as 100 per cent arid and semi-arid, covering two agro-ecological zones (AEZs) (see Table 3): semi-arid and arid (Herlocker et al., 1993; Sombroek et al., 1982; GoK, 2013). The semi-arid zone (Zone V) partially covers the southern parts of Kinna Ward in Isiolo South Constituency. This zone receives between 400 and 650 mm of rainfall annually and the vegetation mostly consists of thorny bush with short grass. The arid zone (Zone VI) covers northern parts of Kinna Ward. Rainfall ranges between 300 and 350 mm annually and supports grassland and few shrubs. Given the aridity of the area, 80 per cent of the land is non-arable and used for grazing. Much of the land is communally owned and is under the trusteeship of the county government.

Table 2: Agro-ecological zones of Kenya

AEZ	Classification	Moisture index R/E_o ration (%)	Annual rainfall (mm)	Land Area (Km^2)	Land Area (%)
I	Humid	>80	700	25,400	4.4
II	Sub-humid	65-80	1000-2200	23,800	4.1
III	Semi-humid	50-65	950-1500	25,700	4.4
IV	Semi-humid to semi-arid	40-50	500-1000	28700	4.9
V	Semi-arid	25-40	300-600	87,300	15.0
VI	Arid	15-25	200-400	126,400	21.7
VII	Very arid	<15	150-300	265,300	45.5
Total				**582,600**	**100**

Source: GoK (2016)

The community in Kalama is predominantly Samburu (82%) with some Turkana (13%), who are semi-nomadic pastoralists practicing livestock management. The total land area is 49,983 hectares with a core conservation area of 3,208 ha and buffer zone of 12,203 ha. The main water sources in Kalama Conservancy are boreholes, hand pumps, windmills, dams, natural springs and shallow wells. The other sources are the Uaso Nyiro River, which is a permanent river and Laresoro, Nolkilepu and Ilkwaso, which are seasonal rivers. Kalama conservancy has a diversity of plant species. The main trees are Ltepes (Acacia tortilis), Loichimi, Samanderi (Commiphora spp.), and Lchurai (Acacia reficiens). Other plant species found in the conservancy include Siteti, Lpupoi (Grewia fallax, G. villosa.); and the invasive, non-indigenous Prosopis juliflora (Mathenge) is also present. The Conservancy Grazing Committee governs community grazing patterns. Management zones within the conservancies have significant impacts on the trends in green vegetation year-round. Both the conservancy and Dedha have experienced significant increases in the amount of green vegetation as shown in Figures 3 and 4.

Figure 3: Changes in green vegetation in the conservancy area

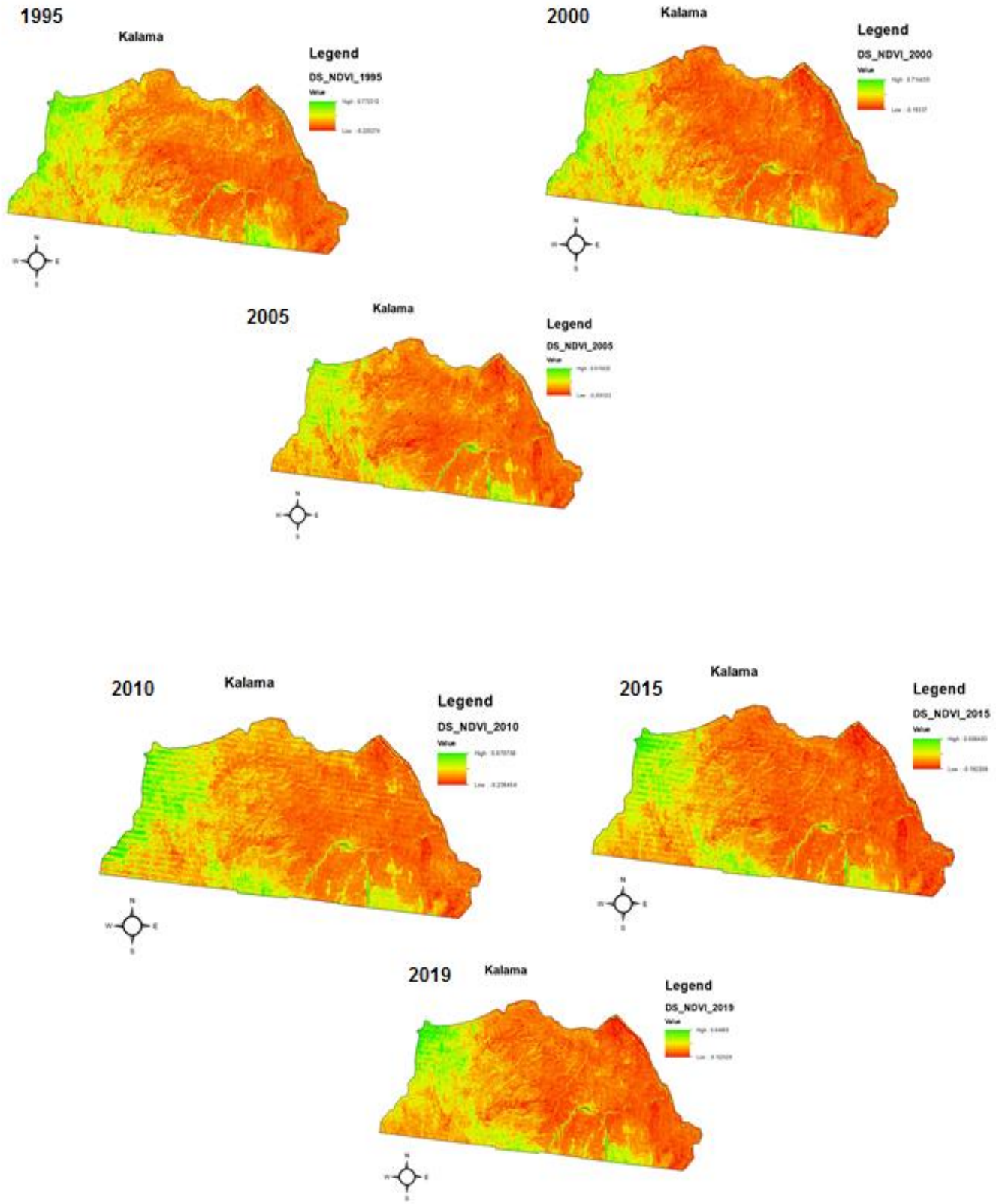
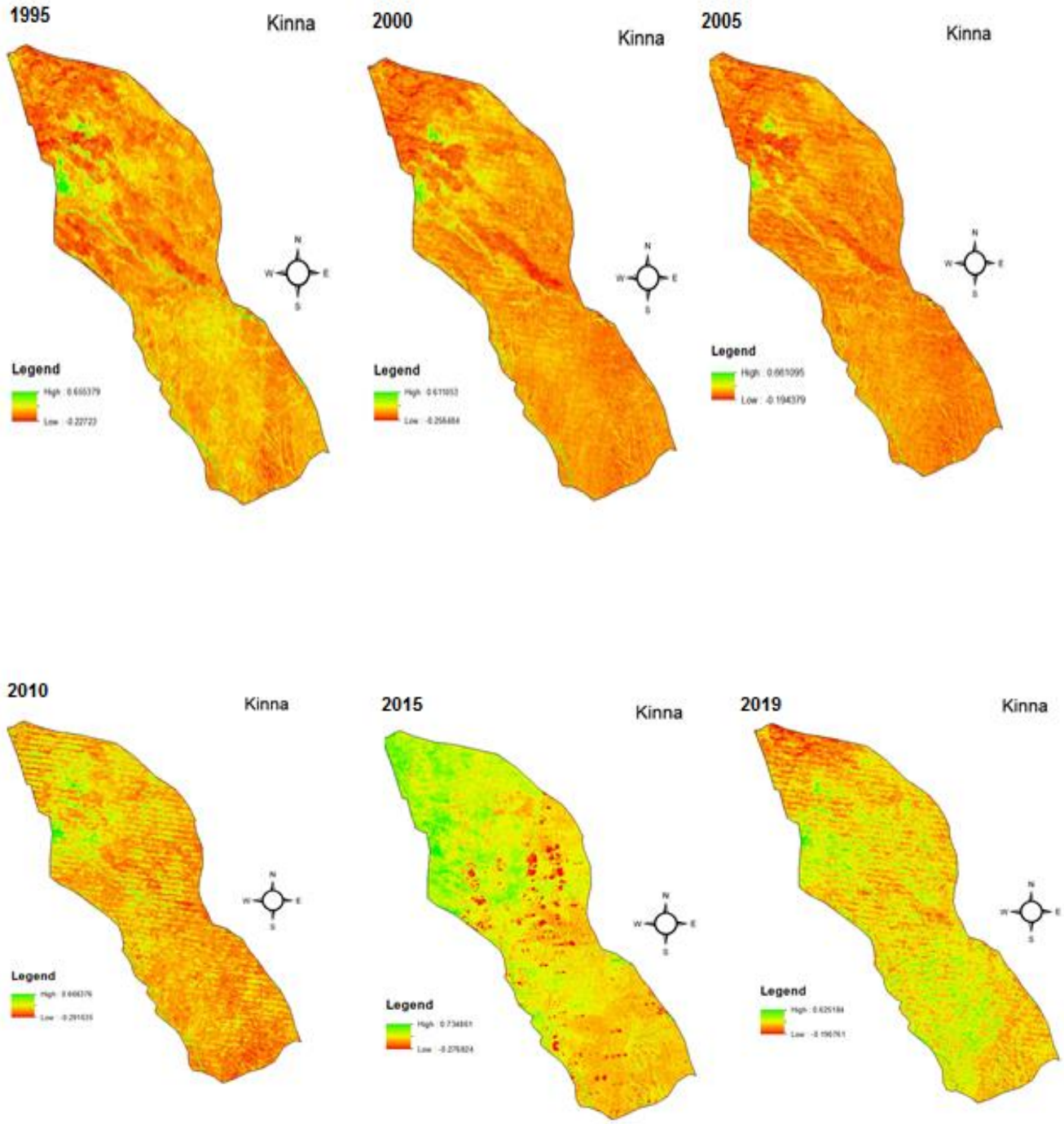


Figure 4: Changes in green vegetation in the Dedha area



Step 3: Ecosystem services inventory

This phase involved the assessment of the type and state of ecosystems services stocks and flows for each study site based on the ecosystem service framework of the Millennium Ecosystems Assessment (2005). Participatory methods including stakeholder workshops, focus group discussions, key informant interviews observation and field surveys were used to determine the main ecosystem services. Ecosystem services identified are shown in Table 4.

Table 3: Ecosystem services identified in the study sites

Provisioning services	Regulating services
1. Water 2. Fodder/pasture 3. Fuelwood 4. Pods 5. Opoponax 6. Medicinal products 7. Livestock 8. Milk, meat, Hides and skin 9. Manure 10. Tree/timber	1. Flood control 2. Reduced loss of livestock 3. Water purification, 4. Air quality maintenance, pollination, pest control, 5. Erosion control 6. Climate control with carbon storage and sequestration.
Supporting services	**Cultural services**
1. Nutrient cycling	1. Peaceful Human-Human interactions 2. Human-Wildlife coexistence

Step 4: Economic valuation of ecosystem services

After identification of ecosystem goods and services, an assessment of the role of ecosystem services to livelihoods of pastoral communities living in the study sites was done. This involved the community attaching monetary value to ecosystem services that do not have a market price but still play indirect roles in the market. Although there has been an increasing trend of undertaking economic valuation of ecosystems goods and services, there are still data gaps, often resulting in incomplete cost and benefit assessments. Because of the short-term nature of projects, economic benefits of ecosystem services also tend to be measured for the short term (Torell et al., 2013; Xie et al 2016; Kelemen et al., 2014). In the case of adaptation, there are similar difficulties in assessing the costs and benefits, specifically when looking at ecosystem-based adaptations and its related benefits. Ecosystem services have value to humans because they are scarce and provide utility. According to Chee (2004), valuation of natural resources is considered a complex process because most of the services and benefits are non-marketed and thus placing a monetary value on them represents a challenge. This has led to little attention being paid to values of ecosystems mainly because their services are not fully traded in a structured market and thus receive no consideration in a decision-making process by

various policy makers (Constanza et al 2016). Valuation methods start with utility, the satisfaction derived from the goods and services provided by the ecosystem (Torell et al., 2013).

Participatory methods were used to determine the social, economic and environmental aspects of the ecosystem services in the study areas. Scenario analysis was used to provide avenue for participatory evaluation which provided information about the potential and desired futures, enhanced understanding for complexity and facilitated discussion of planning options for sustainable rangeland management. Naturally, the pastoral communities use, value and shape the environment they live in, so they were fully involved in scenario analysis as they are the ones who are affected, and eventually will implement ideas, work with conflict resolutoin or make decisions for sustainable management of their ecosystems. Community participation ensured better inclusion and integration of the existing values, experiences and various types of knowledge in the study areas. Local expert knowledge and experiences improved the quality of the information obtained for decision-making, increasing its credibility and legitimacy. In order to determine the economic value of the different ecosystem services, we used different methods for different ecosystem goods and services as shown in Table 4.

Table 4: Valuation methods used for each ecosystem service

Category	Ecosystem service	Valuation method used
Provisioning services	1. Water	Avoided cost/replacement cost/Market pricing
	2. Fodder/pasture	Market pricing/production approach
	3. Fuel wood	Market pricing
	4. Pods	Market pricing
	5. Opoponax	Avoided cost/Market pricing
	6. Medicinal products	Avoided cost cost/Replacement cost
	7. Livestock	Market pricing
	8. Milk, meat, Hides and skin, Manure	Market pricing
	9. Trees/Timber	Market pricing/Avoided cost
Regulating services	10. Flood control	Replacement cost/ CVM
	11. Reduced Livestock loses	Avoided cost/ Market pricing
	12. Air quality maintenance, pollination, pest control	Avoided cost/CVM
Supporting services	13. Nutrient cycling	Avoided cost/Production approach
	14. Land productivity	Avoided cost/Production approach
Cultural services	15. Peaceful Human coexistence	Avoided cost/CVM
	16. Reduced HWC	Avoided cost/CVM

Step 5: Identification of drivers and pressures of SRM

Drivers and pressures on the sustainable management of rangeland resources were identified at this stage. The project engaged local stakeholders including local community members to identify priority ecosystem services and concerns. Subsequently, an inventory and scoping study on potential challenges and management options for improving landscape-level ecosystem service delivery was conducted again with strong stakeholder engagement. A local consultative workshop on rangeland management and resources was held to stimulate dialogue on management planning. Possible gendered differences in prioritisation of ecosystem services, challenges and management options to improve their delivery were considered explicitly in all activities of the project. Effective participation of all genders and ages as well as the all-important split among traditional pastoralists and traditional farmers was ensured from early in the stakeholder engagement process and provided facilitation for separate men and women meetings to enable effective participation of women in focus group discussions and land use planning. Finally, the teams responsible for organisation and facilitation of stakeholder meetings were composed of an effective combination of both women and men, which we believe encouraged the genuine participation of women. This information was used to inform the development of alternative scenarios for cost- benefit analyses.

Step 6: Cost-benefit analysis

This step involved the assessment of the conservancy model and that of the traditional (Dedha) models for sustainable rangeland management. The analysis focused on quantified advantages (benefits) and disadvantages (costs) associated with the management options. The management options here refer to institutions, norms and processes that determine how power and responsibilities over rangeland resources are exercised, how decisions are taken, and how citizens – men, women, indigenous people and local communities – participate in and benefit from rangeland productivity and management of range resources. In order to achieve a LDN rangeland in the context of sustainable development, proper governance structures are required (Robinson and Berkes, 2011). The governance structures ensure sustainable land management practices such as holistic grazing management, controlled grazing while conserving soil and water, and the establishment of forage trees along with grasses and legumes to enhance biodiversity. This study focused on the ecosystem benefits that arise from the proper management of the rangelands by considering the benefits for action in terms of the ecosystem services.

Cost-benefit analyses are used for this purpose, as it compares the costs of adopting a SLM practice against the benefits derived from it (Dallimer et al., 2018). The costs and benefits were estimated using the methods detailed in Step 4. When it comes to decision-making, timing is the most important element. A thirty-year timeline (between 2019-2049) for expected costs and revenue and how much they will pan out over the period was agreed upon by all stakeholders identified in Step 1. The future costs and benefits were converted into their present value by discounting the benefits by the prevailing discount rate. The net present values were computed by subtracting costs from benefits. A sensitivity tests showing what would happen to the indicators if the parameters and assumptions were different from base-case values was also done.

Step 6+1: Take action

This is the final step which require the actual implementation of the recommendations resulting from the cost and benefit analysis. The communities involved in the project were able to understand the economic value of the ecosystem services that rangelands provide. This will stimulate more efforts for conservation and proper management of the land resources to avoid deterioration of rangelands through recommendations herein.

3.3 Data collection

This study adopted a participatory approach where data was collected using various qualitative research methods. The research methods included household interview, focus group discussions, workshops and key informant interviews as well as ad hoc interviews and documentary research. The population from which the sample was selected were pastoral communities living within Kinna (Dedha) and Kalama conservancies, numbering 400 households.

Primary data was collected using a semi-structured questionnaire, administered to the respondents through oral interviews at their homes. Participatory scenario analysis workshops were used to strengthen participatory aspects by engaging local community in interviews and discussions concerning sustainable futures of their grazing management practices. Each workshop comprised of participants who had knowledge in the pastoral ecosystems. The participants consisted of a mix of interest groups such as NGO and Inter-Governmental Organizations representatives (IGO), county officials, resource user associations and community members. During the workshops, participants identified actors in grazing management in the county and ranked them according to their influence and role in grazing management, the role of county government in grazing management, the ecosystem services, the pressure and patterns of rangeland degradation (see the 6+1 approach above) and decision-making.

Focus Group Discussions (FGDs) involving 10–12 participants who had vast knowledge on social and cultural practices of the area were done in each study site. Separate FGDs were conducted for men and women participants. The data collected was used to cross examine the quantitative information collected from household surveys. The key informant interviews were also conducted with the Dedha officials; conservancy officials; Kenya Wildlife Service wardens; Northern Rangeland Trust officials; Kenya Wildlife Conservancy officials; County director of livestock, the director of environment and natural resources; County director of national drought management authority.

3.4 Valuation scenarios

Initial scenario

Rangelands in Kinna and Kalama are characterised by low, spatially and temporally variable rainfall, high rates of evapotranspiration and frequent floods and poor soils, making them susceptible to degradation. Livestock production in these rangelands is carried out through commercial pastoralism. Due to the high spatial and temporal variation in rainfall in these

rangelands, mobility and capacity to access a wide range of resources is necessary in order to cater for the scarcity of grazing and water resources for livestock and wildlife.

However, traditional mobility within these areas continues to be undermined by several factors including loss of grazing land to agriculture, fencing of rangelands, poor water point management, conflicts and insecurity, establishment of administrative boundaries (national and regional) and social change necessitated by changing aspirations and economic needs. As a result of restricted mobility and other unsustainable land uses, these rangelands suffer various forms of land degradation at varying degrees, including loss of vegetation cover, soil erosion, destruction of wildlife habitats, loss of biodiversity, deforestation, salinisation of irrigated areas and soil compaction. The degradation of biophysical rangeland resources has serious consequences for wildlife and the human inhabitants of these rangelands. Large areas are therefore dominated by low quality forage plant species and remained near bare for the greater part of the year. This affected livestock productivity due to inadequate feed supply resulting from increasing drought frequencies and changing land use and tenure systems.

Conservancy scenario

Conservancy is a form of land use where land is set aside by individual landowners, group of owners or a community for purposes of wildlife conservation and livestock grazing. Kalama community wildlife conservancy started in 2002 with a total land area of 49,983 hectares, of which 3,208 hectares was designated as a core conservation area and buffer zone of 12,203 ha. Grazing of livestock is permitted in the buffer zone during the dry season but it is not allowed in the core conservation area. The conservancy is managed by an elected management board which is responsible for the day to day running of the conservancy. The Conservancy Board is the executive body of the conservancy and responsible for managing its resources on behalf of the conservancy members. There is also a grazing committee elected among community members which manages grazing regulations in the pasture lands. They graze their livestock along Uaso Nyiro River and around the settlement areas during the wet season. During the dry season community members graze their livestock within the group ranch to the north and east in the the conservancy buffer zone. Holistically planned grazing defines dry and wet season grazing blocks; animal impact, including setting temporary bomas on highly degraded areas and bunched herding of cattle used in intensive grazing plans; manual clearing of invasive and non-palatable vegetation and re-seeding perennial grasses. The Conservancy Grazing Committee governs community grazing patterns. The board has the following functions:

- Identify degraded areas for rangeland rehabilitation, grass-reseeding, and gully rehabilitation.
- Develop settlement and land-use plan, including settlement relocation.
- Develop and support wet and dry season grazing plans for all settlement areas.
- Develop and enforce grazing by-laws.
- Create water points for wildlife to reduce human-wildlife conflict.
- Carry out effective anti-poaching/wildlife coexistence community awareness meetings.
- Carry out awareness meetings on wildlife compensation and human wildlife conflict.
- Identify critical wildlife corridors and ensure not blocked by settlements.

Dedha scenario

Dedha is an indigenous community-led initiative for natural resource governance comprising of opinion and religious leaders selected by the community. The leaders of Dedha are guided by customary laws derived from the gada, the supreme Borana governance structure that preserves traditional laws and codes of conduct with amendments and additions based on the evolving environmental, social and cultural context (Tari and Pattison, 2014). It was revived in 2013 with support from the Adaptation Consortium to prioritise the strengthening of natural resource governance and significantly move from vulnerability to resilience.

Dedha system aims to sustainably plan grazing areas and their access, and to undertake surveillance. The surveillance has led to preservation of strategic drought reserves such as Yamicha in Merti and Kinna sub-county drought reserve that border Meru National Park. This zoning is designed to cater for pastoralists' needs in different seasons of the year and ensures that the resources are used sustainably. The choice of the grazing areas is made by community members who meet regularly under the council of elders. The grazing area consists of different grazing blocks. Cattle access the grazing areas twice a year: April–July and October–January. At the start of each of these grazing periods, community members aggregate all cattle into one large herd. The aggregated herd is then herded in the grazing blocks sequentially, with grazing being completed in one block before the herd moves to the next block, allowing sufficient recovery time after defoliation hence reducing overgrazing.

Community members make and agree on the laws governing the use of their rangeland resources including: rotation grazing, bunched herding, banning tree cutting for charcoal, livestock grazing, grazing ban near water points during the wet season, maximising stocking densities to ensure the biomass threshold below which grazing is not allowed to avoid overgrazing and rangeland reseeding. Proper management of water points, preventing degradation and overgrazing and preserving dry season grazing areas has had a positive effect on biomass yield and water storage capacity which traditionally benefited the community across the seasons.

3.5 Cost-benefit analysis

Most investments in range improvements and management practices usually have a life expectancy of more than one year. The benefits begin to accrue after a span of more than ten years for some investments. This usually leads to operation and maintenance costs incurred over a span of years. These improvements should, as their main objective, bring in a flow of returns or benefits over a projected period. The future flows of returns and expenditure do not have a common point in time. Therefore, to be able to bring the future flows to a common time base, several factors were taken into consideration. The time value for money was considered by setting a 30-year timeframe (2019–2049) over which to perform the analysis and discounting the future benefits that accrue and costs incurred over the same period of time. These, according Dallimer et al. (2018), allowed calculation of the net present value (NPV) of the different benefits and costs involved in sustainable management of rangeland resources under the different scenarios under study as shown in Equation 1 and 2.

Equation 1

NVP of accrued benefits = $\sum_{t=1}^{n} \frac{B_t}{(1+i)^t}$ ..... (1)

Equation 2

NVP of incurred costs = $\sum_{t=1}^{n} \frac{C_t}{(1+i)^t}$ ..... (2)

Where,
B_t = incremental benefits at time *t*,
C_t = incremental costs at time *t,*
i = prevailing interest rate
n = number of years.

The computations were based on a 30-year project life for the three scenarios. The benefit-cost ratio was used to compare benefits and costs from the conservancy and the community led Dedha scenarios as shown in Equation 3.

The BCR will be computed as follows:

Equation 3

$$BCR = \sum_{t=1}^{n} \frac{B_t}{(1+i)^t} \Big/ \sum_{t=1}^{n} \frac{C_t}{(1+i)^t} \quad \text{..... (3)}$$

It is important to note that the rangelands in this case study are predominantly used for livestock production, mainly through pastoralism. Precise appraisal of rangeland goods and service values permits the integration of unquantified values into principal decision-making frameworks such as cost-benefit analysis and impact assessments along with the costs and benefits that are easily quantified financially (Lambert, 2013). In terms of ecological significance, rangeland vegetation protects fragile soil profiles, they are catchments for major rivers and also provide habitat for wild animals and plants. Despite the economic and ecological contributions of rangelands, there is considerable undervaluation of rangeland resources due to lack of knowledge of the value for those resources which have indirect uses and non-marketed services. Both the ecological benefits of the rangelands and the economic benefits were valued.

Economic valuation of rangeland resources can be defined as the process of quantifying the goods and services that rangelands provide in monetary terms (Barbier, 2007). We therefore considered the rangeland components, functions and processes that produce valuable services in the two scenarios; and how these services translate into particular benefits to the pastoral communities. For complete valuation of the costs and benefits associated with various management practices, both marketed and non-marketed goods and services were valued using cost-based approaches (see Step 4 of the ELD 6+1 approach above). Cost-based approaches are based on estimating the costs that would be incurred if benefits from the ecosystem services had to be recreated through artificial means. Since most of the benefits in the rangeland practices that we valued had no market prices, we inferred their values by how much it costs to replace it or restore it after it has been damaged.

We assumed that the cost of replacing or restoring the ecosystem services was a reasonable estimate of its value to the pastoral communities within Kinna and Kalama. We therefore used four main methods:

1. Avoided cost method where we estimated the costs that would have been incurred in the absence of the ecosystem services;
2. Replacement cost method where we estimated the costs incurred by replacing the ecosystem services;
3. Mitigation cost method by estimating the cost of mitigating the effects of loss of the ecosystem service; and
4. Restoration cost method by estimating the cost of getting the ecosystem service restored.

Valuation of benefits

Through the household survey that was conducted alongside the stakeholder workshops, the community was asked to name the changes they had witnessed in the environment as a result of the management of rangelands under the Dedha and conservancy models. All respondents agreed that there has been a tremendous improvement in the availability of pasture and water, fuelwood, pods, opoponax (natural fragrance), medicinal plants, tree and timber products, livestock products such as milk, meat, hides and skin. They also reported reduced loss of livestock through diseases, reduced floods, enhanced pasture production and reduced human-human conflicts and human-wildlife conflicts (see step 4 of the ELD 6+1 approach above). All these benefits mentioned

were valued to determine the economic value of the benefits derived from the two management systems.

In valuing pasture, we used the replacement cost of buying hay that would represent an added cost to the pastoralist if pasture no longer existed or was not adequate. In the absence of pasture, a substitute of hay which is of a similar function would have been used by the community. Presence of pasture avoids the costs associated with supplying hay substitutes. We assumed that the cost of providing a substitute of hay with a similar function as the monetary value of the pasture available as a result of proper management. To determine the amount of equivalent hay that livestock would consume in a day if pasture was not available, we estimated the Tropical livestock units (TLU) which is livestock numbers converted to a common unit using conversion factors as shown below in Table 5 (see Chilonda and Otte, 2006).

Table 5: Estimated TLU for different livestock species

Livestock species	TLU equivalent
Cow	1.00 TLU
Sheep	0.10 TLU
Goat	0.08 TLU
Donkey	0.50 TLU
Camel	1.25 TLU

The concept of TLU provides a convenient method for quantifying a wide range of different livestock types and sizes in a standardized manner (HarvestChoice, 2011). The standard used for one TLU was one cattle with a body weight of 250 kilograms. The estimation was based on assuming an average daily dry-matter (DM) intake of 2.5% of bodyweight (Mulindwa et al 2009), meaning that each TLU would consume 6.25 kg of forage dry matter daily.

Higher quality forages are fermented more rapidly in the rumen leaving a void that the animal can re-fill with additional forage consequently, increasing forage intake. Low quality forages below about 6% crude proteins will be consumed at about 1.5% of body weight on a dry matter basis per day. Higher quality grass hays above 8% crude protein may be consumed at about 2.0% of body weight. Excellent forages, such as good alfalfa, silages, or green pasture may be consumed at the rate of 2.5% dry matter of body weight per day. The combination of increased nutrient content and increased forage intake makes high quality forage very valuable to the animal and the producer. With these intake estimates, we were able to calculate the estimated amounts of hay that needed to be available.

We assumed that the grass hay quality was good with 8% crude protein since it's made from the green pasture. Cows will voluntarily consume 2.0% of body weight (5Kg of forage dry matter) per day based on 100% dry matter. Grass hays will often be 7 to 10% moisture. By assuming that the hay is 92% dry matter or 8% moisture, then the cows would consume about 6.25 kg of forage dry matter per day. We also considered hay wastage when feeding big round bales. Hay wastage was difficult to estimate, but generally has been found to be from 6% to 20% or more (Mulindwa et al., 2009). We therefore assumed 15% hay wastage. This means that approximately

12.5 kgs of grass hay must be hauled to the pasture for each cow each day. This is therefore equivalent to the standard size of a bale of hay, which is 13-18 kgs depending on the baler mechanism. One bale of hay during the dry season costs Ksh. 400 including transport costs.

In order to have an indication of the livestock resource, we took an inventory of livestock by species and for each species the annual growth rates. Principal species were cattle, camel, goats and donkeys. We then estimated the number of livestock units for each species and multiplied by the total number of livestock species estimated from the average numbers kept by the respondents to give the total value of forage required per day per species.

Water was valued using the avoided cost of buying water that the community would incur if water was not adequate. We considered the volume of water used for domestic and for livestock consumption to determine the total quantity of water needed per household per day. If water was not naturally supplied, an alternative supply had to be found to provide water. The estimates by the Water Resources Management Authority (WRMA) (2013) indicate that goats, cattle and camel will require an average of 3.5, 23.3 and 33.5 litres of water respectively per day. However, in this study, we used the estimates provided during the focus group discussions with pastoralists which showed that goats, camel and cattle require respectively 5, 35 and 25 litres of water per day. This is closer to the estimates for water demand used in the IIED study on the direct use value of ecosystem services that were developed by WRMA (2013). The assumption is that all the animals regardless of the variations due to species, breed, age, gender, lactation, pregnancy, water quality, climate and seasonal effects, animal activity diet or watering regimes take same amount of water.

The cost of buying water was assumed to be the monetary value of the available water. In this study, we used the average number of livestock kept by each household from the survey and the stakeholder workshops to determine the total livestock numbers that use water in a day. We also assumed that only livestock kept by the community members were using the water resources in the area. This is because both the conservancies and the Dedha systems would not allow other animals to graze in their area without their consent. Therefore, livestock that migrates into and consume water from other areas were not included in the study because it was difficult to estimate their numbers. According to Kenya's National Drought Management Authority reports of 2016, consumption of water in Kinna and the nearby areas is about 15–20 litres per person per day while in Samburu (Kalama) the average water consumption was between 10–20 litres per person per day. These figures are not far from what was found from the study which showed that the average water consumption was 12 litres per person per day. Because this was within the range provided for in the NDMA (2016) report, we used 12 litres per person per day in our estimates. The cost of water on average according to NDMA is five shillings per 20 litre jerrican in Isiolo and the surrounding areas, which is above the normal average of two shillings per 20 litre jerrican (NDMA, 2016). According to the community survey conducted during the study, three jerrican of 20 litres each was retailing at Ksh. 10 in Dedha and Ksh. 5 per 20 litres in the conservancy. We therefore used these prices of Ksh. 10 for 60 litres of water in Dedha and Ksh. 5 for 20 litres in the conservancy as was reported in the surveys.

The restoration cost technique was used to determine the value of regulatory services of flooding control. Effective rangeland rehabilitation has the potential to enhance vegetation regeneration and hence forage productivity in terms of herbaceous species diversity, species richness, relative abundance, percent composition, biomass production and percent cover of perennial grasses. This improves the hydraulic conductivity of the soil increasing water infiltration and reducing floods (Lutta et al., 2019). We therefore assumed that the monetary value of the rehabilitated rangelands is equal to the cost associated with restoration of the original state of households if flooding happened. To determine the value of fuelwood, we used the locally estimated market prices provided during the focus group discussions and the averages from the surveys for our calculations. Most households depend on wood energy for cooking and heating. It was found that each household uses one motorbike load of fuel for two weeks (14 days). The motorbike load which according to the group discussions usually consists of dead wood and not felled timber is sold to the households within Isiolo and Samburu areas at a rate of Ksh. 600. From the survey, all the respondents reported that they use fuelwood as a source of energy, which was valued at a rate of motorbike load.

Another important product from the ecosystem valued in both the scenarios was the use of opoponax. Opoponax also called called "sweet myrrh" has been used in perfumery and for treating wounds and clearing respiratory congestion among the pastoral communities in Northern Kenya. To estimate the value of opornanax, we determined the proportion of households that collect opoponax in the study area and the average in kilograms of opoponax that is collected and multiplied by the average price in the local market which was Ksh. 80. Other studies have shown that one kilogram of opoponax is sold to China at a rate of Ksh. 300 to 450 (Sala 2014) while in Ethiopia the traders export opoponax to the Middle East at US$15.66 (Ksh. 1,377) (Aboud et al., 2012). However, in our calculations we used the actual local market price stated by the respondents collecting and marketing opoponax.

We also considered the present value of the incremental change in livestock products such as milk, meat, hides and skin, manure arising from the different rangeland management practices using Equation 4.

Equation 4:

$$\sum_{t=0}^{30} \frac{(\Delta\ in\ LSP * price\ of\ LSP}{(1+i)^t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

Where,

Δ = *is the incremental change*

LSP = the livestock product (Either milk, meat, hides and skin, manure)

i = prevailing interest

For example, in Dedha households, milk availability per household stood at 1.5–2 litres per day compared to one litre per day normally. The increase was attributed to availability of pasture and browse and livestock were grazing within reasonable distance from homestead during the wet seasons and had dry season reserves. The average milk price ranges from Ksh. 40–60 per litre.

Pastoral systems were inherently flexible, enabling families and households to make effective use of constantly shifting resources. However, in northern Kenya, mobile pastoralism as a highly-valued strategy to manage grazing areas and exploit resource variability is becoming more complex due to recurrent droughts, loss of forage and government-led settlement schemes. Livestock numbers have declined due to recurrent droughts, shrinking grazing resource base and resource use conflicts and cattle rustling. Both Dedha and the conservancy have managed to mitigate livestock loses through reduced proper planning and holistic management of resources. We therefore estimated the avoided cost resulting from the loss of livestock which can be attributed to sustainable rangeland management. We established the average number of livestock a household would lose to drought, conflicts, pest and diseases before and after being a member of either Dedha or the conservancy. This was multiplied by the prevailing market price of livestock species as shown in Equation 5.

Equation 5

$$\sum_{t=0}^{30} \frac{(\Delta\ in\ LS\ loses * price\ of\ each\ LS\ species}{(1+i)^t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (5)$$

Where,
Δ = is the incremental change
LS = the livestock species
i = prevailing interest

We also valued the cultural benefits arising from sustainable rangeland management practices. Improved security has been shown to be the major benefit of conservancies and Dedha as well. Security for people and their livestock is one of the primary drivers for communities establishing conservancies and reviving the Dedha systems in Northern Kenya. Peace and security are the foundations for all economic and social development, as well as planning and management of natural resources on community land. Without peace and security there is little opportunity for investment and people are unable to plan how to manage their land. Among the pastoral communities living in ASAL areas of Isiolo and Samburu, conflicts over control of, and access to, natural resources are a common phenomenon.

From the stakeholder workshops and FGDs, we found that conflicts among the pastoral communities are largely caused by competition over control of, and access to, natural resources particularly water and pasture. Other causes of conflicts included historical rivalry, deep-seated cultural values, land issues, political incitements and proliferation of illicit arms. Conflicts were both intra- and inter-community and nearly all revolved around control over and access to natural resources, particularly water and pasture. Intra-community conflicts were largely as a result of land disputes. Land ownership is both communal and freehold. Inter-community conflicts were the most common types of conflict caused by historical rivalry, cattle rustling and competition for water and pasture. Climate and the associated environmental disasters, such as droughts and floods, induce forced migrations and competition over natural resources among the pastoral communities with potential negative consequences for political stability and conflict resolution (Tedesse, 2010). In Isiolo, Samburu and entire northern Kenya, the severe droughts

that used to occur every ten years now occur every five years or less (Oxfam, 2011). Both the Dedha community and the conservancy have devised ways of preventing, alleviating or resolving conflicts amongst the warring communities through the council of elders.

Community elders from the conflicting communities made treaties on peace keeping. The council of elders determined that the community of the assailant would be fined 100 cows if it was a man and 50 cows if it was a woman which was paid to the council of elders of the victim. Upon payment of the fine, a goat would be slaughtered and the blood used for cleansing. A goat meal would be shared among the warring communities' elders as a sign of peaceful coexistence. However, this strategy largely dealt with the situation at hand and thus served for specific warring situations. The study established that even after brokering of peace through the council of elders, sometimes conflicts flared up depending on the intensity of the socio-economic hardship the communities were undergoing. For instance, if livestock loss continued unabated due to climate vagaries, raiding persisted. With the Dedha and conservancy, resource use conflicts have declined and the number of cases of attack has largely reduced by 50 per cent. Conservancies and the Dedha have created a platform for dialogue, bringing different communities together and facilitating relationships, building trust between people who previously did not know each other.

To estimate the value of peaceful coexistence, we estimated the average number of cases of people killed before and after Dedha/conservancy existence. We then multiplied the difference with the number of cows paid as fines. The value of cows was determined by the market price of livestock as shown in Equation 6.

Equation 6

$$\sum_{t=0}^{30} \frac{P(IAx\ LSFP) * Price\ of\ LS}{(1+i)^t} \qquad (6)$$

Where,
P= the proportion of change in attacks
IA = initial estimated number of attacks reported,
LSFP = Livestock fines paid,
LS = livestock

Human wildlife conflicts have also reduced significantly especially in Kalama. Wildlife, livestock and people shared same resources and coexistence together. The emphasis of wildlife management in community conservancies has been through security and monitoring by conservancy rangers, with a particular focus on anti-poaching operations.

Other activities done in the conservancy include provision of water pans for wildlife and demarcation of core conservation areas for tourism where livestock grazing and settlements are restricted. A devolved system for monitoring wildlife developed by NRT (Wildlife-CoMMS) is carried out by the Conservancy. All these aspects have enhanced ecotourism and reduced human-wildlife conflicts. To estimate the value of ecotourism resulting from proper wildlife management, we used the annual revenue reported in the annual general meeting report for Kalama

Conservancy, which shows the amount of revenue paid by lodges to the conservancy. Annual revenue comes from Saruni lodge, Samburu reserve, Sarova Shaba and Bead work (NRT, 2019).

Dedha, on the other hand, do not manage wildlife and thus do not directly benefit from revenues resulting from ecotourism. However, with proper management, we found that human deaths resulting from human-wildlife conflicts have drastically reduced through proper grazing management. The community does encroach the national wildlife protected area of Meru national reserve. We estimated this as an avoided cost by multiplying the change in human-wildlife conflict cases by the compensation rate awarded by Kenya Wildlife Service.

Both the conservancy and the Dedha systems require significant investment in institution building, infrastructure and operational costs. Using the key informant interviews, document reviews and surveys, we found that major costs were incurred through:

- Awareness and capacity building of all stakeholders to understand and seek solutions to degradation of natural resources, to generate collective action and respect for land ownership, settlement plans, livestock and grazing plans, by-laws, traditional knowledge and ecosystem functions;
- Safeguarding of agreed rangelands management and rehabilitation plans and practices including household grass banks, clearing invasive species, warrior/herder forums, elder-endorsed enforcement plans, rangelands social clubs;
- Re-seeding and fodder production;
- Management of forest and wetland ecosystem management systems to stabilise, recover and sustain the forest and wetland resources; and
- Protecting wildlife habitats and threatened species.

Most of the costs incurred were determined from the records obtained for running the conservancy and the Dedha as well. In the conservancy, the main costs incurred included scouting and security, community mobilisation meetings, operation and administrative costs including salaries, range restoration programs which included amount spent on re-seeding, removal of invasive species and gully rehabilitation.

3.6 Estimation of future benefits and costs

It is important to note that the benefits accruing as a result of the proper management of rangelands and the costs incurred therein are expected for several future years to come. This is because investments in range improvements and management practices usually have a life expectancy of more than one year. To estimate the future benefits based on the current year's estimates, we used Equation 7.

Equation 7:

$$Vt = V_0 \; x \; e^{rt} \quad \text{..... (7)}$$

Where,
Vt = Value after time t;
Vo= is the current value
r = % rate of growth in the prevailing conditions,
t =Time, and
e= Euler's number

For livestock estimates, we used the estimated annual growth rates for the livestock sector in Kenya under the Africa Sustainable Livestock 2050 (ASL2050) report that developed agreed scenarios of Livestock in 2050 (FAO, 2018). The report also shows the annual consumption rate of animal products and the long-term projects under the prevailing and anticipated conditions. The report shows that livestock species will be declining in numbers by the year 2050. This was also confirmed in the stakeholder workshops and survey where the respondents attributed the decline to the major challenges to facing livestock production in agro-pastoral and pastoral areas that were skewed towards adverse effects of climate change and variability.

The study found that pastoralism is currently faced with a complex array of problems linked into vicious cycles such as frequent, devastating droughts and declining resilience capacities of pastoralist communities; resurgence of livestock diseases and decaying health delivery systems; reduced communal grazing lands, reduced mobility and diminishing carrying capacities of rangelands; marginalised pastoral economies and lack of political goodwill and deteriorating traditional institutions and rampant insecurity. Other challenges include inadequate extension services, financial constraints and low adoption of innovations. As a result of this, the herd size per household in pastoral communities will be declining. Despite the decline in the herd size, the growing, increasingly affluent and urbanised population will consume more high value food products, in particular animal source foods such as meat and milk as shown in Table 5.

Table 6: Livestock production change rates

Species	Annual growth rates (%)
Cattle	-1.6
Goats	-0.7
Camel	-1.6
Product	Consumption rate (%)
Meat	2.55
Milk	2.56
Hides and skin	Production rate
Cow	2.1
Shoats	1.3

Source: FAO, 2018

Changes in prices of various goods and services over time were determined using Kenya's projected inflation rate. The IMF report on Kenya's economy showed that in 2018, the average inflation rate in Kenya amounted to about 4.69% compared to the previous year, a significant decrease from 7.99% in the previous year. Forecasts see Kenya's inflation levelling off at around five per cent in the near future (IMF 2019). We therefore used a 5 per cent future inflation rate in our calculations. We used a human population growth rate of 2.7% (KBS 2019) to determine changes in human population in the study area.

3.7 Discount rate

Discounting was used to compare costs and benefits occurring over different periods of time by converting costs and benefits into their present values. Discounting is based on the concept of time preference that generally people prefer to receive goods and services now rather than later. We therefore considered the opportunity cost of the use of capital funds because money used in the sustainable management of rangelands costs money. We assumed that if the money was borrowed, the cost is the interest that had to be paid and if it was financed from cash reserves of the community members, then the cost is the interest foregone or could have been earned on those funds if they had been lent out. We therefore made sensitivity analysis of the results from cost and benefits analysis using three discount rates of 3.5%, 8.5% and 12% that have been used to appraise projects in Kenya.

In a study to determine the economic opportunity cost of capital funds in Kenya, Roksana (2015) found that the estimated discount rate for Kenya ranges from 10% to 14.5% in real terms. After various sensitivity analyses, the study concluded that a 12% real rate was the suitable discount rate for Kenya to be used in investment decision making. This is also the social discount rate used by the African Development Bank (AFDB) for the economic appraisal of investment projects. We also used a discount rate of 8.5% which is the average banks' deposit rate that represents the Central Bank of Kenya benchmark interest rate (Onduru and Muchena, 2011). A lower interest rate of 3.5% was also used, which according to Dallimer et al. (2018), represents a typical figure used by national and international donors and policymakers. It is the rate at which government appraisal costs and benefits are discounted using the social time preference rate.

3.8 Determinants of sustainable rangeland management

A multivariate binary logit model (Agresti, 1997) was used to establish the determinants of sustainability of the rangeland management scenarios using equation 8 below:

Equation 8

$$P_i = E\ (Y = 1/\ X_i) = \frac{1}{1+e^{-(\beta_1 \ +\beta_2\ X_i)}} \text{ .... (8)}$$

Where
Y = 1 means the scenario is sustainable, while *Xi* is a vector of explanatory variables, and *e* is the base of natural logarithm.

4. RESULTS

4.1 Socioeconomic characteristics

A total of 400 respondents were interviewed during the study survey. Of the 400 respondents, 67.5% were male and 32.5% were female. Of those interviewed, 24.5% were aged between 51 and 60 years, 22.8% were youth aged between 18 and 29 years, 22% were middle aged between 30 and 40%, 12.5% were aged between 41 and 50 years, and 18.3% were the elderly above 50 years. The majority (82.5%) of respondents were married. More than half (50.3%) of the respondents had a monthly income of less than Ksh. 10,000 (*Ksh. 100 = I dollar*), 43.3% earned between Ksh. 10,000 and 20, 000 while only 6.5% earned between Ksh. 20,000 and 30,000. The average household size was 5.94. The results in Table 6 also indicate that more than half of the respondents (87.4%) had basic education with 39.4 %, 44.2% and 3.8% attaining primary, secondary and tertiary levels of education respectively. As shown in Figure 5, almost half of the respondents (47.5%) reported that the land was severely degraded, 38.6% said it was moderately degraded while 12.7% were convinced that their land was not degraded. A majority (76%) have observed changes in land cover and pastoral resources over the last 2 years since the conservancy/Dedha system was set up in their area (Figure 6).

Figure 6: Land degradation in the study sites

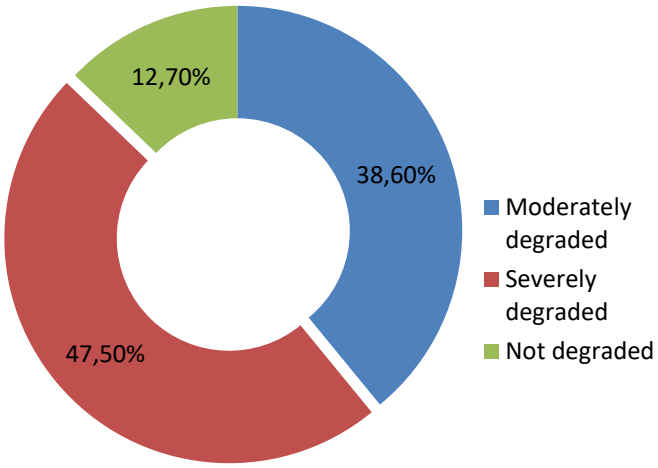


Figure 5: Observed changes in land cover

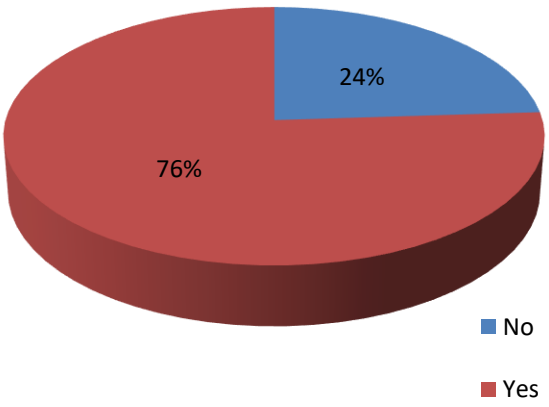


Table 7: Socio-economic characteristics of respondents

Variable	Category	Frequency (N=400)	Proportion (%)
Gender	Male	270	67.5
	Female	130	32.5
Age	Between 18-29	91	22.8
	Between 30-40	88	22
	Between 41-50	50	12.5
	Between 51-60	98	24.5
	Above 60	73	18.3
Education level	None	50	12.6
	Primary	156	39.4
	Secondary	175	44.2
	Tertiary	15	3.8
Marital status	Single	42	10.5
	Married	330	82.5
	Separated	2	0.5
	Divorced	15	3.8
	Widowed	11	2.8
Monthly income	10,000 or less	201	45.6
	10,000- 20,000	173	39.2
	20, 000-30, 000	26	5.9

As shown in Figure 7, 50.5% have been sensitised to SRM. When asked whether the Dedha or conservancy is sustainable form of land management and should continue, 51.3% of those under conservancy and 55.3% of those under the Dedha were in the affirmative as shown in Figure 8. Subsistence based extensive livestock production was the main livelihood activity of more than half (51.3%) of the respondents. Livestock production is done through pastoralism on communally owned land (87%). The grazing resource base has shrunk, with 86.1% of the respondents reporting that the grazing land is already degraded. As a result of reduced grazing resource base, most (68.3%) pastoralist buy supplementary feed in the form of hay at an average of four dollars per bale during the dry season.

Figure 7: Proportion of respondents sensitised on and aware of SLM practices

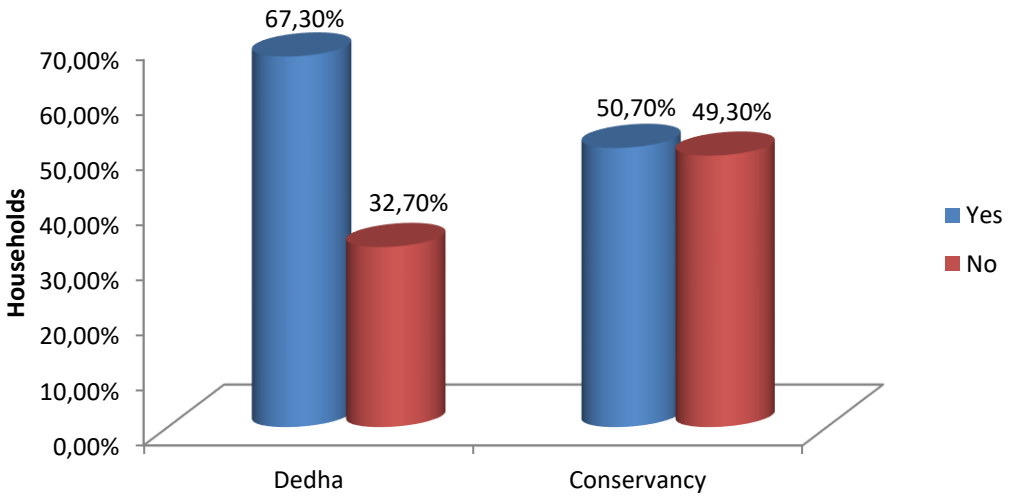
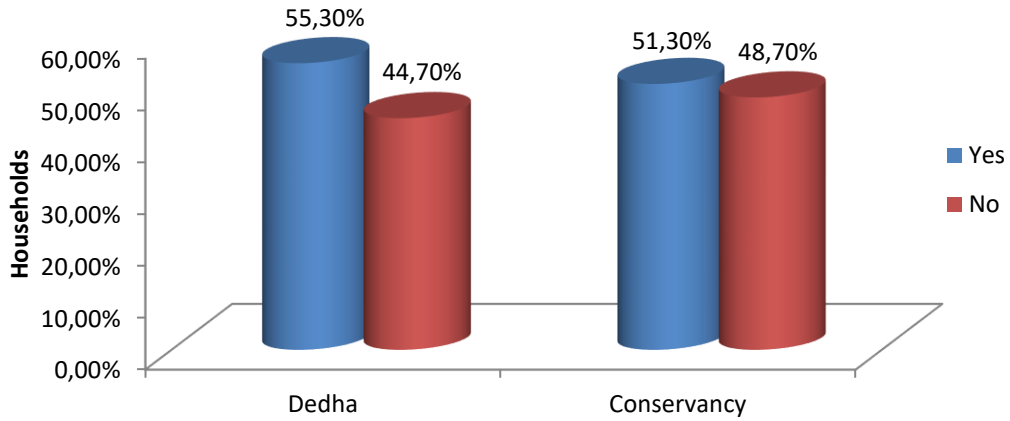


Figure 8: Proportion of HH who believe Dedha and conservancy are sustainable practices



51.3%
Livestock is the main source of livelihood

40
Average herd size

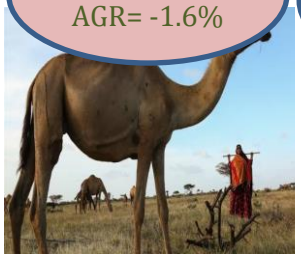
87% of grazing land was communally owned

86.1%
believed their grazing land is degraded

68.3%
Buy hay during dry season

Ksh 400
Price per bale of hay during dry season

The most common livestock species in the study areas include cattle, goats, donkeys and camels. The average number of cattle, camel, goats and donkeys reared per household was 35, 7, 50 and 1 respectively under the Dedha and 20, 5, 35 and 1 under the conservancy respectively. According to the Africa sustainable livestock sector brief of 2050 by FAO (2018), the projected livestock average growth rates (AGR) between the year of 2018 and 2050 in Kenya will decline due to changes in land tenure, continued land degradation and climate change. Using the projections, the population of cattle and shoats in the study area will decline at a rate of -1.6% and -0.7% respectively.

Cattle AGR= -1.6%	Camel AGR= -1.6%	Goats AGR=-0.7%	Donkey AGR=0.0%
			
Dedha = 35 (SD=10.7) Conservancy = 20 (9.6)	Dedha = 7 (4.1) Conservancy = 5 (2.3)	Dedha = 50 (14.34) Conservancy =35 (13.3)	Dedha = 1(0.2) Conservancy = 1 (0.15)

We estimated that due to increasing and combined pressures on land as a result of overgrazing, forest conversion, urbanisation, deforestation, and extreme weather events such as droughts, pastoral livestock per capita will decline as shown in Figures 9 and 10. During the focus group discussions, it was pointed out that due to accelerating land degradation and reduced grazing resources some herds and herders scatter in search of water and pasture pushing into higher-rainfall areas, where they risk not only conflict with settled people but also characteristic animal pest and diseases. Some herds head towards fixed water-points such as boreholes, where the pasture may become exhausted and trampled and the animals die of starvation hence reducing the animal populations.

Figure 9: Changes in herdsize per HH in conservancy

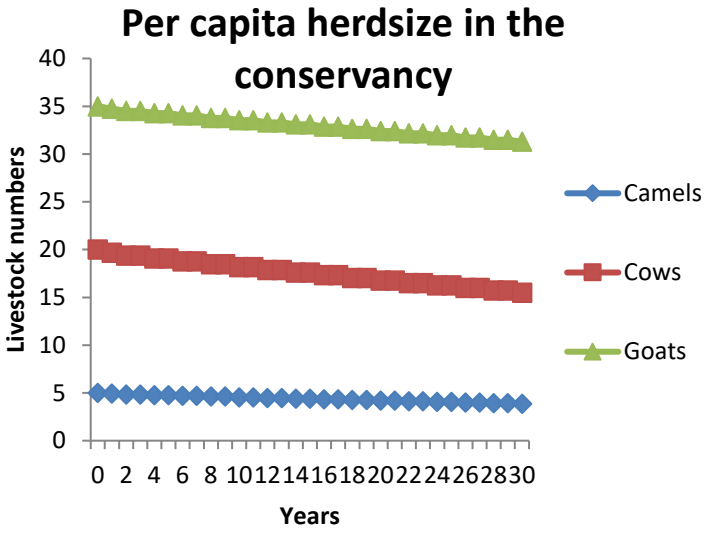
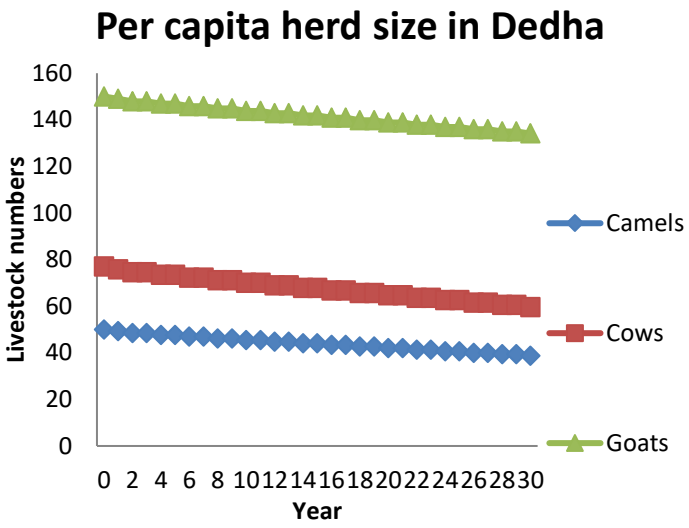


Figure 10: Changes in herdsize per HH in Dedha



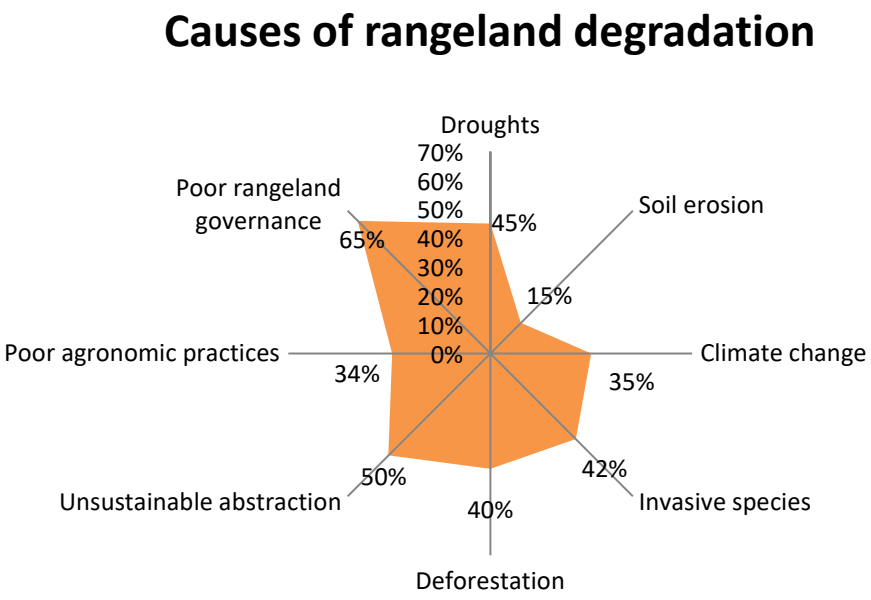
The demand for animal products was expected to increase with the expanding growth of small towns in the study areas. Culturally, beef and dairy are the staple foods for pastoral communities and therefore they are expected to largely spend more on dairy and meat. We can expect this preference to continue to be adopted as income increases across the population in the long term. In aggregate, consumption of beef and milk will increase by 2.55% and 2.56% between 2010 and 2050 respectively according to FAO (2018) estimates. The average price of milk was Ksh. 50 per litre and Ksh. 400 per kilogram of meat.

Figure 11: Annual Consumption Rate (ACR) and average prices of Livestock products

4.2 Causes of rangeland degradation

In this study, we defined land degradation as the reduction in the capacity of rangeland to provide ecosystem goods and services and guarantee its functions over a period of time for pastoral communities. Land degradation is a negative process which lowers the value of land, its utility and thus impacts on livelihoods. As shown in Figure 12, the main cause of rangeland degradation was found to be poor rangeland governance (65%). According to focus group discussions, pastoral land in the study area is communally owned and increasingly faces many complex challenges, including climate change; rapid urbanisation; increased demand for natural resources; food, water and energy insecurity; natural disasters; and violent conflict. Many of these challenges have a clear land dimension: unequal access to land; insecurity of tenure; unsustainable land use; weak institutions for dispute and conflict resolution. Land governance, by extension, concerns the rules, processes and structures through which decisions are made about the use of and control over land, the manner in which the decisions are implemented and enforced, and the way that competing interests in land are managed (Robinson and Berkes, 2011). According to 65% of the respondents, there is weak statutory, customary and religious institutions that govern land hence resulting in unsustainable use of rangeland.

Figure 12: Causes of rangeland degradation



Further, according to 45% of the respondents, drought is another major cause of land degradation (Figure 12). They stated in FGDs that they have suffered from periodic droughts whose magnitude and severity has increased in the recent past. The average incidence of serious drought has increased from around seven serious droughts during the period 1980-1990 to 10 in the period 1991 to 2003. Drought recurrence is becoming ever more frequent, and over the last decade,

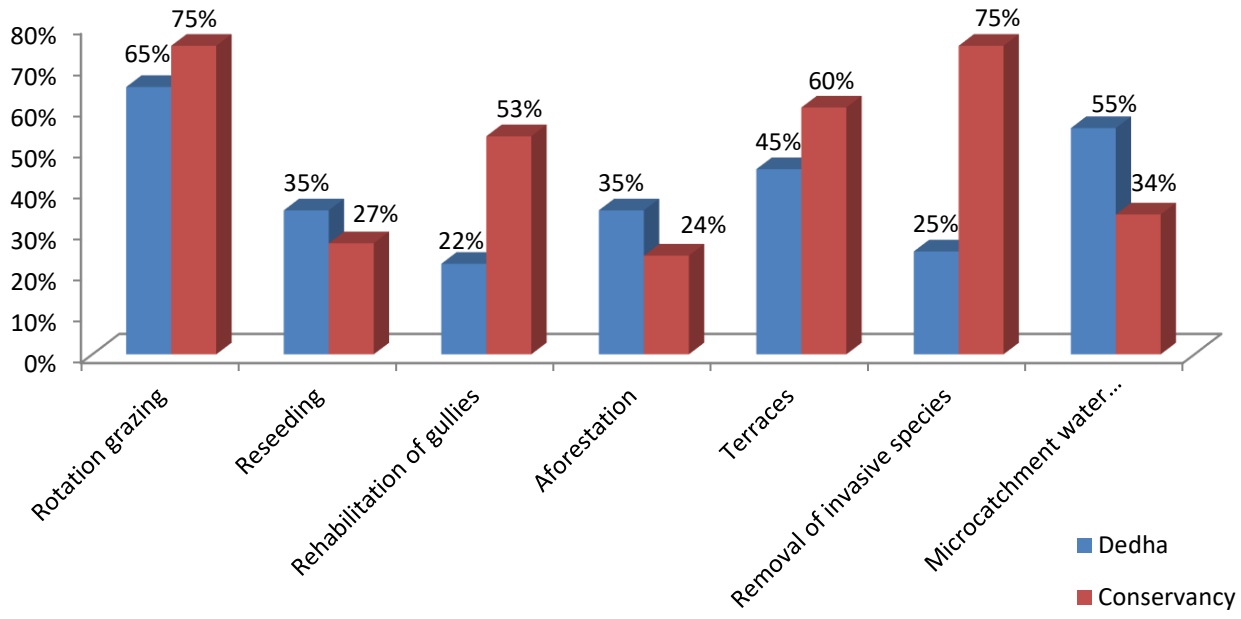
drought events occurred every two years. Droughts destroy vegetation, making land more easily prone to erosion by wind and water. Soil erosion was reported by 15% of the respondents as a contributor of rangeland degradation. Soil compaction is a major problem in the grazing areas with high livestock densities, and especially on denuded dry areas around watering points. Excessive livestock trampling compacts the soil, reducing its infiltration capacity, leading to high runoff flows, soil erosion and even gullying. Another major cause of land degradation was climate change (reported by 35% of respondents). It was further claimed in the FGDs that climate change has reduced the growing seasons for pastures and caused the drying up of several streams and rivers. Climate change has resulted in the drying of land and loss of natural vegetation. This is exacerbated by the occurrence of extreme events and increased climate variability.

Additional, half (50%) of the respondents indicated that unsustainable abstraction and exploitation of rangeland resources is a major cause of land degradation. This is occasioned by population growth and settlements, and over-exploitation of natural biodiversity through charcoal burning, overgrazing and urbanisation. This, according to FGDs, has led to habitat loss and the subsequent alteration of ecosystems' composition. Forest degradation was reported by (40%) respondents as a cause of land degradation as it results in fragmentation and reduced species diversity. The main agronomic practices reported by 34% of the respondents that contribute to unsustainable land use include cultivation of water catchment areas, deforestation, poorly managed rangelands, encroachment of wetlands and pollution from agricultural activities. These unsustainable human activities take place in already fragile areas, and the process is further aggravated by natural disturbances such as drought or flooding, leading to land degradation. Invasive species such as *Acacia reficience* and *Opuntia stricta* were also identified as causes of land degradation by 42% of the respondents.

4.3 Sustainable rangeland management practices

Measures and practices adapted to biophysical and socio-economic conditions in the pastoral areas have been put in place to protect, conserve and sustainably use rangeland resources and restore degraded natural resources and the rangeland ecosystem functionality. Both Dedha and the conservancy promote interventions that avoid, reduce and reverse land degradation, while at the same time meeting food production and economic growth demands, which are on the rise in the pastoral economy. Results in Figure 13 show that the most common practices in the study area include among others, rotation grazing, reseeding, and rehabilitation of gullies, afforestation, and removal of invasive species, micro-catchment water harvesting and use of terraces. Rangeland seeding is widely practiced in the Dedha system where the community has come together as a group and set aside land for growing grass which is later used as hay and harvest grass seeds. According to the FGDs, reseeding is usually meant to alter the composition of vegetation so that the productivity of the land, especially its livestock grazing capacity, will increase. Invasive species such as the acacia reficiens has affected the productivity of rangelands.

Figure 13: Common SLM practices in Dedha and conservancy



The conservancy management has resorted to physically uprooting *Acacia reficiens*. Acacia spreads quickly in areas where overgrazing has occurred, causing highly degraded soils and has no forage value to either livestock or wildlife. Acacia species are allelopathic and release a chemical that displaces other species and further degrades the rangeland by suppressing the growth of grasses preferred as livestock forage.

As more forests are cleared, rangelands that cattle depend on are becoming increasingly degraded, allowing for acacia and other invasive plant species such as the prickly pear cactus to gain a toehold. Heavy rains hasten this process by opening up deep gullies in the landscape, providing an ideal environment for this invasive shrub to take over. Most gullies are therefore rehabilitated to contain the spread of invasive species in the conservancy.

Conservation of trees and planting of trees is practiced by both the Dedha and the conservancy. Trees are an important source of fuel wood and other forest products. They facilitate the rehabilitation of degraded lands, leading to improved ecosystems and environment. The main benefits of planted forests as conversed in the FGDs include rehabilitation of degraded areas, increased availability of wood products, fuel wood and some non-wood forest products, and the role the forests play as carbon sinks especially on degraded soils, sustaining soil fertility. Micro-catchment water harvesting systems common in the area are runoff farming techniques, in which a relatively small portion of upslope land is allocated for runoff collection and which is harvested and directed to a cultivated run-on area or cropped area down slope. Grass is planted on terrace banks for both soil conservation and as livestock feed. Terraces are created by excavating a channel and throwing the soil uphill to create an earthen bund, which acts as a barrier to soil erosion while also retaining runoff water.

Figure 14: Examples of SLM practices in the case study area

Terraces build to harvest water in Dedha kinna

Stone terrace in Dedha (Kinna)

Gullies in Kalama conservancy

Physical removal of *Acacia reficiens in Kalama conservancy*

4.4 Determinants of sustainability of rangeland management practices

A multivariate binary logit model was used to determine factors affecting sustainability of rangeland management practice including the Dedha and the conservancy. After testing for the presence of multicollinearity and heteroskedasticity in the independent variables, the model was statistically significant ($p = 0.00$). The coefficients for benefit sharing, accountability, gender

inclusion, participation in community meetings, access to grazing rights and access to information on SLM as shown in Table 8 are significant and the regressions showed a high adjusted R-squared (R^2 = 0.72), suggesting that the estimated parameters have a strong explanatory power of the sustainability of rangeland management practices.

Although statistically the model does not show a significant relationship between sources of livelihoods against sustainability, most of the respondents whose main source of livelihood is livestock production had a higher probability of ensuring sustainability. There was a weak relationship between monthly incomes against sustainability (McFadden r2= 0.08466). However, the relationship though weak shows that for every unit effort for sustainability, there is an increase of Ksh. 11, 166 (Figure 15). Household characteristics, such as gender, education, and age of the household head, household size, and herd size are not significant in the sample.

Table 8: Determinants of sustainability of rangeland management practices

Sustainability	**Coef.**	**Std. Err**	**Z**	**P>|Z|**	**EXP(B)**	**(95% conf. interval)**	
Benefit sharing	1.45	.55	6.97	**.008*** **	4.27	1.45	12.54
Decision making	1.25	1.23	1.03	.310	.29	.03	3.18
Accountability	2.74	.59	22.02	**.000*** **	.064	.02	.20
Gender inclusion	1.60	.46	12.06	**.001*** **	4.96	2.01	12.25
Meeting participation	2.51	.52	23.58	**.000*** **	12.37	4.48	34.15
Age	-.22	.12	3.27	.071	.80	.64	1.02
Education levels	-.30	.22	1.78	.182	.74	.48	1.15
Marital status	-.22	.31	.50	.478	.81	.44	1.47
Household size	.098	.12	.66	.417	1.10	.87	1.40
Source of livelihood	-.16	.24	.43	.512	.86	.54	1.36
Monthly income	.42	.27	2.47	.116	1.51	.90	2.60
Land ownership	.42	.50	.64	.423	1.50	.56	3.99
Herd size	-.01	.01	1.30	.254	.99	.98	1.00
Buying hay	2.45	1.26	3.78	.052	11.56	.98	136.61
Sensitization on SLM	3.33	.38	75.47	**.000*** **	27.84	13.14	58.96
Constant	-10.41	2.25	21.43	.000	.000	-13.77	-5.90
Number of observations (n)							400
Pseudo R^2							0.72
Log likelihood							38.17

Figure 15: Relationship between monthly income and probability of sustaining management practices

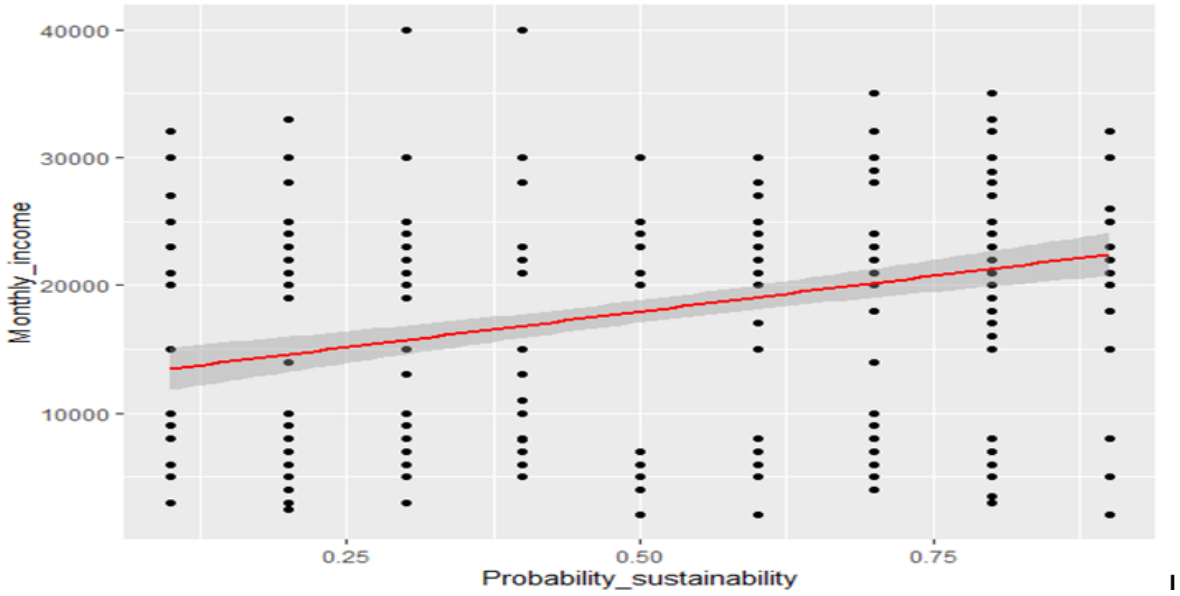
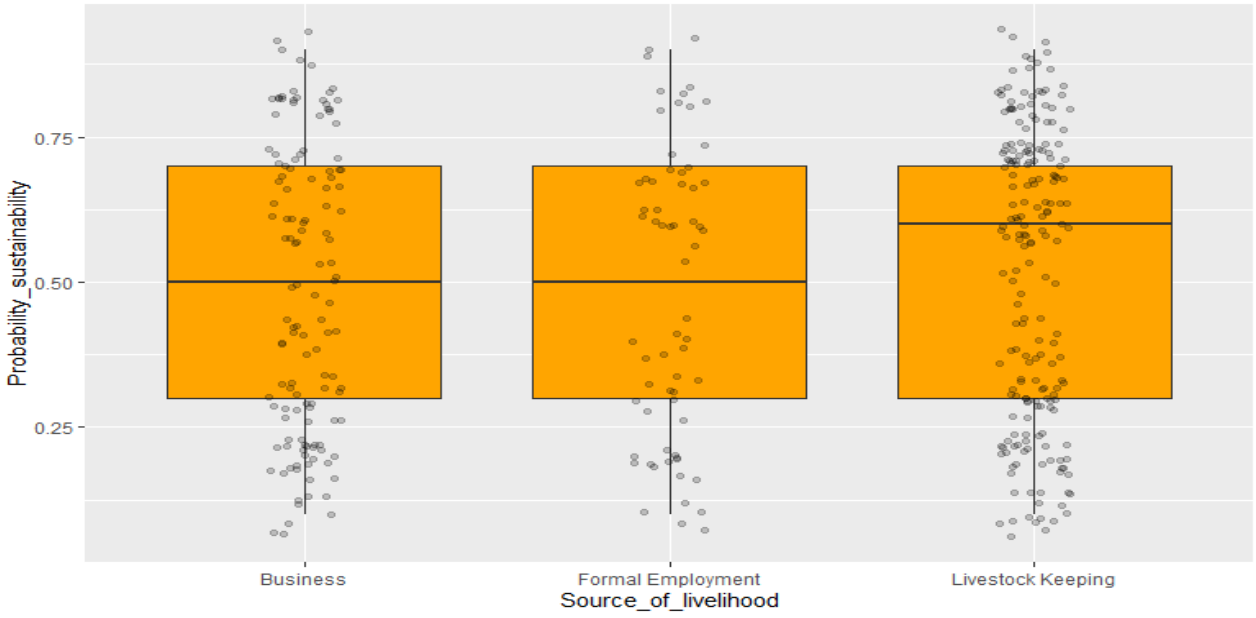
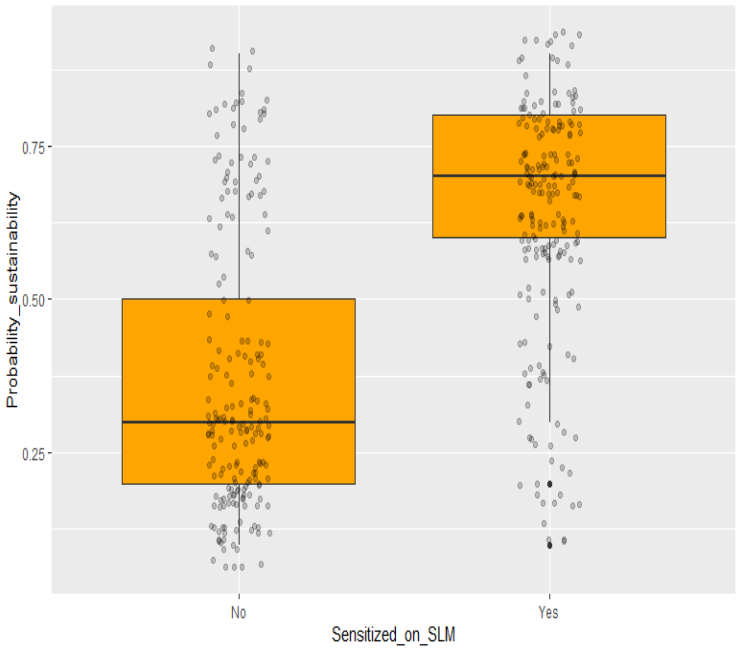
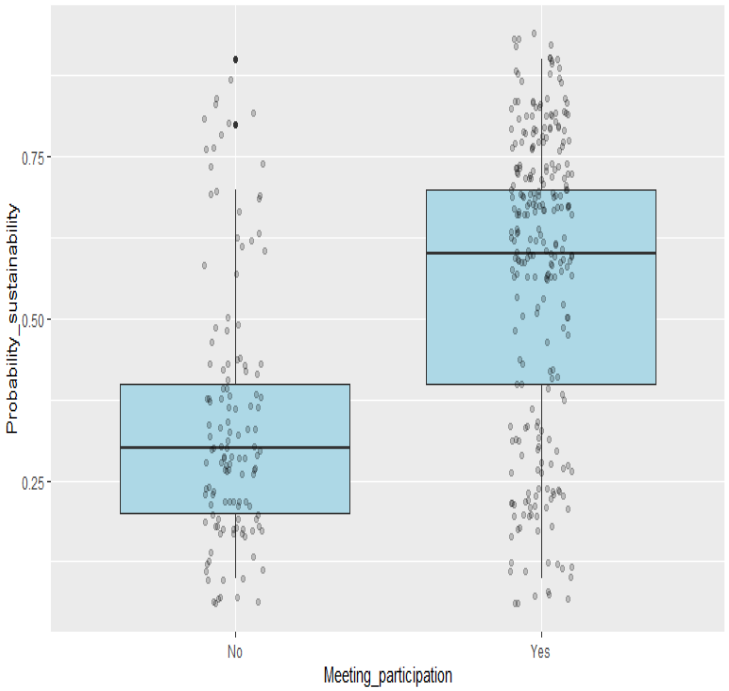
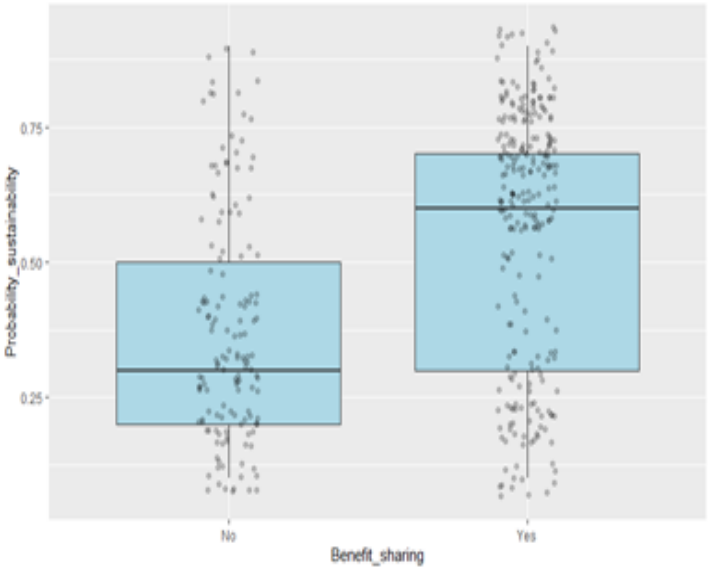


Figure 16: Relationship between sustainability of practices and education level and source of livelihood




Probability_sustainability
0.75
0.50
0.25
No
Yes
Sensitized_on_SLM


Probability_sustainability
0.75
0.50
0.25
No
Yes
Meeting_participation


Probability_sustainability
0.75
0.50
0.25
No
Yes
Benefit_sharing

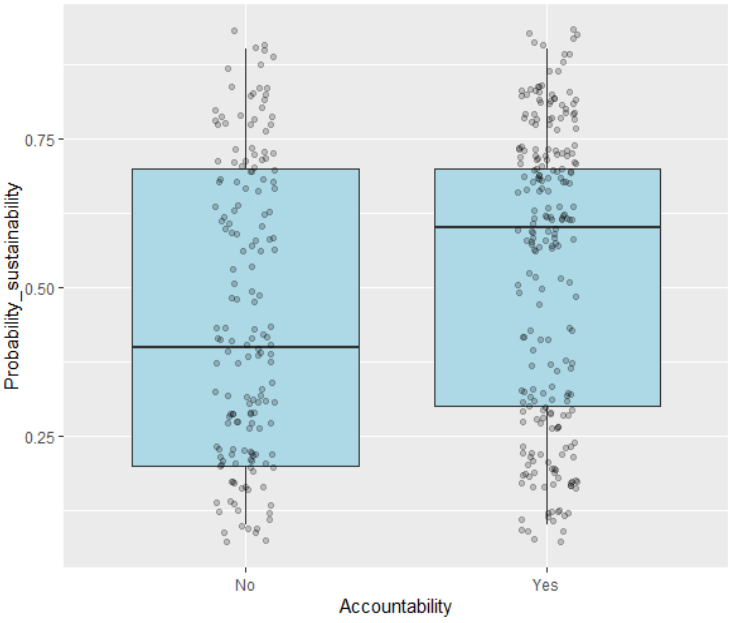

Probability_sustainability
0.75
0.50
0.25
No
Yes
Accountability

Figure 17: Relationship between sustainability of practices and knolwedge about SLM, equitable benefit sharing, accountability of management and involvement in decision making

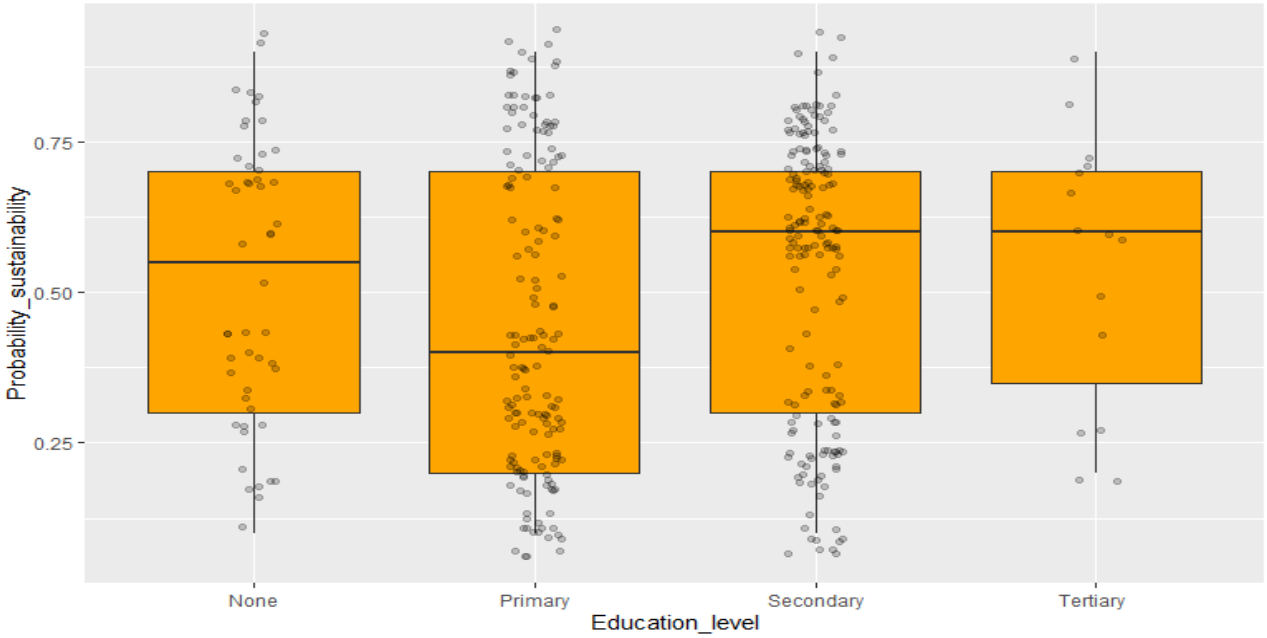


Figure 18: Significant relationship between probability of sustaining the practice and gender inclusion

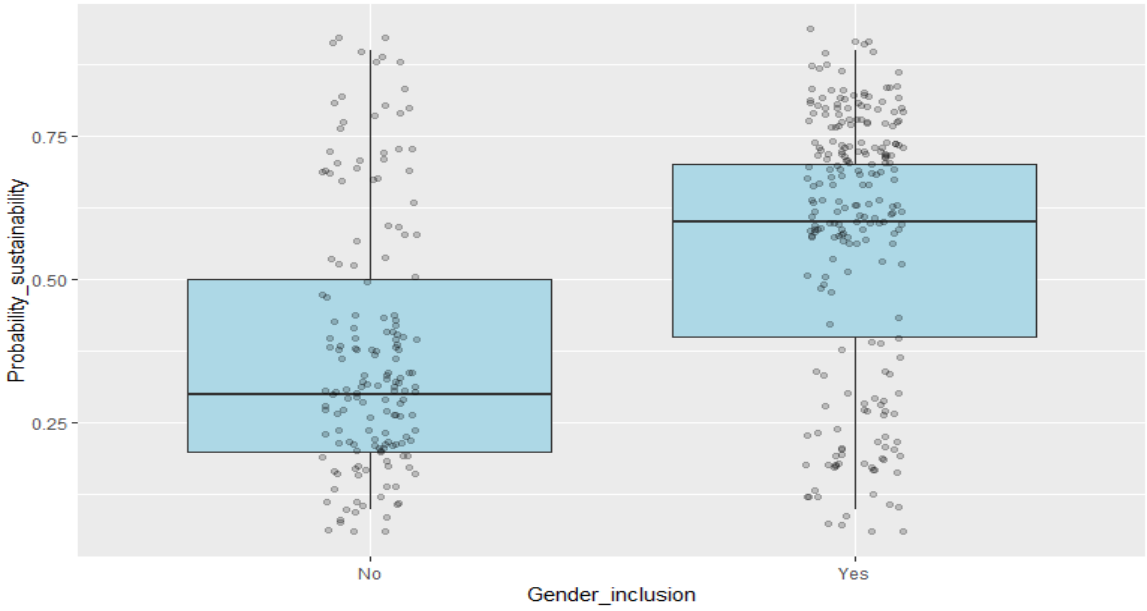
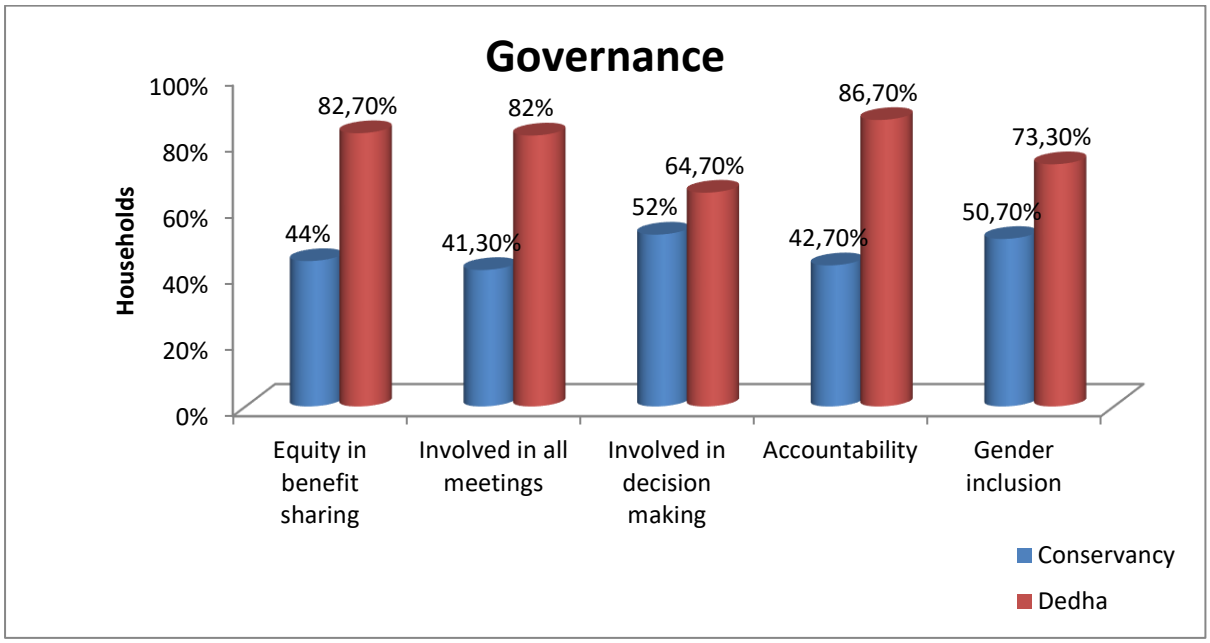


Figure 19: Elements of governance in Dedha and conservancy



Compared to the conservancy, Dedha system is more likely to be sustainable due to higher satisfaction of respondents in the governance of the system in terms of equity in benefit sharing, involvement in decision making, accountability of resources and the bottom up approach which ensures everyone feels included in the management of rangeland resources as shown in Figure 16.

4.5 Ecosystem services

Water

In Dedha, the annual value of water to humans and livestock was estimated at £127,775.55 and £238,666.47 respectively. Under the conservancy scenario, the annual water provisioning value was estimated at £86,888.25 and £759,656.25 for human and livestock respectively. This total value of water only includes the value of water used by humans and livestock kept by the communities within the management unit. The total value of water used by wildlife and other livestock that migrate from other areas was not captured.

Vegetation

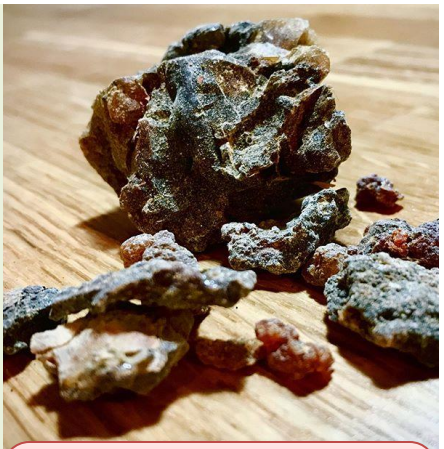
Pasture was estimated at £48,581,500 in conservancy and £22,754,100 in the Dedha. This includes the value of pasture consumed by livestock reared by the communities in the study area. The total value therefore is equivalent to the replacement cost of buying hay that would represent an added cost to the pastoralist if pasture no longer existed or was not adequate.

Fuel wood

Firewood was the main sources of cooking fuel in most of the households surveyed. More than 90 per cent of households used firewood for cooking and heating. We found that each household uses approximately one motorbike load for 14 days. This was universal among the respondents in Dedha and the conservancy. The price of one workload was retailing at Ksh. 400. Considering the inflation rates and projected households, we estimated the value of fuelwood resulting from proper management at £547,500 and £331,002 in Dedha and conservancy respectively.

Opoponax

Opoponax also called sweet Myrrh is an essential oil that exerts a drying action on mucous membranes, allowing relief from bronchitis, colds, sore throats and coughs. Opoponax is also used for its antiseptic and anti-parasitic properties. The survey revealed that at least 60% of the community use opoponax on a daily basis for its medicinal value or as a pesticide or as a repellent. Opoponax is extracted from *Commiphora holtziana Engl*. trees. We estimated the value of opoponax using the local market price per kilogram of opoponax collected, which was at Ksh. 80. This was however lower than the average price in international markets of between Ksh. 300–400 (Salah, 2014). The total annual value of opoponax was valued at £231,848 and £613,200 in the conservancy and Dedha respectively.



Total value
Dedha = £613,200.00
Conservancy = £231,848

Total value
Dedha = £2,625,000
Conservancy = £2,625,000

Avoided cost of Flooding

According to FGDs, floods have increasingly become a major threat to life, property and the environment, a factor that was associated with land degradation and climate change. We estimated the avoided cost of flooding as a result sustainable land management by determining the restoration cost incurred by the government per household in case of floods. We found that the government compensated the previous victims of floods an amount equal to £1,500 to rebuild their homes. We estimated the total annual restoration cost at £2,625,000 and £1,191,000 in Dedha and conservancy respectively using the proportion of households that were affected by floods.

Livestock products

Total value
Conservancy=£289,627
Dedha=£958,125.

The amount of **milk** a cow can produce is directly related to the quality and quantity of food which she eats. If quality and/or quantity is lacking, the cow will respond by producing less milk. To estimate the value of milk as a result of Dedha or conservancy management, we determined the average incremental change in the volume of milk per household as a result of adequate pasture in both Dedha and conservancy which was estimated at 1 and 1.5 litres/day respectively. The average local price of milk was £5 per litre. The total annual value was estimated at £958,125.00 and £289,627.50 in Dedha and conservancy respectively.

The average market price of **meat** was £4 per kg. With an average incremental change of 0.5Kg and 0.25kg in Dedha and conservancy, the total annual value from incremental change in meat production in Dedha and the conservancy was £255,500 and £463,550 respectively.

Total value
Conservancy=£463,550
Dedha = £255,500

Total value
Conservancy= £8,864
Dedha= £3,389

The average production rate of **hides and skin** was estimated at 2.1 and 1.3% (FAO, 2018). The average local market price of hides and skin of a cow and a goat was £2 and £1 respectively. The total annual value of hides and skin was hence estimated at £8,864.29 and £3,389.29 in the conservancy and Dedha respectively.

Cattle manure is on high demand in pastoral areas because of its high organic materials and rich nutrients. It is mixed into the soil or used as top dressing. The study found that most pastoralists were engaging in manure making due to the readly available market. With the average incremental change in the number of people selling manure and the cost per lorry full of manure, we estimated the annual value of manure at £2,080 and £2,184 in Dedha and conservancy respectively.

Total value
Conservancy = £2,184
Dedha = £2,080

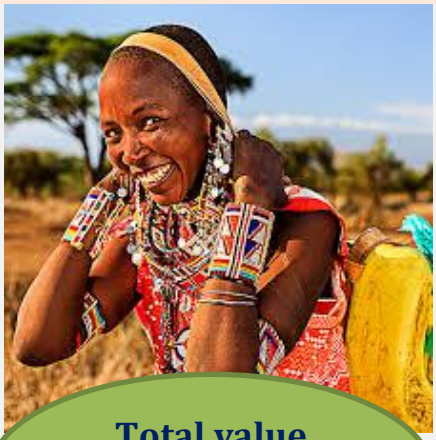
Avoided livestock loses

Total value
Conservancy=£6,686,000
Dedha= £2,772,800

As a benefit for SRM, we found that on average, pastoralists lose approximately 60% of their herd to recurrent droughts, shrinking grazing resource base and resource use conflicts and cattle rustling annually. The average price of mature cow, camel, donkey and goat was £400, £30, £400 and £10 respectively. With the change in the number of livestock lost per each species, we estimated the annual avoided loses at £6,686,000 and £2,772,800 in the conservancy and Dedha respectively.

Value for peace

We estimated the cultural benefits arising from SRM practices through improved security for people and their livestock. We found that both intra- and inter-community conflicts related to competition over control of and access to natural resources particularly water and pasture, land issues, political incitement and proliferation of illicit arms have reduced by over 60% in the conservancy and 80% in Dedha. We estimated the value for peace through the avoided fines paid by the communities in cases of conflicts at £480,000 and £920,000 in the conservancy and Dedha respectively.



Total value
Conservancy=£480,000
Dedha=£920,000

Total Ecotourism revenue
Conservancy=£261,120

The human-wildlife conflicts have also reduced by 67% and 83% in Dedha and conservancy respectively. The estimated annual cost of human wildlife conflicts saved based on the government of Kenya's compensation rate was valued at £60,000 and £75,000 in Dedha and conservancy respectively. We also estimated the value of ecotourism especially in the conservancy where conservation areas for wildlife have been set aside. Through the ecotourism sector, we found the conservancy generates total annual revenue of £140,000, £20,000, £1,120 and £10, 000 from Saruni lodge, Samburu reserve, Sarova Shaba and bead work sales respectively.

Table 9: Present values accruing from Dedha and conservancy management practices

		r =8% (Business as usual)		r = 3.5%		r = 12%	
	Benefits (KSH)	**Dedha**	**Conservancy**	**Dedha**	**Conservancy**	**Dedha**	**Conservancy**
Provi--sion services	Water	8,961,497	19,640,332	17,198,065	36,634,398	5,743,531	12,965,238
	Vegetation (pasture)	537,380,611	1,142,299,955	1,022,999,572	2,172,029,477	346,657,917	737,572,122
	Pods for animal feed	851,806	42,590	1,582,180	79,109	560,312	28,015
	Fuelwood	14,244,324	8,611,711	27,706,845	16,750,766	9,029,064	5,458,714
	Medicinal value	598,584	542,831	987,211	895,259	429,701	389,678
	Opoponax	19,020,313	7,191,489	38,685,296	14,626,726	11,614,289	4,391,307
	Incremental value for milk	**3,983,089,543**	207,392,164	**12,433,655,001**	601,244,394	1,541,434,195	87,552,429
	Incremental value for meat	11,923,285	20,736,028	26,310,914	45,407,427	6,764,646	11,849,812
	Incremental value for hides and skin	88,426	259,103	172,871	520,033	55,828	160,022
	Incremental value for manure	64,518	67,743	131,222	137,783	39,396	41,365
	Trees saved	1,554,547	3,886,367	2,887,479	7,218,697	1,022,569	2,556,424
Regula--ting services	Flood control	81,422,573	36,942,584	165,604,864	75,137,292	49,718,704	22,558,086
	Reduced livestock losses	85,955,695	208,177,880	174,820,385	423,815,582	52,496,777	127,034,343
Cultural services	Social cohesion	19,591,549	10,221,677	36,390,142	18,986,161	12,887,178	6,723,745
	Human-wildlife conflicts	1,277,709	1,597,137	2,373,270	2,966,588	840,468	1,050,585
Support--ting services	Value for ecotourism	-	5,560,592	-	7,921,667	-	3,657,717
	Payment for ecosystem services	-	1,128,644	-	2,096,389	-	742,414

Table 10: Present values of costs incurred in Dedha and conservancy

	r =8%		r = 3.5%		r = 12%	
COSTS (KSH)	Dedha	Conservancy	Dedha	Conservancy	Dedha	Conservancy
Scouting	16,405	559,530	28,272	1,039,295	11,661.	368,055
Security	139,582	179,285	283,894	364,646	85,232	109,471
Community meetings	51,108	459,976	94,931	854,377	33,619	302,569
Restoration costs	-	1,160,312	-	1,899,022	-	864,455
Operational and admin	-	2,427,648	-	4,509,213	-	1,596,889

In the estimation of the costs and benefits, we focused on the benefits that accrue as a result of SRM under the Dedha and the conservancy. We focused on both marketed and non-marketed goods and services from the rangeland ecosystem. We estimated the net present value of the benefits of both the Dedha and the conservancy and deducted the costs involved in the management of the systems. As shown in Tables 8, 9 and 10. The benefits of action for sustainably managing the degraded rangelands and rehabilitating them through the Dedha and conservancy practices far outweighs the costs incurred in the management process. The main costs incurred were through the scouting of rangeland resources for planned grazing, security of the differed grazing reserves, community meeting costs. The conservancy incurred extra costs in terms of administration of cost for payment of the staff as well as rehabilitation cost carried out through gully rehabilitation and removal of the invasive species. The Dedha does not incur administration costs because the management is voluntary. We therefore did not consider the opportunity cost of their time in our analysis. The main costs incurred as labour are for the youth who scout for resources and security which were included in the analysis of CBA for Dedha. Based on this analysis, the NPV per hectare for Dedha and conservancy was positive irrespective of the discount rate.

The net present value per hectare for Dedha was KSH22,356, £64,911 and KSH9,680 using 8%, 3.5% and 12% discount rates respectively while for the conservancy the NPV was KSH38, 597, KSH78,297 and KSH23,792 using the 8%, 3.5% and 12% discount rates respectively.

Figure 20: Cumulative NPV for conservancy

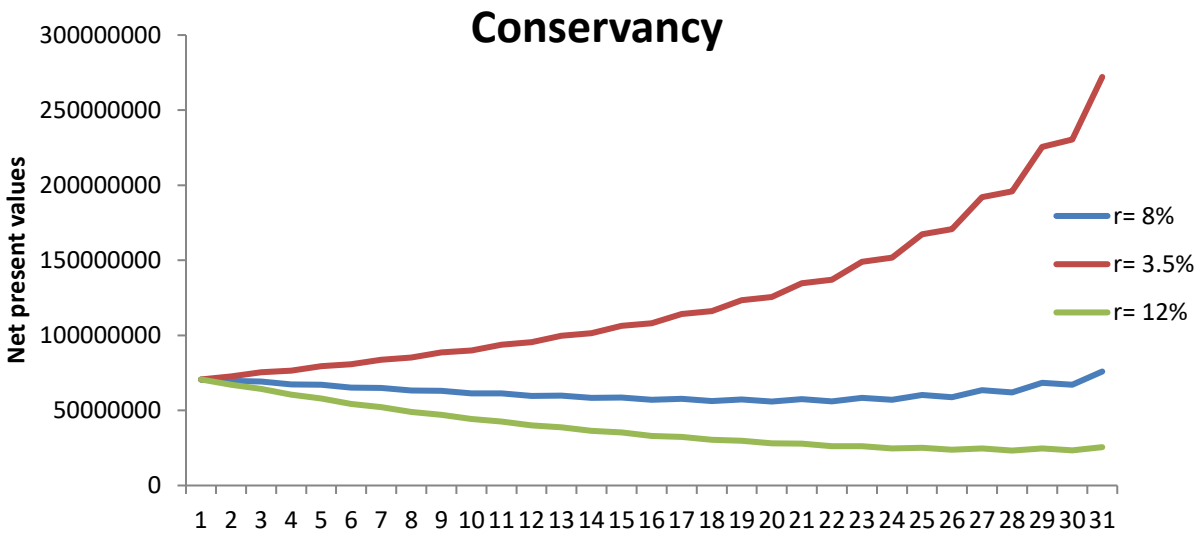


Figure 21: Cumulative NPV for Dedha

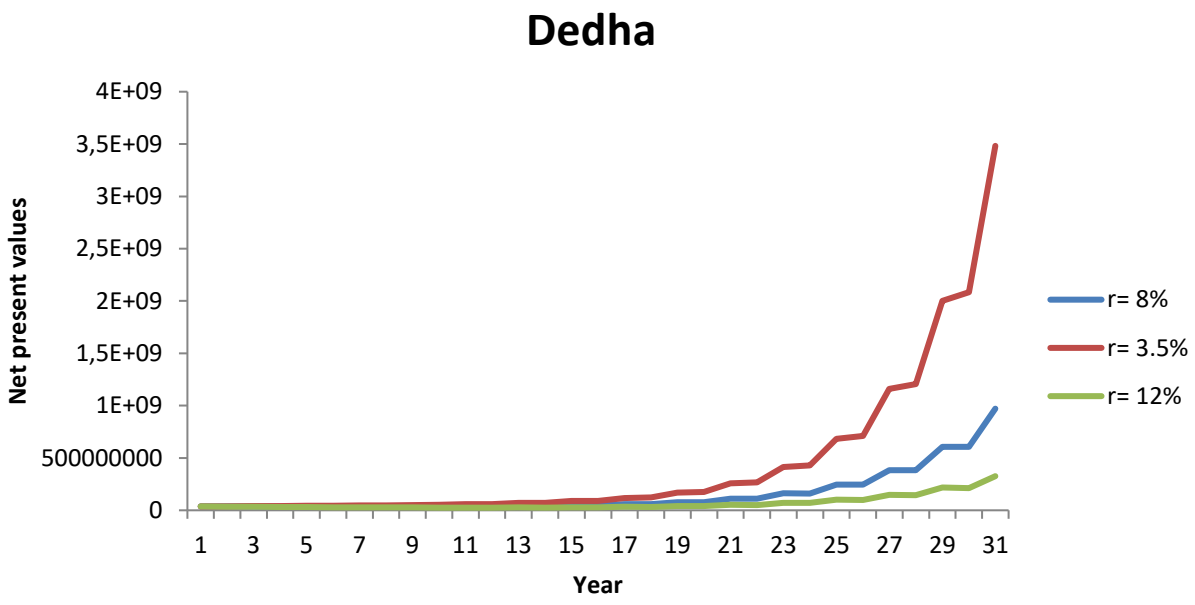


Table 11: Net present values and costs benefit analysis from the year 2019 to 2049

		r =8%	r = 3.5%	r = 12%
Dedha	NPV (Dollar per ha)	22356	64911	9,680
	Benefit Cost Ratio	1:23545	1:34777	1:16177
Conservancy	NPV (Dollar per ha)	38,597	78,297	23,792
	Benefit Cost Ratio	1:402	1:453	1:368

5. DISCUSSION

The degradation of rangeland ecosystems has rapidly increased as found in the study, posing daunting challenges to achieving sustainable development and poverty reduction in pastoral communities. Degradation of ecosystems results in environmental challenges that lead to the loss of land productivity which in turn leads to the deteriorating livelihoods, where the majority of the rural poor heavily depend on natural resources (Glew et al., 2010). The resulting scarcities are often exacerbated by prohibiting and dispossessing pastoral communities from access to land, water and grazing resources for pastoralists whose main livelihood is livestock production (Mulinge et al., 2015). Rangeland degradation is manifested by the losses of vegetation cover and increase in proportion of bare soil surface (Wasonga, 2013). The loss of vegetation cover and increased erosion can be attributed to livestock overgrazing. Due to these, land degradation is particularly severe in the arid and semi-arid rangelands as the soils are highly erodible and natural vegetation is scanty due to a combination of harsh climate and overgrazing (Venton, 2018).

In order to address land degradation issues in Kenya, the Ministry of Environment and Natural Resources developed the Kenya strategic investment framework (KSIF) for sustainable land management (SLM) in 2016 to guide in addressing land management issues through effective multi-sectoral, multi-stakeholder partnerships and collaboration. The framework has proposed measures to tackle the effects of regular droughts, climate change, soil erosion, aridification, loss of biodiversity and food insecurity in arid and semi-arid areas. These measures include water harvesting, run off harvesting, contour bunds, controlled grazing, reseeding rangelands, promoting sustainable livestock production by improving breeds, management and marketing of products, controlling stocking rates through grazing management, creation of pastoral unions, transhumance corridors, area closure, rotational grazing, disaster management and preparedness, water point availability improvement, integrated rangeland management such as Dedha and conservancy, as well as alternative livelihood strategies such as ecotourism. This study is therefore focusing on the integrated management of communal resources through Dedha and conservancy.

In the study areas, livestock herds are primarily comprised of cattle (Bos indicus), goats (Capra hircus) as well as smaller herds of donkeys (Equus asinus) and camels (Camelus dromedarius). Pastoralism, the socioeconomic system based on rearing and herding livestock, has been the dominant livelihood in the arid rangelands for at least 5,000 years (Swift et al., 1996). Communities are highly reliant on livestock, and limited income diversity leaves many vulnerable to resource shocks, such as drought (Esilaba, 2005). Livestock production plays a crucial role not only in sustaining livelihoods of pastoralists but plays a significant role in national development by contributing about US$4.54 billion to agricultural GDP (GoK, 2013; Behnke and Muthami, 2011). Livestock production is however hampered by reduced grazing biomass productivity brought about by degraded lands, translating to high costs to the nation as a whole. Natural resources are the foundations for development of pastoral communities, underpinning livelihoods, food security, trade and employment. As found in the study, the majority of communities rely on livestock and other natural-based resources to sustain lives and livelihoods.

The results of this study reveal that lack of effective governance structures and capacity has hindered efforts to combat illegal and unsustainable resource exploitation. Depletion of natural resources is exacerbated by conflicts and in turn feeds into the cycle of insecurity and violence as clans and communities clash over access to the diminishing natural resource base of pasture, water and forest resources (Lutta et al., 2019). Conflict and environmental degradation, with their negative effects on each other, contribute to heighten rural poverty and, faced with the limited prospects for livelihood diversification, many people are opting out of the rural pastoral and agro-pastoral economies and moving into the urban areas in search of employment or food aid.

The key aspects of the uniqueness of land use in the study area include: scarcity of water resources, fragile heterogeneous landscapes that are prone to degradation; communal ownership of land and its use for pastoralism where mobility is integral to survival; high levels of poverty; strong reliance by communities on natural resources for livelihood options; increasing constraints to mobility as dry season grazing reserves and pastures areas are converted into farm lands and haphazard settlements; the spread of invasive weeds adversely affecting natural pastures; adverse impacts of climate change in recent decades contributing to higher rainfall variability and lower reliability than in the past; weak governance due to dysfunctional traditional and modern management and governance of natural resources resulting in unsustainable use; and poor understanding of the dynamics and key elements of dryland systems leading to inappropriate approaches to development. Poor land governance, mostly destruction of natural vegetation through activities such as overgrazing, encroachment and haphazard illegal tree felling for fuel use and timber, has caused increased runoff, flash flooding, reduced infiltration, soil erosion and siltation in the water pans and other water reservoirs.

The causes of land degradation identified in this study, such as unsustainable abstraction and exploitation of biodiversity, invasive species and soil erosion are mediated and altered by the institutional environment. The demand for fuel wood is one of the major drivers of deforestation in the study areas. As a result, forests and woodlands are rapidly being degraded, while biodiversity is seriously depleted and basic ecosystem services are being negatively affected, particularly in areas with no formal protection. Unsustainable land use practices in ASALs leave the land near bare throughout the year, hence reducing the hydraulic conductivity of the soil (Lutta et al., 2019). This results in surface runoff and floods that inundate homes and villages and disrupt transportation networks, ultimately affecting food security and market distribution systems.

Land improvement and mitigation of land degradation can come about through behavioral change of land users and following their re-allocation of resources to land-improving practices (Kirui and Mirzabaev 2014). The land users' decisions regarding their resource allocation will depend on contextual factors such as incentives, knowledge, capabilities or access to resources. These are partly a function of their socio-economic characteristics and partly the outcome of the institutional environment which enables and constrains their actions. SRM and responsible land governance have great potential for being one of the cornerstones of achieving the SDGs (Mwaniki et al., 2007). SRM is the use of rangeland resources, including soils, water, animals and plants for the production of goods to meet changing pastoral needs, while simultaneously ensuring the long-

term productive potential of these resources and the maintenance of their environmental functions. It is the adoption of land-use systems that through appropriate planning and management practices enable land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources.

SLM is finally receiving much needed attention following the establishment of the SDGs by the United Nations in 2015 with their recognition of increasing threats to current and future land productivity and the provisioning of ecosystem services (UN, 2015). SDG 15 focuses on land and life with its pledge to "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss". Underpinning SDG 15 is the concept of land degradation neutrality (LDN) that is generally understood as "a state where the amount and quality of land resources, necessary to support ecosystem functions and services, remains stable or increases" (UNCCD 2017). In addition, productive land use also underpins several other SDGs including SDG 1 on poverty reduction, SDG 2 on food security and sustainable agriculture, SDG 5 on gender equality, SDG 6 on water, SDG 7 on sustainable energy, SDG 10 on reduced inequality, SDG 14 on reduced marine pollution from land-based activities and SDG 16 on peaceful and inclusive societies requiring adequate land rights. Both the Dedha and the conservancy are SRM practices which address land degradation issues. With ecological benefits being witnessed with the Dedha and the conservancy, the most important thing is to maintain and/or improve them to ensure sustainability in management of rangeland resources. The research presented here shows that Dedha and conservancy investments of addressing land degradation have significant economic payoffs.

Next to investments, we have to address the question of maintaining and improving them. Studies have shown that characteristics at household level, including the socio-economic characteristics such as age, gender, level of education, characteristics of the plot and the natural conditions such as herd size, plot size and farm management practices significantly explain the adoption and sustainability of SLM practices that address land degradation (Dallimer et al., 2018; Tenge et al., 2004; Bravo-Ureta et al., 2006). On the contrary, other than the institutional aspects of governance, all the socio-economic characteristics obtained at household level were not significant in determining the sustainability of either the Dedha or the conservancy. This therefore means that the impacts of these biophysical and socio-economic factors are context-specific and must therefore take into account how different elements interact at the landscape level, within or among ecosystems and as part of different institutional arrangement and political realities. For instance, Dallimer et al. (2018) identified that farms where the head of the household is female are more likely to take up SLM practice. Tenge et al. (2004) identified a positive influence of education on investment in indigenous conservation measures. To the contrary, our study identifies a negative link between the socio-economic factors and SLM practices. We therefore ascertain that the broader institutional environment plays a major role in determining the sustainability of the SLM practices, especially those aimed at conservation of communally owned resources.

The results of this study also show that particular attention needs to be paid to equitable access to conservation economic benefits both assets and incomes, gender inclusion, particularly women in decision-making, accountability of resources and inclusivity and participation of all members in community meetings pertaining to the use of rangelands. Gender inclusion was significant in determining the sustainability of conservation of resources under both Dedha and the conservancies. Given gender-differentiated roles and responsibilities in natural resource management, both Dedha and conservancy must address the specific needs and opportunities of women and men so as to reduce inequalities, stimulate growth and reverse environmental degradation. The Convention on Biological Diversity recognizes the vital role women play in the conservation and sustainable use of biological diversity by reaffirming the need for the full participation of women at all levels of policy-making and implementation to achieve effective biological diversity conservation (WEDO, 2012). Murphy (2013) notes that in many areas of sustainable development including land and natural resources governance, it is becoming increasingly well known that gender equality and equity is key to conservation effectiveness and sustainability. According to Aditya (2016), the recognition of women's land and resource rights would reinforce their social and economic empowerment, resulting in financial security and decision-making power. One of the requirements for reaching and maintaining LDN and advancing land restoration and rehabilitation is the achievement of a more equitable balance in workloads and in the sharing of economic and social benefits between rural women and men. Women's unique knowledge on natural resources management, their influence on the youth and their role in stewarding ecosystems makes them an important stakeholder group in determining and developing sustainable rural economies.

Social accountability was also a significant factor in the sustainability of Dedha and conservancies that reduce land degradation. According to Nuesiri and Emmanuel (2016), social accountability is a central principle for good governance, including governance of natural resources, because it serves to prevent or mitigate negative social and environmental impacts and protects against abuses of power. In this study, we defined social accountability as the requirement for the management of either Dedha or conservancy to accept responsibility and answer for their actions to the community members.

Koppell (2005) identifies five aspects of accountability: transparency, liability, controllability, responsibility and responsiveness. Transparency is the most fundamental aspect, which relates to communication of accurate and comprehensible reporting of the right information to community members. According to Bovens (2007), social accountability enhances collaboration between local people and powerful stakeholders in natural resources governance, potentially improving conservation and sustainable use of natural resources. Beyond legitimacy, accountability is important in preventing resource conflicts (Darby, 2010; Iwerks and Venugopal, 2016), and this also contributes to improved conservation and sustainable use of natural resources (United Nations 2011). Despite the climatic limitations, rangelands are important socio-economically and ecologically. They offer a variety of ecosystem goods and services with direct and indirect economic and social benefits to their inhabitants. The initiatives taken by the community either as conservancy or Dedha have shown to have myriad benefits to the community.

The results of this study show that equitable benefit sharing is strongly significant in maintaining sustainability of the SLM practices. Good governance of revenue and benefits to ensure equitable, transparent and accountable distribution provides a foundation for strong community support and ownership of community initiatives for reducing land degradation (Makindi, 2010). According to Groom and Harris (2008), poor management of benefits erodes trust, creates low community participation and undermines the legitimacy of the conservancy or Dedha to its members. There must therefore be a transparent and equitable sharing of benefits including revenue, employment and communal benefits across settlements/zones, ethnic groups and sub-groups.

Both the Dedha and the conservancy involve proper planning for use of communal rangeland resources. This involves an iterative process based on the dialogue amongst all stakeholders aiming at the negotiation and decision for a sustainable form of land use as well as initiating and monitoring its implementation. Rangeland use and planning creates the prerequisites required to achieve a type of rangeland use, which is sustainable, socially and environmentally compatible, socially desirable and economically sound. It sets in motion social processes of decision-making and consensus building concerning the use and protection of communal land. It is therefore important that when preparing sustainable land use plans, the local community who depend wholly or partly on natural resources actively participate in the process. This explains why the results of the study show that inclusive participation in community meetings was a significant determinant of sustainability.

According to Sterling et al. (2017), the results of planning and the implementation of measures can only be sustainable if plans are made with and by the local community, not behind them or even against them. To ensure a feeling of ownership concerning self-help activities, the local community who are affected have to be involved in the planning process from the early beginning (Whelan and Lyons, 2005). There should be proper engagement with all communities and consideration of cultural viewpoints and builds up on local environmental knowledge. Engagement covers a range of participation options, ranging from information sharing and consultation to active involvement in decision-making processes. Engaging the community will ensure they are informed and involved, and ultimately have ownership and responsibility in development of the land use plan.

5.1 Cost and benefits

The pastoral communities depend on natural resources for their livelihoods. Degradation of these productive resources will thus affect them disproportionately higher (Nkonya et al., 2008). Land use and land cover changes in rangelands has led to friction between people, livestock and wildlife over the scarce rangeland resources, with the intensity of the friction increasing over the years (Maitima et al., 2009; Campbell et al., 2003). Land use/land cover changes are also associated with loss in plant biodiversity and decline in soil productivity (Maitima et al., 2009). The approach used in the study for determining the value of the management practices for Dedha and the conservancy that mitigate rangeland degradation considered the cost of re-establishing the high value rangeland lost and the opportunity cost of foregoing the benefits drawn from the lower

value rangeland that is being replaced. The cost of inaction on the other hand is the sum of annual losses due to rangeland degradation. The cost of taking action to rehabilitate lands was found to be lower than the cost of inaction over a 30-year period. This may strongly justify the urgent need for taking action against land degradation.

Addressing land degradation involves investments in SLM. The government of Kenya recognizes that land and environmental degradation pose serious challenges to the country, causing an estimated annual economic loss of US$390 million or 3% of the national GDP (GOK, 2013). Benefits for rangeland rehabilitation through either Dedha or conservancy occur at both the household and community level and are typically not financial in nature. We found that economic benefits of conservation of rangeland resources are substantial using both Dedha and the conservancy and, depending on which services are counted, they both outweigh costs involved by far. In these pastoral areas, financial mechanisms that capture the economic value of ecosystem benefits can help finance rehabilitation of rangelands and conservation of rangeland resources, freeing up resources for investment elsewhere. Although mapping and valuing ecosystem services can help to inform planning efforts, it is not sufficient to motivate conservation. For most ecosystem services, financial mechanisms and institutions such as markets and subsidies do not exist to capture values and compensate landowners for bearing the costs of providing them (Pagiola et al., 2005). An increasing number of examples in Kenya demonstrate the potential of such mechanisms, including payments for services from conservation of wildlife (Osano et al., 2013), water management (Nyongesa et al., 2016) and land conservation (Curran et al., 2016). For all but these and a few other exceptions, however, payment schemes for services outside traditional markets are typically absent. Without such mechanisms, according to Naidoo and Ricketts (2006) many economic values associated with natural habitats will remain outside the calculus of agents who actually make land-use decisions.

Ecosystem services often hold significant economic value (Egoh et al., 2008), but according to Favretto et al. (2016), they remain undervalued within policy decisions because they are poorly understood and typically external to markets. As a result, cost-benefit analyses are biased toward development over conservation, and planning efforts miss potential win-win areas and associated opportunities to finance conservation in innovative ways (Chan et al., 2006). It is therefore important to ensure that ecosystem services and biodiversity conservation is incorporated into decision-making to an extent that is commensurate with the importance of their values. Complete incorporation of the value of ecosystem services from rangelands through adequate valuation data and assessments would provide concrete arguments as to why stewardship of rangeland biodiversity is crucial to pastoral livelihoods.

6. CONCLUSION AND RECOMMENDATIONS

Sustainable rangeland use and protection play a vital role in food, climate, and human security of pastoral communities. Land degradation has become a major challenge in arid and semi-arid areas owing to the fact that fertile soils are a non-renewable resource by human time spans as their formation and renewal could take hundreds, if not thousands, of years. For this reason, the human management of communal rangeland resources will have wide-ranging consequences on human security for generations to come.

This study presents an economic valuation of the common sustainable rangeland management practices – Dedha and Conservancy – used to manage the communally owned pastoral land in northern Kenya. Based on the results, most of the grazing land in the pastoral community is communally owned. Weak statutory and customary institutions that govern communal land result in unsustainable use of land. The causes of land degradation in this study such as unsustainable abstraction and exploitation of biodiversity, invasive species, soil erosion identified by the respondents are mediated and altered by the institutional environment. The impacts of biophysical and socio-economic factors of pastoral communities are context-specific and must therefore take into account how different elements interact at the landscape level, within or among ecosystems and as part of different institutional arrangements and political realities. The broader institutional environment plays a major role in determining the sustainability of the SLM practices especially those aimed for conservation of communally owned resources. Particular attention needs to be paid to equitable access to conservation economic benefits both assets and incomes, gender inclusion particularly women in decision making, accountability of resources and inclusivity and participation of all members in community meetings pertaining the use of rangelands. The process for development of a sustainable land use plan is scale-dependent, and it integrates multiple stakeholders and sectors. The guiding principles are that people and participatory approaches should be at the center of the process and that governance and enabling policies and institutions should support the achievement of the land-use plan. Policies and institutional support are crucial at all scales to match national and county economic, social and environmental goals with the needs of stakeholders including the public and private-sector and to manage trade-offs and inequalities between sectors and actors. The cost of inaction on the other hand is the sum of annual losses due to rangeland degradation. The cost of taking action to rehabilitate rangelands was found to be lower than the cost of inaction over a 30-year period.

We therefore recommend that to address land degradation in communally owned rangelands:

Key recommendation to pastoral communities:

- Land improvement and mitigation of land degradation can come about through behavioral change of pastoralists and following their re-allocation of resources to land-improving practices.
    - Destruction of natural vegetation through activities such as overgrazing, encroachment and haphazard illegal tree felling for fuel use and timber was found

to have caused increased runoff, flash flooding, soil erosion, and siltation in the water pans and other water reservoirs.
    - The research presented here shows that Dedha and conservancy investments of addressing land degradation have significant economic payoffs through improved rangeland productivity.
    - Sustainable rangeland management and responsible land governance such as the conservancy and the Dedha have a great potential for being one of the corner stones of achieving the sustainable pastoral livelihoods and peaceful coexistence.
- There is need for holistic approach to achieving productive and healthy ecosystems by integrating social, economic, physical and biological needs and values.
    - This can be embraced through proper land governance such as soil and water conservation, natural resource management and integrated landscape management
    - Weak governance due to dysfunctional traditional /customary laws and institutions and poorly or non-functioning modern laws and institutions, lead to the proliferation of unsustainable management practices
    - There is more economic value in sustainable rangeland management which is seen by the reduced cost of the loss of ecosystem functioning as found in the study.

Key recommendations to NGOs and private sector

- Rangeland rehabilitation and improvement should be an iterative process based on the dialogue amongst all stakeholders aiming at the negotiation and decision for a sustainable form of land use in rural areas as well as initiating and monitoring its implementation. This should be based on:
    - Targeted policy and institutional support, including the development of incentive mechanisms for SLM adoption and income generation at the local level;
    - Land-user-driven and participatory approaches;
    - The integrated use of natural resources on farms and at the ecosystem scale; and
    - Multilevel, multi-stakeholder involvement and partnerships at all levels – land users, technical experts and policy-makers.
    - The results of planning and the implementation of measures can only be sustainable if plans are made with and by the local community, not behind them or even against them. Sustainable land use planning is therefore not just a matter for experts but should be carried out together with those affected by it. To ensure a feeling of ownership concerning self-help activities, the local community who are affected have to be involved in the planning process from the early beginning
- Capacity building should be undertaken for communities and their leaders to enable them manage rangelands and their resources effectively.
    - Capacity building should include sustainable rangeland management practices, financial management, dispute resolution, security operations and data collection and analyzing, and documentation.

- It is equally important that social institutions and regulatory mechanisms should be structured in such a way to enable data for ecosystem services and assessments to become the actual basis for decisions and actions with the goal of achieving sustainable social and economic development that promote ecosystem service conservation.
    - This will ensure that the various assessments and data on economic value of rangeland ecosystem services and assessments are helpful and enable the pastoral society to be more efficient and successful in addressing their livelihoods.
- Gender equality and equity is key to rangeland rehabilitation, conservation effectiveness and sustainability.
    - Given gender-differentiated roles and responsibilities in natural resource management, sustainable rangeland management must address the specific needs and opportunities of women and men so as to reduce inequalities, stimulate growth, and reverse environmental degradation.
    - The recognition of their land and resource rights would reinforce their social and economic empowerment resulting in financial security and decision-making power.
    - One of the requirements for reaching and maintaining land degradation neutrality and advancing land restoration and rehabilitation is the achievement of a more equitable balance in workloads and in the sharing of economic and social benefits between rural women and men.
    - Their unique knowledge on natural resources management, their influence on the youth and their role in stewarding ecosystems makes them an important stakeholder group in determining and developing sustainable rural economies.
- Benefits are the most important and usually complicated aspects of the conservancy development.
    - It should be made clear to the community that not only monetary benefits should be regarded as benefits but rather the health of the environment which biodiversity is rich is also an imperative benefit, although the ultimate goal of the conservancy concept is poverty alleviation.
    - Realizing the benefits associated with the conservancy is entirely dependent on the conservancy members awareness about the conservancy, conservancy development stage and effectiveness, therefore there should be sensitization of the community about what the conservancy could offer them, conservancy concept and a general understanding of benefits associated with it. This should be done by the Northern Rangeland Trust in charge of the conservancies.

Key Policy Recommendations

- There is need for the development of a Community Based Natural Resource Management Policy at the national level that would provide guidelines on community participation across all-natural resource sectors in Kenya.
    - The policy would provide a common definition of CBNRM, its principles, characteristics and clearly outline benefits expected by the communities.

    - Whereas the various sectoral policies and laws influencing conservancies outline benefits from community participation in natural resource conservation, there is need to develop a cost and benefit sharing policy and legislation between the lead actors and community institutions
    - Need to build the capacity of governments, environmental policy experts and other relevant stakeholders on drafting policies with regards to making sound policy decisions geared towards conservation and improved livelihoods.
- There is a need for a guideline for sustainable rangeland use planning at the County level to ensure that livelihoods depending on natural resources for their food and their livestock are considered in the planning of county integrated development plans and its implementation.
    - Such a guideline shall significantly contribute to the regeneration of biodiversity, increase the forest cover, and provide clean drinking water for people and their livestock and to protect the other environmental services provided by an adapted, protected, healthy and diverse environment.
    - Sustainable land use planning at county level and the sustainable management of natural resources could significantly contribute to the livelihoods of pastoral communities who extensively depend on livestock keeping.
    - Devolution has wide-ranging implications for SLM, affecting land use, its management and decisions at county level and factoring in the County Integrated Development Plan (CIDP) will ensure that both the Dedha and conservancy receive support from the county governments.
- Proper coordination of sustainable land management practices is needed in arid and semi-arid counties.
    - Counties should form Inter-Ministerial SLM Coordination Committee (IMCC) as proposed in the Kenya Strategic investment Framework on SLM 2017-2027 to serve as a platform for high-level consultation between the ministries contributing to the core SLM sector development in the counties.
    - This will ensure that the line ministries complement each other and learn from the projects implemented by other line ministries to ensure successful implementation of SLM practices.
    - This will also lead to proper budgeting and support of pastoral communities

REFERENCES

Aboud, A et al. (2012) Natural Resource management and biodiversity conservation in the drylands of eastern and central Africa. Entebbe: ASARECA

Aditya, S. K. (2016). Role of women in environmental conservation. *International Journal of Political Science and Development*, *4*(4), 140-145.

Alper, M. E., Clements, M. B. J., Hobdari, M. N. A., & Porcel, R. M. (2019). *Do interest rate controls work? Evidence from Kenya*. International Monetary Fund.

Barbier EB (2007) "Valuing ecosystem services as productive inputs," Economic Policy, CEPR & CES & MSH, vol. 22, pages 177-229, 01

Barrow, E., & Mogaka, H. (2007). Kenya's drylands–wastelands or an undervalued national economic resource'. *IUCN–The World Conservation Union. Nairobi*.

Behnke, R., & Muthami, D. (2011). The contribution of livestock to the Kenyan economy. IGAD LPI working paper no. 03-11. *Intergovernmental Authority for Development: Djibouti*.

Bovens, M. 2007. "Analysing and assessing accountability: a conceptual framework." European law journal no. 13 (4):447-468

Bravo-Ureta, B. E., Solis, D., Cocchi, H., & Quiroga, R. E. (2006). The impact of soil conservation and output diversification on farm income in Central American hillside farming. *Agricultural Economics*, *35*(3), 267-276.

Campbell, T. A., Long, D. B., & Shriner, S. A. (2013). Wildlife contact rates at artificial feeding sites in Texas. *Environmental management*, *51*(6), 1187-1193.

Chan, K. M., Shaw, M. R., Cameron, D. R., Underwood, E. C., & Daily, G. C. (2006). Conservation planning for ecosystem services. *PLoS biology*, *4*(11), e379.

Chee, Y.E., 2004. An ecological perspective on the valuation of ecosystem services. Biol. Conserv., 120: 549-565.

Chilonda, P., & Otte, J. (2006). Indicators to monitor trends in livestock production at national, regional and international levels. *Livestock Research for Rural Development*, *18*(8), 117.

Costanza R, d'Arge R, De Groot R, Farber S, Grasso M, Hannon B, Raskin RG (2016) The Value of the World's Ecosystem Services and Natural Capital (1997). The Globalization and Environment Reader, 117

Cowie, A.L.; Orr, B.J.; Sanchez, V.M.C.; Chasek, P.; Crossman, N.D.; Erlewein, A.; Louwagie, G.; Maron, M.; Metternicht, G.I.; Minelli, S.; et al. Land in balance: The scientific conceptual framework for land degradation neutrality. Environ. Sci. Policy 2018, 79, 25–35.

Curran, M., Kiteme, B., Wünscher, T., Koellner, T., & Hellweg, S. (2016). Pay the farmer, or buy the land?—Cost-effectiveness of payments for ecosystem services versus land purchases or easements in Central Kenya. Ecological Economics, 127, 59-67.

Dallimer, Martin Lindsay C Stringer, Steven E Orchard, Philip Osano, and Patrick Gicheru. 2018. "Who Uses Sustainable Land Management Practices and What Are the Costs and Benefits ? Insights from Kenya," no. August 2017: 2822–35. https://doi.org/10.1002/ldr.3001.

Dankelman, I. (2012). Introduction: exploring gender, environment and climate change. In *Gender and climate change: An introduction* (pp. 29-46). Routledge.

Darby, S. 2010. Natural Resource Governance: New Frontiers in Transparency and Accountability. London: Transparency and Accountability Initiative

De Jode H (2009). Modern and mobile, The future of livestock production in Africa's drylands. IIED and SOS Sahel UK ISBN 978-1-84369-752-7 Eastern Ethiopia: A case study conducted in the southern Afar Region. A Ph.D ecosystems in Mbeere District, Kenya. LUCID Working Paper Series No. 36

Egoh, B., Reyers, B., Rouget, M., Richardson, D. M., Le Maitre, D. C., & van Jaarsveld, A. S. (2008). Mapping ecosystem services for planning and management. *Agriculture, Ecosystems & Environment*, *127*(1-2), 135-140.

ELD Initiative 2017. ELD Fact sheet on Africa. The costs of land degradation and benefits of sustainable land management in Africa.

Esilaba, M. O. (2005). Household production and risk management among pastoral communities in Samburu District, Kenya. *Eastern Africa Social Science Research Review*, *21*(2), 67-82.

FAO (2009) Review of evidence on drylands pastoral systems and climate change: Implications and opportunities for mitigation and adaptation: Land and Water Discussion Paper 8, ISSN 1729-0554

FAO (2018) Africa Sustainable Livestock 2050. Country Brief Kenya

FAO 2012 FAO Food security Statistics. Online Available from RL: http://ww.fao.org/economic/ess/en/

FAO. 2015. FAOSTAT Database, FAO, Rome, Italy (www.faostat.org).

Favretto N, Luedeling E, Stringer LC, Dougill AJ (2016) Valuing Ecosystem Services in Semi-arid Rangelands through Stochastic Simulation, Land Degradation & Development.

Foley, Jonathan A., Navin Ramankutty, Kate A. Brauman, Emily S. Cassidy, James S. Gerber, Matt Johnston, Nathaniel D. Mueller, et al. 2011. "Solutions for a Cultivated Planet." *Nature* 478 (7369): 337–42. https://doi.org/10.1038/nature10452.

Galvin KA (2009) Transitions: Pastoralists Living with Change Annual Review of Anthropology185-198

Gao, Q. Z., Li, Y., Wan, Y. F., Jiangcun, W. Z., Qin, X. B., & Wang, B. S. (2009). Significant achievements in protection and restoration of alpine grassland ecosystem in Northern Tibet, China. *Restoration ecology*, *17*(3), 320-323.

Gichenje, H., Muñoz-Rojas, J., & Pinto-Correia, T. (2019). Opportunities and limitations for achieving land degradation-neutrality through the current land-use policy framework in Kenya. *Land*, *8*(8), 115.

Glew, L., M.D. Hudson & P.E. Osborne (2010) Evaluating the effectiveness of community-based conservation in northern Kenya: A report to The Nature Conservancy. Centre for Environmental Sciences, University of Southampton, Southampton.

GoK 2008. Kenya vision 2030. A globally competitive and prosperous Kenya. The Government of the Republic of Kenya. Ministry of Finance and Planning, Nairobi.

GoK, 2013. Second Medium Term Plan, 2013 – 2017. Ministry of Devolution and Plan

Government of Kenya (2013). The Wildlife Conservation and Management Act, 2013. Kenya Gazette Supplement No. 181 (Acts No. 47).

Government of Kenya (GoK). 2002 National Action Programme: A Framework for Combatting desertification in Kenya in the Context of the United Nations Convention to Combat Desertification.

Government of Kenya. (2013). Isiolo county: First county integrated development plan (2013–2017). *Kenya Vision 2030*.

Groom, R., & Harris, S. (2008). Conservation on community lands: the importance of equitable revenue sharing. *Environmental Conservation*, *35*(3), 242-251.

Harvest Choice 2011 "Total livestock population (TLU) (2005)." International Food Policy Research Institute, Washington, DC., and University of Minnesota, St. Paul, MN.

Herlocker, D. J., Dirschl, H. J., & Frame, G. (1993). Grasslands of east Africa. *Ecosystems of the world*, *8*, 221-264.IMF 2019.

Iwerks, R, and V Venugopal. 2016. It takes a village: Routes to local-level extractives transparency (Natural Resource Governance Institute Policy Paper). New York: Natural Resource Governance Institute.

Kagunyu, A. W. (2014). Effect of climate variability on the livelihood and coping strategies of the Borona community in Isiolo County, Northern Kenya. *A PhD thesis submitted to the Institute of Anthropology, Gender and African studies, University of Nairobi*.

Kassahun A, Snyman HA and Smit GN (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.

Keeler BL, Polasky S, Brauman KA, Johnson KA, Finlay JC, O'Neill A, Dalzell B (2012) Linking water quality and well-being for improved assessment and valuation of ecosystem services. Proceedings of the National Academy of Sciences, 109(45), 18619-18624.

Kenya Central Bureau, and Of Statistics (KBS). 2010. The 2009 Kenya population and housing census.

Khasanova, A., James, J. J., & Drenovsky, R. E. (2013). Impacts of drought on plant water relations and nitrogen nutrition in dryland perennial grasses. *Plant and soil*, *372*(1-2), 541-552.

Kigomo, M. Bunyasi; S. Onywere; M. 2013. "Sustainable Catchment Management : Assessment of Sedimentation of Masinga Reservoir And Its Implication on the Dam's Hydropower Generation Capacity School of Environmental Studies Department of Environmental Planning and Management P . O Box 43844-00100." *International Journal of Humanities and Social Science* 3 (9): 166–79.

Kimani, M. 2008. Agricultural land management for sustainable development in rural Kenya. *African Habitat Review* 2, 100-110.

King J., Kaelo D., Buzzard B. & Warigia G. (2015). Establishing a Wildlife Conservancy in Kenya: A guide for Private Land Owners and Communities. Kenya Wildlife Conservancies Association.

King-Okumu C. 2018. Valuing environmental benefit streams in the dryland ecosystems of Sub-Saharan Africa. Land 7, 142- doi:10.3390/land7040142.

Kirui, Oliver Kiptoo; Mirzabaev; Alisher. 2014. www.econstor.eu , 128 41.

Koppel, J. V. D., Wal, D. V. D., Bakker, J. P., & Herman, P. M. (2005). Self-organization and vegetation collapse in salt marsh ecosystems. *The American Naturalist*, *165*(1), E1-E12.

Kust, G.; Andreeva, O.; Cowie, A. Land degradation neutrality: Concept development, practical applications and assessment. J. Environ. Manag. 2017, 195, 16–24.

Lambert A (2003) Economic valuation of wetlands: an important component of wetland management strategies at the river basin scale, Ramsar bureau

Lutta, A. I., Robinson, L. W., Wasonga, O. V., Ruto, E., Sircely, J., & Nyangito, M. M. (2019). Economic valuation of grazing management practices: discrete choice modeling in pastoral systems of Kenya. *Journal of Environmental Planning and Management*, *63*(2), 335-351.

MacLeod, N. D., & Brown, J. R. (2014). Valuing and rewarding ecosystem services from rangelands. *Rangelands*, *36*(2), 12-19.

Maitima, Joseph M, Simon M Mugatha, Robin S Reid, Louis N Gachimbi, Amos Majule, Herbert Lyaruu, Derek Pomery, Stephen Mathai, and Sam Mugisha. 2009. "The Linkages between Land Use Change, Land Degradation and Biodiversity across East Africa." *African Journal of Agricultural Research* 3 (10): 310–25. https://doi.org/10.5897/AJEST08.173.

Makindi, S. M. (2010). Communities' perceptions and assessment of biodiversity conservation strategies: the case of protected areas in Kenya (Doctoral dissertation).

MEA, M. E. A. (2005). Ecosystems and human well-being: wetlands and water.

Ministry of Environment and Natural Resources 2016a. Report on Land degradation assessment in Kenya. Kenya Agricultural Productivity and Sustainable Land Management Project (KASLMP).

Mulindwa H, Galukande E, Wurzinger M, Okeyo M A and Sölkner J 2009 Modelling of long term pasture production and estimation of carrying capacity of Ankole pastoral production system in South Western Uganda. Livestock Research for Rural Development. Volume 21, Article #151. Retrieved October 7, 2014, from http://www.lrrd.org/lrrd21/9/muli21151.htm

Mulinge W., Gicheru, P. Murithi F, Maingi P, Kihiu E Kirui OK, Mirzabaev, A. 2015. Economics of land degradation and improvement in Kenya. In "Economics of Land Degradation and Improvement – a global assessment for sustainable development". IFPRI, Washington DC pp471-498.

Murphy, T. (2013). Ecofeminism and Rhetoric: Critical Perspectives on Sex, Technology, and Discourse. *Journal of Ecocriticism*, *5*(1), 1-2.

Mwaniki, T. W. (2007). *Peace Building & Conflict Management in Kenya: Joint Case Study of Northrift Region of Kenya* (Vol. 15). Paulines Publications Africa.

Naidoo, R., & Adamowicz, W. L. (2005). Economic benefits of biodiversity exceed costs of conservation at an African rainforest reserve. Proceedings of the National Academy of Sciences, 102(46), 16712-16716.

Naidoo, R., & Ricketts, T. H. (2006). Mapping the economic costs and benefits of conservation. *PLoS biology*, *4*(11), e360.

NDMA (2016) Isiolo County 2015 short rains assessment report, March 2016. Nairobi: NDMA.

Nkonya, Ephraim, Alisher Mirzabaev, and Joachim von Braun. 2015. "Economics of Land Degradation and Improvement - A Global Assessment for Sustainable Development." In *Economics of Land Degradation and Improvement - A Global Assessment for Sustainable Development*, 1–686. https://doi.org/10.1007/978-3-319-19168-3.

Noor, I. M., Guliye, A. Y., Tariq, M., & Bebe, B. O. (2013). Assessment of camel and camel milk marketing practices in an emerging peri-urban production system in Isiolo County, Kenya. *Pastoralism: Research, Policy and Practice*, *3*(1), 28.

NRT 2019. Kalama Community wildlife conservancy annual report. Available online www.nrt-kenya.org

Nuesiri, Emmanuel O. 2016. Accountability of Powerful Actors for Social and Environ-mental Outcomes. NRGF Conceptual Paper. Gland, Switzerland: IUCN and CEESP.

Nyongesa, J. M., Bett, H. K., Lagat, J. K., & Ayuya, O. I. (2016). Estimating farmers' stated willingness to accept pay for ecosystem services: Case of Lake Naivasha watershed Payment for Ecosystem Services scheme-Kenya. *Ecological Processes*, *5*(1), 15.

Onduru, D.D and Muchena, F.N. 2011. Cost benefit analysis of Land Management options in the upper Tana, Kenya. Green Water Credits Report 15, ISRIC, World Soil Information, Wageningen

Osano, P. M., Said, M. Y., de Leeuw, J., Ndiwa, N., Kaelo, D., Schomers, S., ... & Ogutu, J. O. (2013, November). Why keep lions instead of livestock? Assessing wildlife tourism-based payment for ecosystem services involving herders in the M aasai M ara, K enya. In *Natural Resources Forum* (Vol. 37, No. 4, pp. 242-256).

Oxfam, S. C. F. (2012). A Dangerous Delay: the cost of late response to early warnings in the 2011 drought in the Horn of Africa.

Pagiola S, Arcenas A, Platais G. (2005). Can payments for environmental services help reduce poverty? An exploration of the issues and the evidence to date from Latin America, World development, 33(2), 237-253

Republic of Kenya, 2013. Second Medium Term Plan, 2013 – 2017. Ministry of Devolution and Plan

Robinson, L. W., & Berkes, F. (2011). Multi-level participation for building adaptive capacity: Formal agency-community interactions in northern Kenya. Global Environmental Change, 21(4), 1185-1194.

Roskana, G. (2015). *Estimating the Economic Opportunity Cost of Capital for Kenya* (Doctoral dissertation, Eastern Mediterranean University (EMU)-Doğu Akdeniz Üniversitesi (DAÜ)).

Salah, Y M S (2014) The role of indigenous gums and resins in pastoralists' livelihood security and climate change adaptation in Garba Tula area of northern Kenya. Future Agricultures.

Sombroek, W. G., Braun, H. M. H., & Van der Pouw, B. J. A. (1982). *Exploratory soil map and agro-climatic zone map of Kenya, 1980. Scale 1: 1,000,000*. Kenya Soil Survey.

Sterling, E. J., Betley, E., Sigouin, A., Gomez, A., Toomey, A., Cullman, G., ... & Filardi, C. (2017). Assessing the evidence for stakeholder engagement in biodiversity conservation. *Biological conservation*, *209*, 159-171.

Swift DM, Coughenhour MB and Atsedu M 1996. Arid and semi-arid ecosystems. In: TR McClanahan and TP Young (eds) East African Ecosystems and their Conservation. Oxford University Press, New York.

Tari, D and Pattison, J (2014) Evolving customary institutions in the drylands: Anopportunity for devolved natural resource governance in Kenya? Issue paper. IIED,London.

Tadesse, B., Tesfaye, Y., & Beyene, F. (2010). Women in conflict and indigenous conflict resolution among the Issa and Gurgura clans of Somali in Eastern Ethiopia. *African Journal on Conflict Resolution*, *10*(1).

Tenge, A. J., De Graaff, J., & Hella, J. P. (2004). Social and economic factors affecting the adoption of soil and water conservation in West Usambara highlands, Tanzania. *Land Degradation & Development*, *15*(2), 99-114.

Torell LA, Torell GL, Tanaka JA, Rimbey NR (2013) The potential of valuing rangeland ecosystem services on public rangelands. In Western Economics Forum (Vol. 12, No. 1, pp. 40-46)

UN 2015: United Nations Sustainable Development Goals.

UNCCD, 2019. The LDN Target Setting Programme. Available online: https://www.unccd.int/actions/ldntarget- setting-programme

Venton C. 2018. Economics of resilience to drought – Kenya analysis. US Agency for International Development (USAID) Washington DC USA. P.47

Vlek, P. L., Le, Q. B., & Tamene, L. (2010). Assessment of land degradation, its possible causes and threat to food security in Sub-Saharan Africa. *Food Security and Soil Quality. CRC Press, Boca Raton, Florida*, 57-86.

Wasonga OV,, John Musembi, Kennedy Rotich, Ibrahim Jarso, Caroline King-Okumu. (2016). Vegetation resources and their economic importance in Isiolo County, Kenya, IIED, London. http://pubs.iied.org/10141IIED ISBN: 978-1-78431-247-3.

Wasonga O (2013) Using Value Chain Approach to Reveal the Total Economic Value of Pastoral Livestock in Isiolo County, Kenya

Wasonga, OV,John Musembi, Kennedy Rotich, Ibrahim Jarso, Caroline King-Okumu. (2016). Vegetation resources and their economic importance in Isiolo County, Kenya, IIED, London. http://pubs.iied.org/10141IIED ISBN: 978-1-78431-247-3.

Westerberg V (2016). Jordan Case Study An economic valuation of a large-scale rangeland restoration project through the Hima system in Jordan.

Whelan, J., & Lyons, K. (2005). Community engagement or community action: choosing not to play the game. *Environmental politics*, *14*(5), 596-610.

World Bank 2009. Kenya- Agricultural carbon project, World Bank, Washington DC.

WRMA (2013) Final report: surface and groundwater assessment and planning in respect to the Isiolo County mid term ASAL program study. Volume 1, main report. Report No. 47/2013. Earth Water Ltd.

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