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Regional Sustainable Land Management

Sustainable rangeland management in Sub-Saharan Africa

Guidelines to good practice

World Bank Group

Conference Edition

Sustainable rangeland management in Sub-Saharan Africa

Guidelines to good practice

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Abbreviations

AFSA	Alliance for Food Sovereignty in Africa
ASAL	Arid And Semi-Arid Lands
AU	African Union
BMBF	German Federal Ministry of Education and Research
CDE	Centre for Development and Environment, University of Bern
CEDEAO	Economic Community of West African States
CIT	International Certificate of Transhumance
CSIR	Council for Scientific and Industrial Research
DRR	Disaster Risk Reduction
ESS	Ecosystem Services
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FFS	Farmer Field School
FMNR	Farmer-managed natural regeneration
GDP	Gross Domestic Product
GEF	Global Environment Facility
GGW	Great Green Wall initiative
GGWSSI	Great Green Wall for the Sahara and the Sahel Initiative
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GoK	Government of Kenya
GREAD	Groupe de Recherche, d'Etudes et d'Action pour le Développement, Niger
HIV-AIDS	Human Immunodeficiency Virus infection and Acquired Immune Deficiency Syndrome
IFAD	International Fund for Agricultural Development
ILRI	International Livestock Research Institute
IUCN	International Union for Conservation of Nature
IWGIA	International Work Group for Indigenous Affairs
JRC	Joint Research Centre-European Commission
KFS	Kenya Forest Service
KLIP	Kenya Livestock Insurance Program
KMD	Kenyan Meteorological Department
LADA	Land Degradation Assessment in Drylands project (FAO)
LD	Land Degradation
NDVI	Normalized Difference Vegetation Index
NGO	Non-governmental organization
NLRP	non-livestock rangeland products
NRM	Natural Ressource Management
NRT	Northern Rangelands Trust
ODI	Overseas Development Institute
RDS	Rural Development Strategy
RUS	Rangeland Use System
SADC	Southern African Development Community
SLM	Sustainable Land Management
SOC	Soil Organic Carbon
SRM	Sustainable Rangeland Management
SSA	Sub-Saharan Africa
SSD	Sub-surface dams
STDM	Social Tenure Domain Model
UNEP-WCMC	United Nations- Environment World Conservation Monitoring Centre
WAD	World Atlas of Desertification
WB	World Bank
WISP	World Initiative for Sustainable Pastoralism
WLRC	The Water and Land Resource Centre Project
WOCAT	World Overview of Conservation Approaches and Technologies

Foreword

Ecosystems and their services – livestock and non-livestock rangeland production, wildlife and tourism – can only be sustained and improved if the resources they provide and the people who depend on them are healthy.

Rangelands take pride of place among Sub-Saharan Africa's varied ecosystems. They make up nearly half (48 percent) of the land, or up to 62 percent if woodlands are included, and provide a rich range of resources, including soils, water, vegetation and genetic diversity. These landscapes also have a critical role to play in achieving multiple development gains, including food and nutrition security, water, rural jobs, livelihoods and growth in rapidly transforming economies; climate change adaptation and mitigation efforts; as well as peace, security, stability and natural resource-related conflict prevention.

More specifically, Sub-Saharan Africa's rangelands feed over 55 percent of Africa's livestock and provide a major source of income to 268 million pastoralists and agro-pastoralists, including in some of the most vulnerable areas.

These Guidelines on Sustainable Rangeland Management in Sub-Saharan Africa come at a critical moment. Rangelands are under growing pressure from land degradation as well as crop and urban land expansion, among other threats. Moreover, the capacity of rangelands to sustainably supply markets will be tested over the coming decade as the global and regional demand for beef and sheep continues to grow. African governments, stakeholders and other partners are fortunately taking note of the importance of rangelands. For example, the African Union has contributed to the renewed promotion of pastoralism under its 2013 Policy Framework for Pastoralism in Africa. Similarly, the World Bank, along with Sahelian countries, regional organizations and the UN, has committed to promote it under the Declaration of Nouakchott on pastoralism in the Sahel in 2013. In addition, considering their spatial dominance, rangelands should continue to receive sustained attention within the land, forest restoration and climate change commitments made by governments. This interest by governments in sustainably managing rangelands has increased demand for technical information and guidance on how this can be done. That's where we think these guidelines, which synthesize recent knowledge and practices about managing rangelands effectively, will be particularly useful.

This substantial piece of work was prepared by Swiss-based Centre for Development and Environment and the World Overview on Conservation Approaches and Technologies (WOCAT) network for the World Bank on behalf of the TerrAfrica partnership on Sustainable Land Management (SLM). The 30 new case studies presented in this research cover the different regions of Sub-Saharan Africa and a diverse range of practices and systems, from small scale settled pasture to bounded rangelands with wildlife management and pastoral rangelands.

We expect that these guidelines will also contribute to informing the necessary dialogue between rangeland stakeholders dealing for example with livestock, protected areas, wildlife, agriculture and forests. Since knowledge is constantly being developed, we hope these guidelines will stimulate further work to assess, document and share more rangeland management practices, stimulate knowledge exchanges between Africa's regions, and hence inform the preparation and implementation of impactful interventions in Africa's valuable rangelands.

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Part 1

Diverse landscapes in the Sub-Saharan rangelands. Of special attraction to wildlife, livestock and their herders are water sources and seasonal rivers. These also provide grazing grounds, and rich habitats for wildlife as well as opportunities for tourism. Buffalo Springs, Kenya§ (Hanspeter Liniger).

Chapter 1
Setting the scene and aim of these guidelines

In Sub-Saharan Africa (SSA), the popular perception of rangelands and their management is almost always negative. These vast areas are seen as a problem without a solution: the common narrative focuses on overgrazing, herds of undernourished livestock, erosion and desertification, drought, famine, and conflict. However, evidence compiled and analysed in this book show that such a view of rangelands – as being unproductive and mismanaged systems – does not reflecting reality. It needs reconsideration and revision. Indeed the considerable contribution of rangelands to livelihoods and national economies is being increasingly recognised (Behnke et al. 1993, Davies and Hatfield 2007, Vetter et al. 2013, Kratli 2015). While acknowledging the very specific and widespread challenges of the rangelands, a profound reassessment of their role and potential is emerging. This change in position has been informed by better understanding and appreciation of their social, ecological and economical dynamics, and the management systems that have developed over centuries – and are still evolving. Nevertheless, there remains confusion about many aspects, and the discourse around rangelands is full of contradictory statements and differing conclusions about their importance, role and future.

While different definitions of rangelands exist, it is undisputed that their spatial extent is enormous, there is a wide variety of land management practices and uses, and their impacts on the environment, ecosystems and livelihoods are huge. Thus, it is common to find statements that underestimate the economic role of rangelands in Sub-Saharan Africa – and can be simply contradicted by facts. In the broad belt from Mauritania in the west, across through Mali, Niger, Chad, Sudan, Ethiopia and on to Somalia in the east – the livestock sector is hugely significant. Meat and milk production typically comprise up to 60% of agricultural GDP and 5–15% of total GDP (de Haan et al. 2016). Often overlooked, the drylands livestock sector is also an important source of foreign exchange. Millions of sheep are shipped every year from the Horn of Africa to the Gulf States, and more than one million head of cattle each year are trekked or trucked from the Sahel to coastal countries in West Africa (de Haan et al. 2016).

Furthermore, rangelands in Sub-Saharan Africa are increasingly being recognised as providing a wide variety of ecosystem services, and while many of these do not have any direct market value, they represent a key role. Rangelands are home to wide variety of ecosystems with extraordinary biodiversity. Their unique wildlife, and especially the 'charismatic megafauna' – rhino, lion, leopard, elephant, buffalo, giraffe, zebra and others – remain a magnet for tourism (Balmford et al. 2015). Benefits for society include the provision of a wide range of products from meat, milk, hides and wool, to non-livestock rangeland products (NLRP) of fibre, fruits, medicinal and cosmetic products, minerals and oil. Importantly, discussion is opening up about the regulating ecosystem processes of rangelands. These include climate regulation and flood control. Furthermore, the sheer size of rangelands makes them significant contributors to global carbon sequestration and storage (Reynolds and Buendia 2017). Rangelands are also important in the context of cultural services, with their strong links to ethnic identity of many pastoral and agro-pastoral groups. All-in-all, these services, which are often of national and global importance, are not sufficiently appreciated and valued by policy makers, by implementing agencies or by the public at large.

Since the domestication and introduction of livestock several thousand years ago, the influence of pastoralists and their animals has grown to the point that they now dominate both the ecological processes and the economies of large tracts of Africa's rangelands (du Toit and Cumming 1999, Hempson et al. 2017). In those parts of the rangelands occupied by pastoralists, their management has had a significant impact on the vegetation – and this varies from location to location. Profound local knowledge about fauna, flora, water sources and the landscape has informed a wide range of traditional and indigenous rangeland management practices – as explored in these guidelines. However, the mechanisms and patterns of pastoral management

Different rangelands: from desert fringes with sandstorms, Namibia **(left)** to grasslands close to forested hills and mountains in Kenya **(centre)** to the wetlands of river deltas, Okavango, Botswana **(right)**.

left and right: (Hanspeter Liniger)

centre: (© Charlie Shoemaker)

and their changes over time have been poorly understood, respected or valued by non-pastoral communities since the start of the colonial era. Much of the most productive pasture has been converted into crop farming, cross-border and regional mobility has been constrained, traditional governance systems have been undermined, and there are ever-increasing claims on the land from both non-pastoral communities and external investors.

Many associated development policies have undermined the integrity of traditional and innovative local rangeland management systems. Such systems have evolved together with the changing environment and climatic patterns over thousands of years. Cultural institutions and traditional governance structures that had managed natural resources have been eroded in many locations.

Unsurprisingly, there have been widespread disruptions to rangeland management. These have been further fuelled by other factors, including the continued growth in human population increasing demand for agricultural products, security threats created by livestock rustling, trafficking of arms and open domestic and international conflicts, and more recently the growing reality of climate change and associated extreme events.

Rangelands in SSA have regularly been reported as being some of the most degraded ecosystems in Africa: "mis-management" is often cited as the underlying reason. Specialists and development reporters are quick to diagnose degradation in the rangelands – but equally slow to suggest sound and sustainable remedies to guide policy makers. Meanwhile it usually goes unnoticed that a share of rangeland areas and the livestock they support are sustainably managed. This may be based on traditional community practices, or through the introduction of innovative methods, or, increasingly, a combination of the two. As this book shows, there are many and varied experiences in sustainable rangeland management (SRM) in SSA. These embrace a wide range of different land/ resource management practices in different ecosystems. Without doubt, there is a knowledge base that is continuously evolving – yet is hardly known to the wider development community. On the other hand, there is also considerable technical expertise, information, and knowledge about current rangeland issues in SSA, which is fragmented and largely hidden.

Exchange of experience and knowledge between African countries and institutions remains weak and localised, with minimal opportunities for "cross-fertilization". Furthermore, there is no comprehensive, contemporary compilation of rangeland management knowledge and practices in SSA. Their evolution and recent adaptations to a changing human and natural environment remain mainly unknown. The growing knowledge about rangeland management has not been synthesized or disseminated.

The overall goal of the guidelines is to contribute to improved rangeland management by illustrating a wide range of innovative rangeland management practices, grouping them, clarifying their characteristics and requirements, and by illustrating their impacts on ecosystem services and human wellbeing. The ultimate aim is to demonstrate – through this unique set of convincing case studies – the value and potential of investment in rangelands. It is also hoped that this exercise will stimulate, and assist, the identification of further cases. The guidelines attempt to provide:

1. A practical guideline for the formulation of rangeland policies and investments programmes in rangelands
2. A common knowledge base for improved decision-making
3. A starting point for 'how-to-do' that can be complemented and expanded in future
4. The basis for knowledge sharing workshops and programmes with various African stakeholders, and training beyond the mere dissemination of these guidelines
5. An attractive, illustrative, straightforward and reader-friendly book to help inform the future development of SRM.

This book is meant, in particular, for those involved in programmes and projects, specialists, and rangeland users to use the wealth of their experiences for improved decision-making, in order to upscale and outscale SRM. The target group thus comprises:

- Professionals who design and implement rangeland projects
- Technical support/ extension services, project implementers/ advisors and other actors working at field level
- National/local leaders and decision/ policy makers involved in rangeland policies
- Research organisations focussing on rangelands and their management
- Development partners at international and regional levels
- Knowledge and information services in or related to SSA-Saharan countries
- Livestock owners/ keepers, conservationists and other rangeland users
- The broader public – to raise awareness about, and engagement in, SRM.

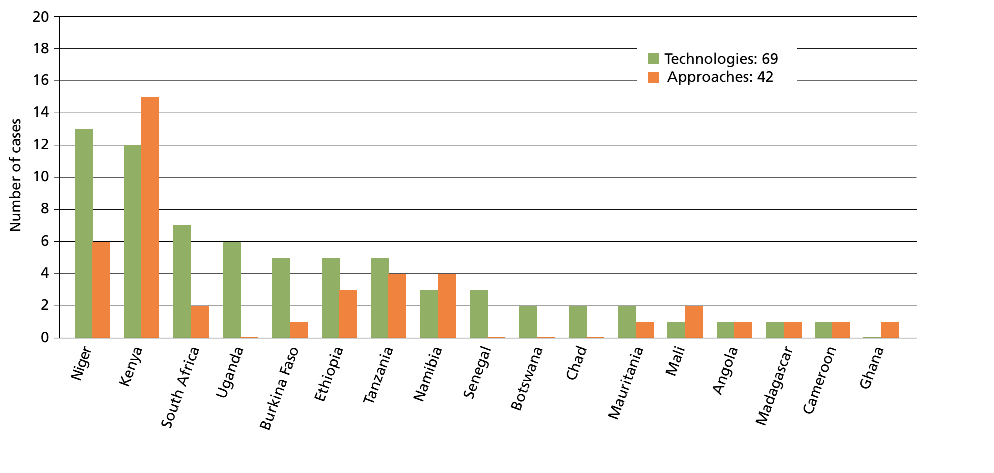


Figure 1.1: Country distribution of rangeland management technologies and approaches from Sub-Saharan Africa (SSA) used in the guidelines.

Given the vast variety of different environments and rangeland management practices and the large rangeland area in SSA, this book presents a selection of case studies. It cannot be comprehensive: it is impossible to do full justice to what is currently underway. Despite efforts to compile a full representation of SRM practices, there remain gaps in terms of regions and practices. The guidelines offer neither "one-size-fits all" solutions nor comprehensive "how-to-do" instructions. However, it is hoped that the book will stimulate the further compilation and identification of options and potentials for spreading SRM in SSA. The more knowledge and data is collected that covers different/ all regions and a wide range of SRM practices, the better the evidence base for decision-making.

Thus, this book aims to identify "good practice", taking lessons from both the ancient and the modern, and steer a new course that will encourage managers across the continent to restore and improve sustainable management of the rangeland. The guidelines present a compilation of a wide range of sustainable rangeland management practices from Sub-Saharan Africa, for different rangeland use systems (RUS) and different SRM groups. These include indigenous and traditional practices, innovations, trials, and emerging trends implemented by the land users themselves, and/or various agencies and research institutions.

At the outset, concepts of rangeland management are discussed, a working definition proposed and an operational classification system set out. Challenges faced in rangeland management, with potential solutions and their impact on natural resources, as well as ecosystem services, are discussed and synthesized. Supported by the literature, this is based on an analysis of the SRM practices from SSA documented in the global sustainable land management (SLM) database of WOCAT (World Overview of Conservation Approaches and Technologies). Forty-two (42) approaches and 69 technologies from the WOCAT SLM global database have been included in the data analysis. The cases are distributed over a number of countries (Figure 1.1). Of these, 28 approaches and 28 technologies are newly documented.

Part 1 is composed of five chapters, which contribute as follows:

- Chapter 1: An introduction to the rangelands and to these guidelines.
- Chapter 2: Defining the rangelands begins with, in 2.1, key characteristics such as vegetation cover, the climate with a focus on droughts, the inhabitants, livelihoods, land tenure, user rights, conflict, protected areas, fire and land degradation. In 2.2 there is an overview of the importance of the rangelands underpinned by data. 2.3 then goes on to look at 'changing concepts' of rangelands and development issues over the last century.
- Chapter 3: Rangeland uses and management systems are presented. In 3.1 Rangeland Use Systems (RUS) are

left: Typical savannah rangelands with grassland and a wetland in the background offering rich habitat diversity and refuge for wildlife such as buffaloes and egret herons, Chafa wetlands, Kenya (Hanspeter Liniger).

centre: Chafa spring in a protected area in Kenya fenced against intrusion of animals at the head of the spring, 2016. Wildlife and livestock have access to the water below the spring head (Hanspeter Liniger).

right: The same Chafa spring during a prolonged drought period in 2018. The fence has been removed and livestock have been watered in the fragile spring source zone. This illustrates the challenge of sustainable rangeland management with increasing pressure by users and within high natural and climate variability (Hanspeter Liniger).

divided into 6 categories, and in 3.2 Sustainable Rangeland Management (SRM) groups are categorised into 9 types. Each is explained.
- Chapter 4: Drivers, land management responses, impacts and change are covered in five sections. In 4.1 the key drivers are identified, and then in 4.2 SRM practices are presented and analysed. 4.3 looks at the impact of SRM on the 'health' of the land, and 4.4 focuses specifically on SRM and its effect on ecosystem services and people. 4.5 then analyses feedback mechanisms on the drivers.
- Chapter 5: The way forward is summarised – tying together what has been discussed in 6 sub-sections covering the need for a greater focus on rangelands (in 5.1), principles of SRM technologies (5.2), principles of SRM approaches (5.3), capacity requirements (5.4), the future of rangelands (5.5) and finally how to overcome barriers to SRM (5.6). Through this chapter, there are "Focus boxes", which encapsulate the key guidelines themselves.

Part 2 of the guidelines provides case studies classified in five SRM technology groups and four approach groups. For each group, examples of "good practice" case studies have been selected and are presented in a standardized and consistent format – as pioneered by WOCAT.

Additional practices included in the analysis but not presented in Part 2 are listed in the Annex and are available in the WOCAT database[1].

The process: From the very beginning of the exercise, it was evident that rangeland management was very complex and extremely challenging and developing rangeland management guidelines would require considerable support and commitment from local and regional rangeland specialists and practitioners. The strategy adopted was to compile case studies and examples from the field that were as comprehensive and diverse as possible. Then through analysing and synthesising the results, to try to come up with guiding principles and best practices for rangeland management. Finding the right partners with the knowledge and experience to identify and document the wide variety of current successful and innovative good rangeland management practices was a challenge. It was felt important from the start that there should be co-ownership by African institutions as a prerequisite to a widely accepted and supported process and product.

Two workshops with local and regional rangeland specialists from different organisations and institutions were held: in Nairobi, Kenya during August 2016, and then Pretoria, South Africa in February 2018. During the first workshop, ten experts from West, East and Southern Africa brainstormed on how to structure the book, how to involve key partners, how to compile the available knowledge related to rangeland management and which specific practices to document in details. Nine experts came together in the second workshop to review the draft, discuss results from the data analysed and identify gaps in the documentation of interventions where attention was still required. Throughout the whole process of working on the book, documentation of good rangeland management practices was ongoing, and there was a continuous feedback loop to ensure that the cases were complete and the data robust.

Challenges were faced in compiling a full set of representative, good quality case studies. Rangelands, by their nature are often remote, and contact with people working there was difficult. Another problem is that experiences and knowledge are scattered. Furthermore, in contrast to cropland, the complexity of rangelands and the associated management systems is much higher. This made the compilation of the case studies all the more complicated.

The involvement of a number of key experts from different organisations during and outside the workshops has been a big asset – and needless to say without them this book would not have been possible. However, specialists come with their own experience, institutional background, language, agenda, visions and beliefs: this meant that there needed to be a very careful and complex process of sorting out and editing. The aim was to represent various opinions while seeking common denominators in experiences.

It has not been an easy exercise, but having in mind the complexity of rangelands and the vast diversity of users and organizations involved, hopefully this publication leads to a better appreciation and understanding of rangeland management, does justice to rangelands and the people that manage them, and supports current and triggers new initiatives for sustainable rangeland management worldwide and specifically in Sub-Saharan Africa.

[1] https://www.wocat.net/en/global-slm-database/

Chapter 2
Sub-Saharan Africa rangelands defined

2.1 What and where are rangelands?

There exist numerous definitions of rangelands. For these guidelines the definitions of Blench and Sommer 1999, Allen et al. 2011, McGahey et al. 2014 are merged.

"Rangelands are spatially defined ecosystems that are dominated by grasses, grass-like plants, combined with various degrees of bush and tree cover that are predominantly grazed or browsed, and which are used as a natural and semi-natural ecosystem for the production of livestock and safeguarding of wildlife and additional ecosystem services."

Rangelands in Sub-Saharan Africa (SSA)[1] cover areas with a broad span of characteristics: vegetation and cover (grasses alone, or combined with bushes and trees), topography (mostly gentle slopes, but some hills and mountains or escarpments especially in East Africa), water (high variability of access to surface water, with a mixture of seasonal and some perennial sources, and often access to groundwater) and use (grazing and browsing by wildlife and/ or livestock). The type and use of rangeland is, in turn, determined by the climate (rainfall and temperature), climate variability and change, fire whether natural or human-induced, but also topography and altitude.

2.1.1 Vegetation and climate

The maps of rangeland derived from vegetation and land use data, resemble a banana-shape around the forests of Central Africa – the "SSA rangeland crescent". They stretch from the Sahelian zone of West Africa to Sudan and the lowlands in the Horn and East Africa, to Southern Africa. Rangeland limits are determined by aridity of the deserts in the north towards the Sahara, and in the south to the south-western deserts of the Namib and Kalahari. Rangelands are also limited by the wetter spectrum of the climate, towards conditions more favourable for cropping – for example in the southern regions of the Sahel, the highlands of the Horn and East Africa, the closed forests of Central Africa and the wet mountain areas in East and Southern Africa. Towards the croplands and forests the boundaries are not sharp, and there is some overlap. The transition zones in the three regions of SSA is illustrated in the inserts of Figure 2.1. Mainly driven by rainfall availability and seasonality, there is a gradual transition from sparse grassland at the dry end of the scale, through grassland, open shrubland, savannah, woodland, and on to dense woodland at the wetter end of the climate spectrum.

Low temperatures limiting the growth of vegetation in SSA's rangelands occur in Southern Africa during the winter, with average temperatures of 5–10 degrees. Other areas affected by cold are the mountain regions of the Horn and East Africa, where there are merely patches of rangelands amongst the croplands and forests. Apart from these areas, there are no low temperature restrictions to continuous growth of vegetation. However, high temperatures where averages reach 30 degrees or more put stress on the vegetation – when moisture availability becomes the limiting factor under the dry conditions of many rangelands. This is the case for most of the year for the West African Sahel and the lowlands of the Horn and East Africa (Figure 2.2a).

Looking at seasonal rainfall (Figure 2.2b) this clearly depicts the movement of the inner tropical convergence zone, with its associated rainy seasons starting in the first quarter of the year in the south (southern summer) and reaching the north in the third quarter of the year after the peak of the northern summer. In the second and last quarters of the year, the main rains fall in the inner tropics within the equatorial zone. This implies that this zone has a bimodal rainfall regime (two rainy seasons each year), whereas the northern and southern areas in the subtropical zones around the Tropic of Cancer and Capricorn only have one rainy season (a unimodal regime) with a single prolonged dry season. Whether a region has one or two rainy seasons has significant implications on forage reserves and the movement of animals – as the unimodal regime dry season is around

left: Peulh herder with his cattle on the move in northern Niger in search of grazing lands (Friederike Mikulcak).

centre: Typical savannah – grasslands dominated by spread-out acacia trees and grasslands at the foot of Kilimanjaro (Hanspeter Liniger).

right: Herd of cattle moving within a river bed, Kenya (Ibrahim Jarso).

[1] Area of Africa south of the Sahara and the 20 degrees north latitude line

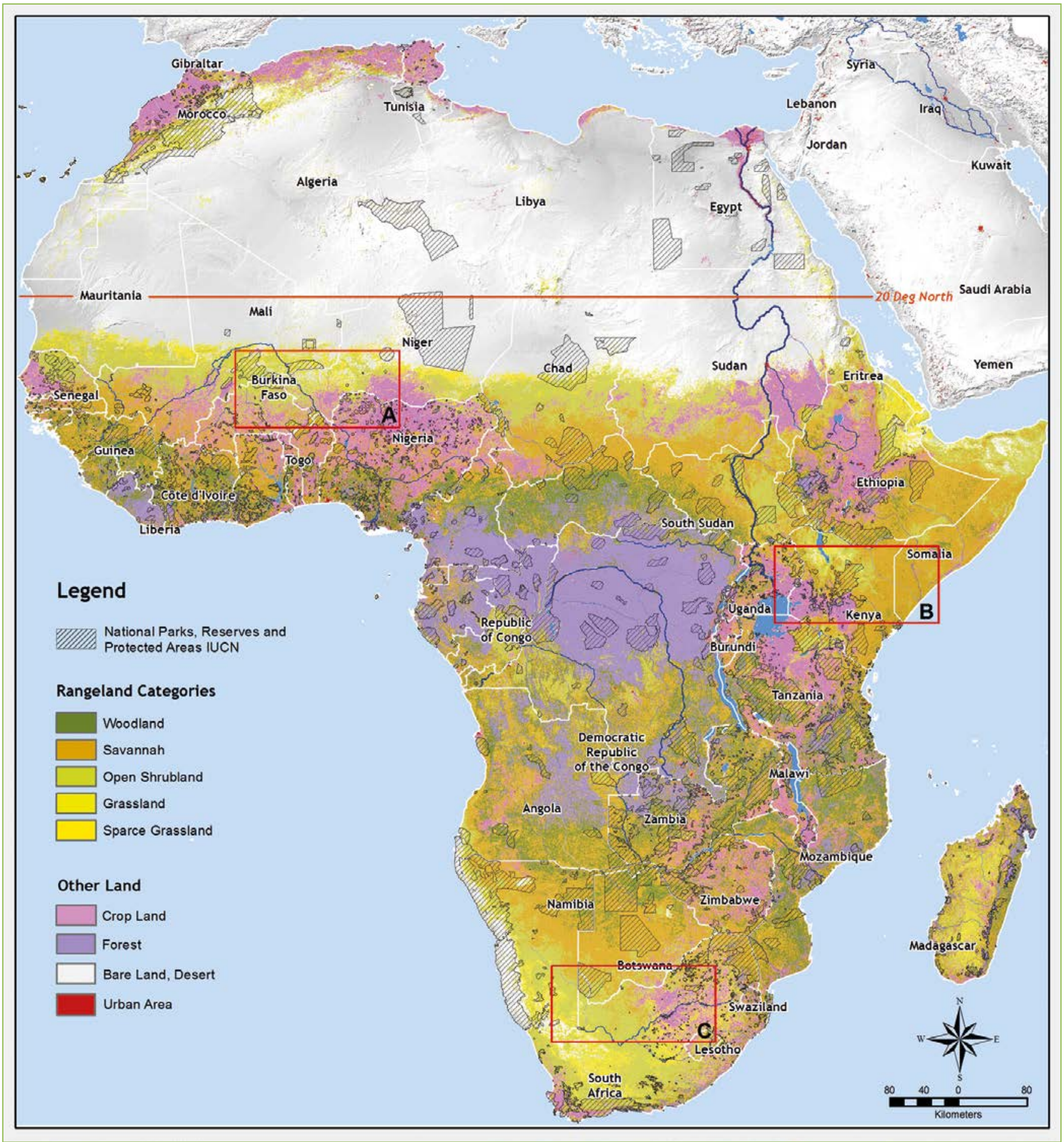
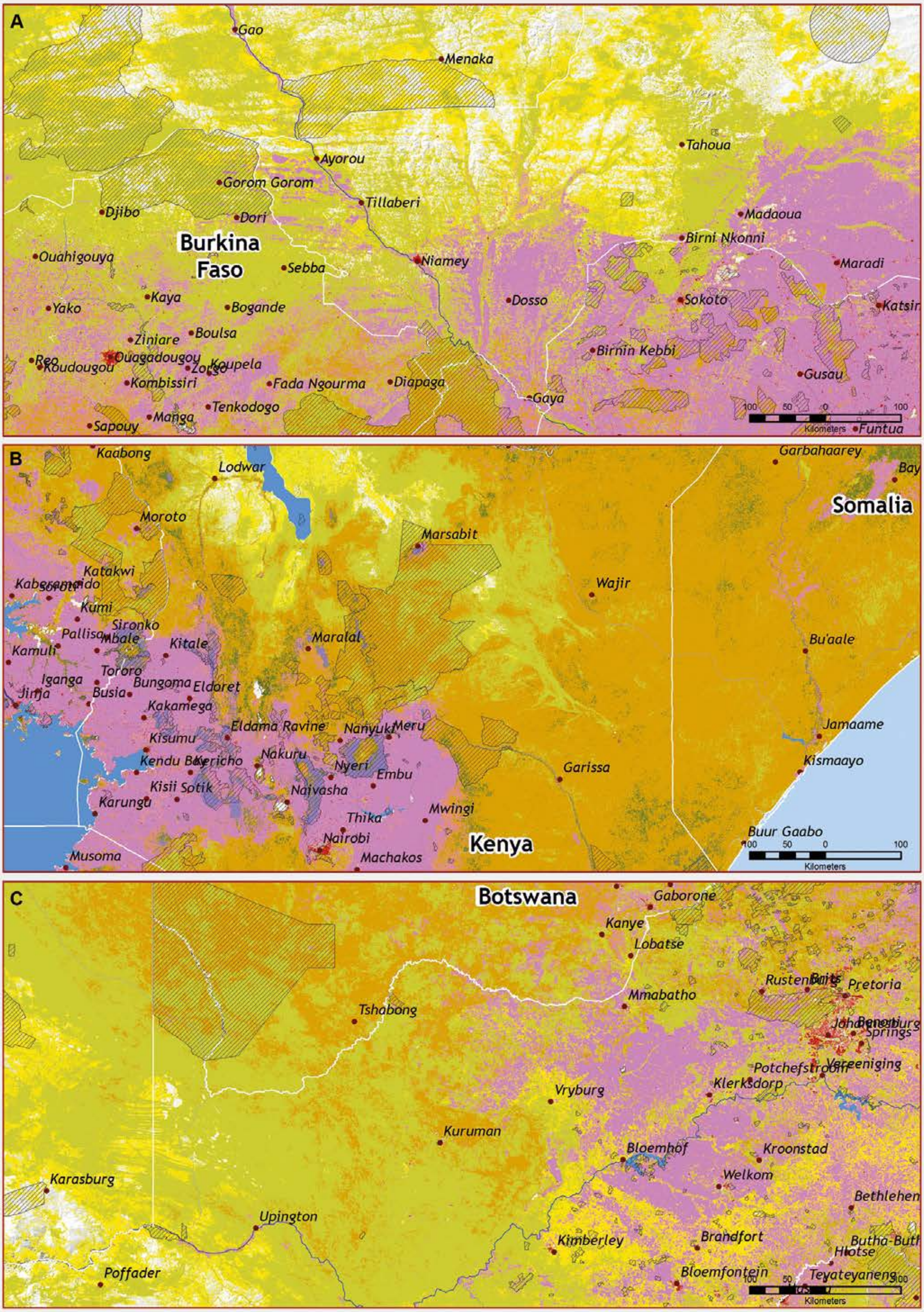


Figure 2.1: Rangeland, cropland, forest, bare land/ desert and urban areas in Africa. Rangelands are defined by fractions of grass, shrub and tree cover. Sub-Saharan Africa is considered south of 20 Deg North. Data sources: Copernicus 2018 reassembled data, World Database on Protected Areas (WDPA) 2018.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Ayorou
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Niamey
Sebba
Maradi
Kaya
Yako
Bogande
Dosso
Sokoto
Katsin
Ziniare
Boulsa
Birnin Kebbi
Ouagadougou
Koudougou
Reo
Koupela
Kombissiri
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Wajir
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Maralal
Kamuli
Bu'aale
Tororo
Iganga
Bungoma
Eldoret
Jinja
Busia
Kakamega
Eldama Ravine
Nanyuki
Meru
Jamaame
Kisumu
Nakuru
Kericho
Nyeri
Kismaayo
Embu
Garissa
Kisii
Sotik
Naivasha
Karungu
Thika
Mwingi
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Vryburg
Kuruman
Bloemhof
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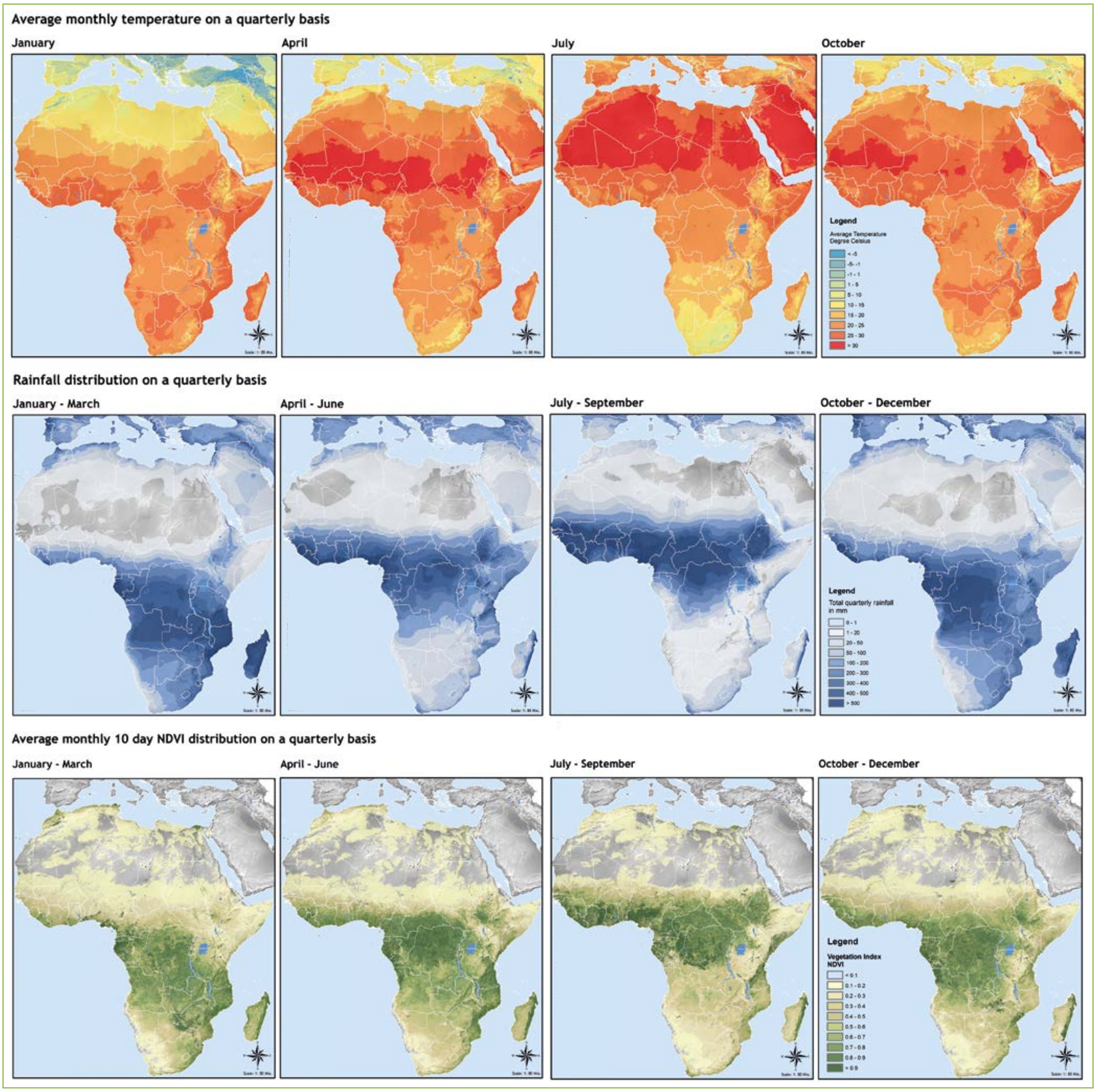


Figure 2.2: (a) Seasonal temperatures (top), (b) rainfall (middle) and (c) greenness (bottom) in Africa. Data source: WorldCim 2017; Copernicus Global Land Service: average monthly 10-day NDVI 2017.

seven to nine months while the bimodal regime has two dry periods of around two to three months each. Where there is only one rainfall season, a failure can be catastrophic, while with two seasons a single failure can be partially compensated by the second rains – as in the equatorial zone (Figure 2.2b). Additionally, in the equatorial and northern hemisphere, there is rainfall gradient from the west with higher amounts, to the east with lower rainfall; in the southern hemisphere it is the opposite. This can be attributed to global atmospheric circulations and warm, or cold, sea currents. Rainfall, its variability, reliability and seasonality is the main driver of production in the rangelands of SSA.

With the movement of the rains the vegetation growth and the available biomass changes, as indicated by the Normalised Difference Vegetation Index (NDVI) "greenness" value (Figure 2.2c). This index picks up the movement of the greenness and availability of fresh fodder. It clearly indicates if animals (whether wildlife or livestock) will need to follow the available fodder through migration, or whether they will have enough biomass production during the rains to tide them over the dry season.

The high variability and unpredictability of rainfall, in both space and time, characterises rangelands, and gives rise to heterogeneous forage resources. This heterogeneity is a defining feature of rangeland ecology. Both wildlife and livestock require mobility at a scale which allows them to adapt to, and capitalise upon, this inherent variability (see Chapter 3.1.1). Climatic variability also leads to challenges of water scarcity, both seasonally and spatially, which affects rangeland ecology and limits both land use and management options. While rainfall is the primary factor governing plant growth and productivity, water availability also depends on the landform.

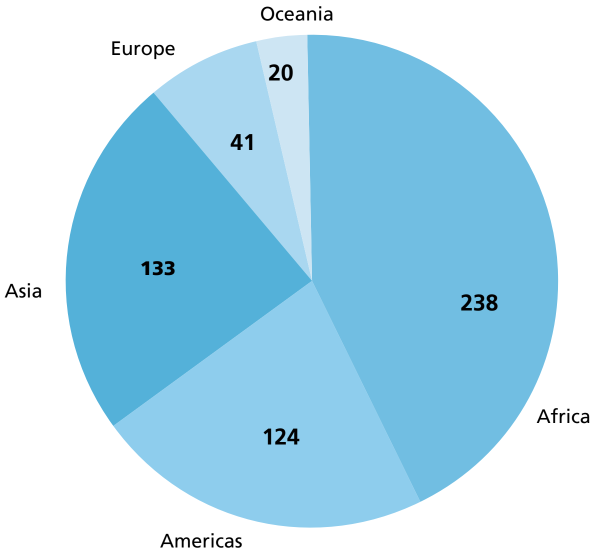


Figure 2.3: Number of global drought events (1975-2014). Data source: WAD 2018

While mountains in Africa are often termed “water towers” (Liniger and Thomas 1998, Liniger and Weingartner 2000, Notter et al. 2007), the rangelands can equally claim to be important “water reservoirs”. Vast rangelands situated in dry lowlands are often connected with wetter and resource-richer mountains. Perennial and seasonal rivers and “wetlands in drylands” are strongly depend on water and land use in the mountain areas. Depressions in the landscape create wetlands, swamps and floodplains, all acting as reservoirs and this concentration of water is a vital resource because it provides a source of drinking water (in places) and creates pockets – microclimates – of high productivity within the overall rangelands. There are many wetlands and lakes situated in the rangelands of SSA – receiving flows directly from the drylands and the mountain areas and providing services for rangeland users: Lake Victoria is one, Lake Chad and Lake Tabalak (in Niger) are other large and significant lakes with associated wetland. Rivers bring water from mountains to drylands provide special habitats and valuable resource along their riparian zones and end up in swamps, wetlands, lakes and deltas. Examples are the expanses of the Okavango swamp in Botswana (Murray et al. 2006, see Box 4.23), the Gash Delta in Sudan, the extensive and biodiverse Masura swamp adjacent to the Serengeti in Tanzania, the Niger in West Africa, and the Ewaso Ng’iro in with the Lorian Swamps in Northern Kenya. All have a massive impact on rangelands. In the West African Sahel, sub-surface water stored beneath the drylands, dependent on rainfall infiltration, constitutes a lifeline to inhabitants who tap into it through wells.

2.1.2 Drought and aridity change – climate change

A drought is a continuous period of dry weather, when an area receives below-average rainfall, over weeks, months or even years, resulting in prolonged shortages of water supply. As rainfall is such a strong driver of conditions in the rangelands, drought periods closely affect water availability for the vegetation, animals and people. Impacts range from mild to severe. Droughts are characteristic of climate variability in the rangelands. The regular – but inherently unpredictable – reoccurrence of droughts is stressful to vegetation and thus forage availability for livestock and wildlife. Forty-three percent of globally recorded droughts between 1975 and 2014 occured in Africa – the continent most affected (Figure 2.3).

Drought frequency change of Africa

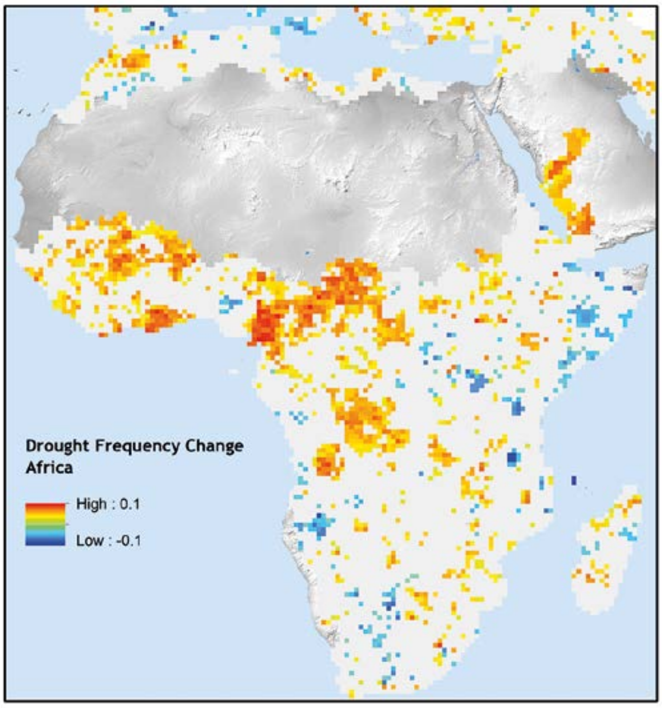


Figure 2.4: Trend in meteorological drought frequency in Africa (1951 to 2010) measured as the change in the number of drought events per 10 years. Source: WAD 2018 based on Spinoni et al. 2014.

Changes in the frequency of droughts show that rangeland regions most affected are found in West Africa (Chad, Mali, Mauritania and Nigeria) and in Angola and Zambia. The Horn of Africa and western parts of Southern Africa have decreasing drought frequencies (Figure 2.4).

At the global level, a hotter and (often) drier climate coupled with more uncertain precipitation for most of Sub-Saharan Africa is projected (IPCC 2014). At the regional and local level, impacts will manifest themselves mainly through the increase in frequency and severity of dry weather conditions, and through altered patterns of precipitation. Inter-annual and intra-annual variability (year-to-year, and within years and seasons), especially in terms of precipitation, are expected to increase. The main challenge of climate change for livestock and wildlife is that hotter conditions will mean longer and more severe dry seasons, and increasingly patchy and unpredictable rainfall will make it more difficult to access fresh high-quality grazing. This is being exacerbated by growing fragmentation of rangelands and associated reduced mobility, resulting in an inability to reach critical seasonal habitats such as areas of drought-reserve forage in high rainfall regions or wetlands (Homewood 2009, Fynn et al. 2015). The Mediterranean areas of both North Africa and Southern Africa are likely to receive less rain, whereas, contrastingly, precipitation could increase in East Africa (Hoffman and Vogel 2008). The continued warming of Sub-Saharan Africa is projected to result in temperatures 2–4 degrees higher by the end of the century (IPCC 2013, Serdeczny et al. 2017). Such increases will most likely be greater in Northern and Southern Africa than in the moister areas of West, Central and East Africa (Hoffman and Vogel 2008). This will have impacts on the production potential of rangelands, and at a broader level on various rangeland-based ecosystem services. A recent analysis of the Mount Kenya area and its surrounding drylands, using the densest and longest possible data records from early colonial times

Box 2.1: Trends in mean and extreme precipitation in the Mount Kenya region

A recent study by Schmocker et al. (2015) carried out an analysis of mean and extreme rainfall in Mount Kenya region in Kenya using a unique dataset, combining both the measurements from private raingauges and several governmental agencies such as the former District Ministry, the Kenya Forest Service (KFS), and the Kenyan Meteorological Department (KMD). The study used four climate change indices from ETCCDI. The adopted indices are: total precipitation (PRCTOT), the number of heavy rain days (R10 mm); where rainfall ≥10 mm in a day; maximum of consecutive 5-day precipitation (Rx5day) and the maximum number of consecutive dry days (CDD); days recording <1 mm. The findings of the study showed that R10 mm and intensity of extreme events are increasing, especially in the October-December (OND) rain season. It was also noted that CDD was on the increase (Ongoma et al. 2018).

(some starting in the 1920s), revealed the "long rains" (April-June) to be decreasing in amount while the "short rains" (October-December) were increasing (Schmocker et al. 2015, Box 2.1). The total annual rainfall showed a slightly increasing trend. Rainfall intensities, as well as the length of dry spells, also showed an upturn, indicating more erosive and more erratic rains. However, there were marked differences within the region, depending on their position in relation to the mountains.

The aridity index is defined as the ratio of precipitation over potential evapotranspiration (the amount of water needed to maintain constant green vegetation cover). For the immediate future, 2011-2040 aridity as an indicator of expected climate change shows that most of the SSA region will get drier, especially in Southern Africa. The rangelands in East Africa are expected to get wetter, as is the northern fringe of the Sahel. Only in those regions where the aridity index is increasing – meaning areas are expected to become less arid – will the impact of climate change trigger better vegetation growth; in all the other areas the water stress on the vegetation will increase (Figure 2.5).

2.1.3 Population density and change

Rangelands in SSA are inhabited by 384 million people (Figure 2.6), at an average density of 27 people per square kilometre (in 2015). Population density within of the rangeland crescent is the highest in the wetter parts (towards the cropland regions, as clearly illustrated in Burkina Faso and northern parts of Nigeria, as well as the highland of Ethiopia and Kenya, and in Zimbabwe (Figure 2.6a). The average population density in the savannah and open shrublands is around 30 person per square kilometre. In the drier parts of the rangelands only 10 persons per square kilometre were recorded. A closer look reveals the population being concentrated close to urban centres, towns and cities. The change over the 40 years from 1975 to 2015 shows an increase in the population, and most growth in the wetter regions of the rangeland and also close to agricultural and urban areas and rural centres (Figure 2.6b). As far as analysis of the data allows (given their limited accuracy and availability) the population has been growing, in general, all over the rangelands, with some decreases in specific locations. Over the last 50 years SSA's population has more than tripled (Tabutin and Schoumaker 2004).

In SSA, many rangeland areas unsurprisingly, lag behind in terms of development and provision of basic services

Change of aridity 2011-2040

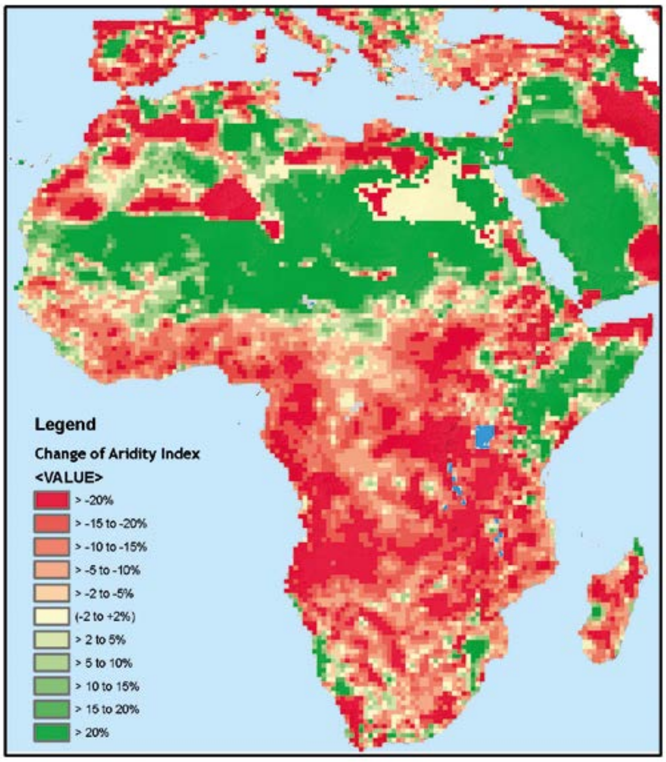


Figure 2.5: Change of aridity index in Africa (2011-2040). Data source: WAD 2018.

relative to other areas, due to their remoteness but also to a long history of marginalisation of rangeland users (Holechek et al. 2017).

Additionally, many inhabitants rely on animal products (meat, milk, blood, hides and skins) to buy their daily diet, which is generally based on cereals, most often purchased from agricultural neighbours or on the open market. Even though they produce a variety of different items for their livelihoods, they still depend heavily on the rains, and thus are very vulnerable to unpredictable stressors, especially droughts and land degradation. Poverty diminishes the adaptability of rangeland users, reducing the resilience of communities to shocks. Compounding these problems is the fact that these stressors do not work in isolation. When coupled with poor management practices, development priorities and policies (especially those that undermine traditional rangeland management strategies), risks and vulnerabilities will continue to increase.

The need to increase productivity is indeed high on the agenda of the African Union and is documented in the poverty reduction strategies of many states, for example Les Nigériens nourrissent[2], the Food and Nutrition Policy for Tanzania[3], Poverty Reduction Strategy Paper of Mozambique[4].

Many rangeland inhabitants are involved in complex livelihood systems that include a variety of non-livestock rangeland products (NLRP). There are many non-livestock rangeland products already commercially viable– tapping biodiversity. Medicinal products are to be found in the driest of regions (e.g. the endemic "devils claw", *Harpagophytum procumbens*, as a treatment for arthritis), some foods and beverages are also endemic (e.g. Rooibos, *Aspalathus linearis*, infused as a tea and has growing popularity worldwide) and the widely used, commercially valuable gum arabic (from *Acacia senegal*) is found across most of the rangelands

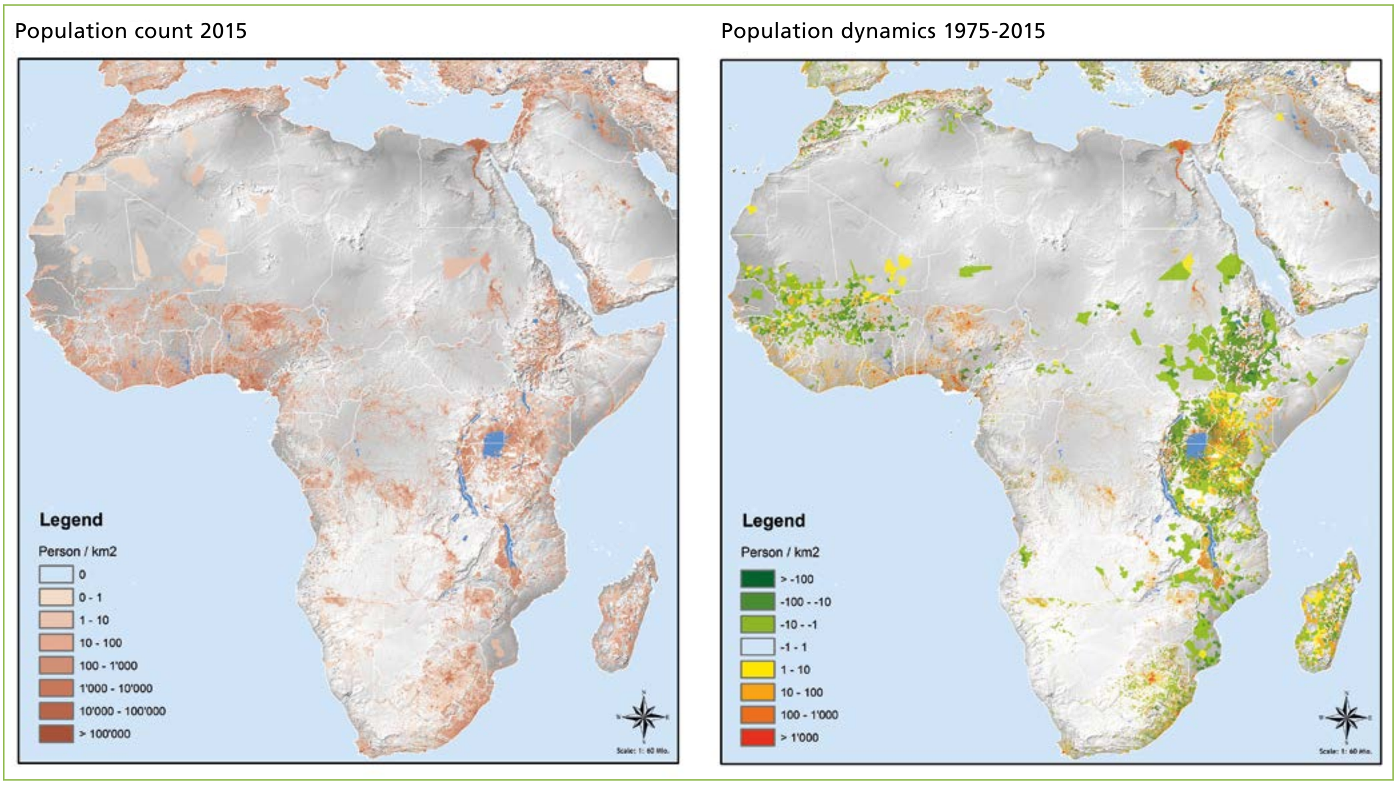


Figure 2.6: (a) Population density in Africa 2015 (left), and (b) population dynamics 1975–2015 in Africa (right); (b): increase (red colours) and decrease (green colours). Data source: JRC and CIESIN 2015.

in SSA; shea butter from the tree *Vitellaria paradoxa* is a another example of an NLRP with international, commercial prominence. Aloes – native to semi-arid areas all over Africa – provide the basis for cosmetics.

2.1.4 Livestock and their distribution

Because of the underlying climatic variability, rainfed crop production is problematic within the rangelands. Rangeland users, despite some having relatively diversified income earning strategies, are basically reliant on livestock and wildlife for their livelihoods. There is a very long history of livestock keeping within the African rangelands, primarily through pastoralism, which has been practiced across the continent for thousands of years. Livestock in SSA rangelands include mainly cattle (with its many breeds), sheep, goats, and a smaller number of camels and donkeys: numbers and distribution vary considerably and accurate data are difficult to attain.

Using the most recent and reliable source, maps of densities for cattle, sheep and goats have been produced (Figure 2.7) – bearing in mind that accuracy differs for the various regions and countries. Nevertheless, the available information for the different zones in the rangelands of SSA has been analysed. The total livestock number in SSA can be approximated to 138 million cattle, 123 million head of sheep and 144 million head of goats (Wint and Robinson 2007).

Looking at the distribution of cattle, sheep and goats and their density in SSA, this shows that the highest numbers are reported in the rangeland crescent that curves around Central Africa, with the largest concentration in the middle; neither at the driest nor at the wettest fringes (Figure 2.7). This confirms the central role of rangelands for production of livestock in SSA. Densities of the three main species of livestock in the rangelands vary greatly, but in many locations cattle numbers are similar to, or greater than, goats or sheep. There are some regional differences that need to be highlighted, however these are often difficult to explain. In the western part of the Sahel, sheep extend the furthest north to the sparse grasslands along dry river valleys, especially in Mali, Mauritania and Niger. Cattle densities are highest in Burkina Faso in woodlands and savannah, and in the contact zone with crop land. It is remarkable to note the sharp difference between Chad with very low livestock densities especially sheep and goats, and Sudan and South Sudan with medium to high densities. Due to conflicts and theft many herds from Chad are moved more south crossing the border. Southern Somalia has mainly cattle, while the northern part around the Horn and the lowlands, southwest of Ethiopia, have high sheep densities, and patchy goat distribution. Combining all three livestock species, the dry lowlands of Kenya have the highest density compared to neighbouring countries. The boundary with Tanzania is distinct in terms of sheep and goats densities, less so for cattle. In Southern Africa, Malawi, Mozambique and Zambia generally have low livestock densities. Cattle densities in Southern Africa are high in Zimbabwe and the eastern regions of South Africa, including Swaziland and Lesotho, and south western areas of Angola. Sheep are mostly found in the southern and eastern parts of South Africa and Lesotho. Goats are concentrated along the south eastern part of Southern Africa with the highest densities in Lesotho and Swaziland. In some areas, camels and donkeys are also important – though their number is small and the distribution is very variable over SSA.

Camels deserve special attention, as they are specifically adapted to dryland conditions being browsers, feeding mainly on bushes and trees. Thus they do not add to pressure to the grasslands – and can complement herds of grazing

[2] http://www.initiative3n.ne/

[3] https://extranet.who.int/nutrition/gina/sites/default/files/TZA%201992%20Food%20and%20Nutrition%20Policy.pdf

[4] http://www.imf.org/external/pubs/ft/scr/2007/cr0737.pdf

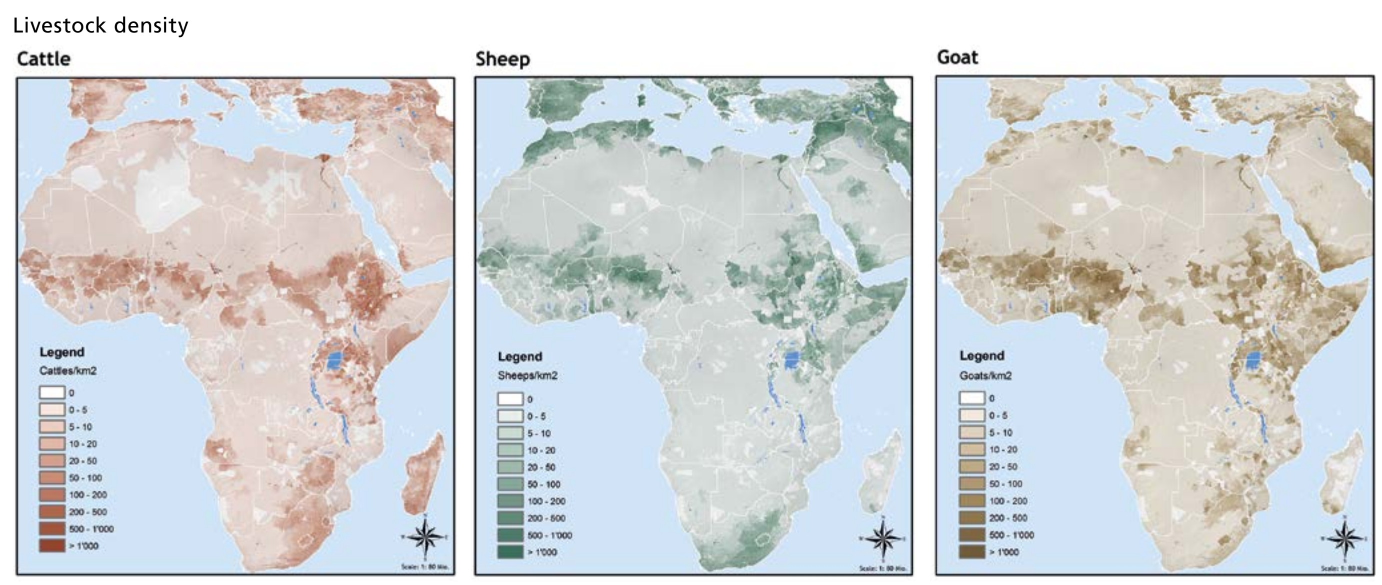


Figure 2.7: Livestock densities in Africa for cattle, sheep and goats. Data source: FAO GLW 3 2010.

herbivores to better utilise the available vegetation. Furthermore, analysis of the rangelands shows that they have a substantial tree and bush cover, which in most areas is stable or increasing (see Figure 2.1). Thus this is a large fodder resource for browsing livestock and wildlife.

The Horn of Africa has the largest concentration of camel herds in the world, with Somalia estimated to have the highest population globally. Large camel populations are found in the eastern lowlands of Ethiopia, northern, western, and north-eastern Kenya, and in most parts of Somalia. According to FAO, Somalia had seven million camels in 2008, while Ethiopia and Kenya had about 2.4 and 0.95 million camels in 2009, respectively (Catley et al. 2013).

While some management systems largely depend on a single type of livestock, in most areas land users combine several species. This mimics the natural ecological coexistence of multiple types of herbivores, enabling them to exploit different niches and to use resources efficiently. Furthermore, some livestock keepers split their herds, keeping some animals close to the homesteads (often those producing milk, and younger livestock) while others exploit pastures far away. It is also common practice to lend animals to other herders, to reduce risks.

While casual observers may perceive goats as being the root cause of degradation because they are a threat for the rejuvenation of shrubs and trees, the real threat for the grass cover are actually sheep. Unlike cows, they can graze pastures area-wide down to the soil surface, a major threat for the regeneration of the grass cover (see Figure 2.12).

Although rangelands consist primarily of indigenous vegetation, landscapes may be natural (edaphic) or man-made (anthropic). They are untilled – apart from pockets of cropping practised by agropastoralists – and influenced most by the actions of herbivores; wild and domesticated. The varying degrees of human interference mainly through livestock management, fencing-off wildlife and deliberate use of fire, has transformed large rangeland areas away from their natural state into semi-natural environments, or into environments characterised by high levels of human interference which has modified the composition and densities of trees, grasses and herbivores.

According to FAO and IRLI, the SSA rangelands can be subdivided into different ruminant livestock production systems (Robinson et al. 2011). Figure 2.8 shows that rangelands in SSA mainly consist of two main production groups – one where ruminant livestock (cattle, sheep and goats) play the dominant role, and one where livestock and cropping play closely interactive roles. These two larger groups are mainly:

- The 'livestock only' group, in areas ranging from hyper arid to arid, humid and temperate-tropical highland areas.
- The 'mixed-rainfed' group, also located in hyper arid, arid, humid and in temperate-tropical highland areas.

Mixed rainfed production systems are characterised by a combination of rainfed agriculture and livestock in an integrated and complementary way: livestock benefit through feeding on crop residues (straw, harvested by-products and weeds) and in turn produce dung and urine (used as fertilizer for crops) and provide draught power (to pull ploughs and carts). These systems are only possible in areas with climatic conditions that make crop farming feasible.

In 'livestock only' production systems, there is not enough production from cropping to make any significant contribution to the diet of the ruminant livestock – apart from small seasonal supplements. Thus the livestock – cattle, sheep and/or goats – need to be mobile to access forage and secure sufficient dry matter intake. The less reliable the forage supply, the more mobile the herds need to be.

Over the course of the year, in livestock-only systems, the animals move away from areas of settled cropping in the wet season, but back towards these zones when it becomes drier. Thus they reciprocate between the rangelands and the mixed zones (see arrows in Figure 2.8). During dry cycles, livestock move into the wetter areas close to the mixed rainfed production systems. Then, during wet periods, livestock move out of these zones into the drier rangelands where vegetation has recovered. These north–south seasonal migrations are characteristic of the 'livestock only' systems in West Africa. Mobility of livestock is the key tool to enable this dynamic to function. A similar dynamic is at work in the SSA highlands: in the Horn and East Africa (Ethiopia, Kenya and Uganda) and Southern Africa (Lesotho and Swaziland).

Ruminant production system

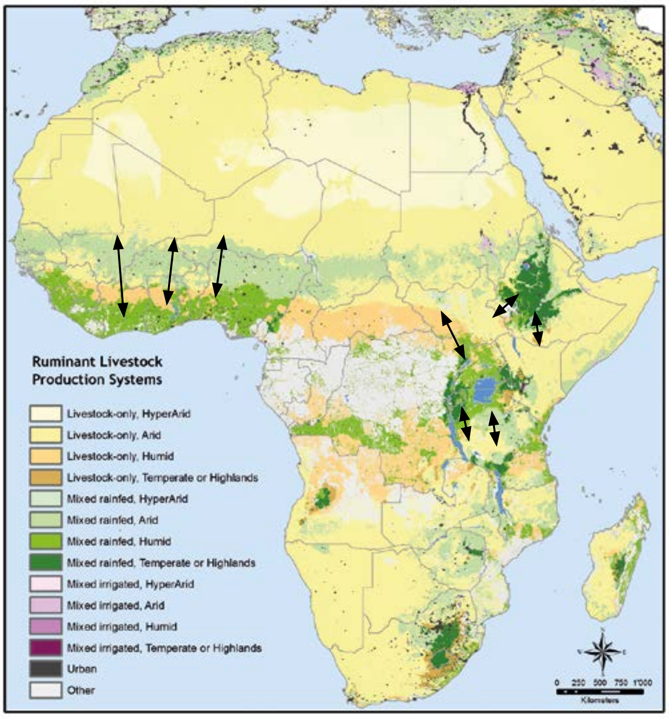


Figure 2.8: Ruminant livestock production system classes in Africa. Note: ruminant livestock include cattle, sheep and goats. Arrows indicate common seasonal movements. Source: Robinson et al. 2011.

In terms of the future of rangelands, the mixed rainfed systems and their fringes play a key role. They provide the basis for intensification of livestock production – in combination with cropping – which, if better developed and expanded can reduce the pressure on the core rangelands. However, this intensification may also reduce areas available for pastoralists and my reduce mobility.

Extensive grazing land in Africa is concentrated in the semi-arid environments for several reasons: (i) crop production in these regions is limited by rainfall, thus reducing to some degree competing demands for land, (ii) forage production in the arid and semi-arid regions, although less in terms of biomass, is generally much better in terms of nutritional value compared to forage from the mesic savannahs and humid zones, and (iii) most ruminants suffer increasing disease incidence in more humid regions, reducing their utility for meat and milk production (Milne and Williams 2015).

Sub-Saharan Africa can be classified into four sub-regions: West Africa (27.3% of the total area), Central Africa (23.8%), Horn and East Africa (27.7%) and Southern Africa (21.2%)[5]. In this study Central Africa as a region has been excluded due to marginal importance of rangelands (Table 2.1). For this study the countries included in the sub-regions are:

West Africa: Benin, Burkina Faso, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone and Togo. Cameroon, Central African Republic and Chad are geographically part of Central Africa but for this study are included in the West Africa sub-region.

Horn and East Africa: Burundi, Djibouti, Eritrea, Ethiopia, Kenya, Malawi, Mozambique, Rwanda, Somalia, South Sudan, Tanzania and Uganda.

Southern Africa: Angola, Botswana, Lesotho, Madagascar, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe.

Take-home messages

- Rangelands in SSA cover areas with a broad span of characteristics: vegetation and cover, topography, water and use.
- Whether a region has one or two rainy seasons per year has significant implications on forage reserves and the movement of animals.
- Rainfall, its variability, reliability and seasonality is the main driver of production in the rangelands of SSA.
- The high variability of rainfall characterises rangelands, and gives rise to heterogeneity – a defining feature of rangeland ecology.
- While mountains in Africa are often termed "water towers", the rangelands can equally claim to be important water reservoirs.
- Rivers bring water from mountains to drylands provide special habitats and end up in swamps, wetlands, lakes and deltas.
- The main challenge of climate change for livestock and wildlife is that hotter conditions will mean longer and more severe dry seasons.
- Rangelands in SSA are inhabited by 384 million people, at an average density of 27 people per square kilometre.
- Many rangeland areas lag behind in terms of provision of basic services, due to their remoteness and a history of marginalisation.
- Many rangeland inhabitants are involved in complex livelihood systems that include a variety of non-livestock rangeland products (NLRP).
- There is a very long history of livestock keeping within the African rangelands, primarily through pastoralism, which has been practiced for thousands of years.
- Combining several livestock species mimics the natural ecological coexistence of multiple types of herbivores, enabling them to exploit different niches and to use resources efficiently.
- For the future of rangelands, the mixed rainfed systems and their fringes play a key role. They provide the basis for intensification of livestock production.

2.1.5 Land tenure/ rights and water rights

In much of SSA, grazing lands and use of rangeland resources, water resources and forage resources have historically been governed under traditional common property regimes. These have been guided by indigenous institutions – through traditional groups of elders – which set rules and regulations in respect to use of resources and control of livestock. While it is popularly thought that most rangelands have slipped into an open access, free-for-all 'tragedy of the commons' situation, many continue to be governed to one extent or another by local institutions. Traditional management systems enabled rangeland users to pool and reduce the temporal and spatial risks associated with the climatic variability of the rangeland, in particular spatially and temporally heterogeneous and variable forage production (Bationo et al. 2015). Because of the long history of pastoralism and rangeland management in SSA, land and water use rights in rangelands are complex and are often a result of traditional practices. However, traditional land management practices on rangelands in many SSA countries are increasingly running up against modern law, especially as a result of the increasing demand for alternative use of the rangelands. The challenges which traditional land tenure systems in many SSA countries face require not only better understanding about, but also adaptation of, traditional systems.

[5] http://www.fao.org/docrep/005/Y4176E/y4176e04.htm

Table 2.1: Climatic, vegetation and water characteristics of Sub-Saharan rangelands according to region. Note: The differences within regions can be greater than between regions.

Sub-Saharan rangelands			
Region **Characteristic**	**West Africa**	**Horn and East of Africa**	**Southern Africa**
Agro-climatic zone	Arid, semi-arid and sub-humid (Sahara, Sahel and Sudanian zone). Warm to hot throughout the year. Heterogeneity: north-south, spread out over long distances.	Arid, semi-arid and sub-humid. Warm to hot throughout the year, temperate to cool on the highlands and mountains. Heterogeneity: east (drier except at small coastal fringe) to west (wetter areas in Congo basin); influenced by mountains and may change within very short distances.	Cool during southern hemisphere winter arid, semi-arid and highland temperate. Heterogeneity: northeast to southwest; in some areas influenced by mountains but less pronounced than in the Horn and East Africa.
Rainfall and seasonality	One rainy season: from July to September. Rainfall in hot summers between 200 mm – 1200 mm (in the coastal areas two rainy seasons: main End of April to July and shorter in September and October).	Two rainy seasons: • March – May and October to November (in EA); • June- July and January (in the Horn). Bi-modal rainfall wiuth annual total between 250 mm and 800 mm.	Periodic summer rainfall: • Semi-arid savannah regions: wet season from mid-November to April, then a cool early dry season from May to August, followed by the hot, late dry season from September to mid-November. Timing of first good rains can be highly variable from year to year; • High rainfall grasslands have a similar pattern except that the rains come in October and finish later (May).
	Summer rainfall influenced by the Inter-Tropical-Convergence Zone (ITC). Frequent droughts.	Rainfall influenced by in Inter-Tropical Convergence Zone, trade winds from the Indian Ocean and by weather patterns associated with sea surface temperatures and the El Niño Southern Oscillation and La Niña Oscillation. Common and increasing droughts.	
Vegetation/ land cover	Dominated by annuals and dwarf shrubs, with perennial grasses common in depressions where soil moisture levels high. Heterogeneity/ gradient: north-south.	Annuals and dwarf shrubs account for a greater proportion than perennial grasses in the diet of pastoralists' livestock. Sudano-Sahelian region: annuals and dwarf shrubs, with perennial grasses common in depressions where soil moisture is high. Heterogeneity/ gradient: altitude.	Mostly savannah, although increasingly encroached by bush. Heterogeneity/ gradient: Proximity and exposure to the sea.
Surface water availability	Dependent on seasonal streams and one perennial river (Niger).	Dependent on perennial streams from mountains, flow is overconsumed in the upper parts of the watersheds for irrigation water use, thus water availability is declining; Most of the area is dependent on seasonal streams and some springs (e.g. on the Ewaso Ngiro) in low-lying downstream areas, the water scarcity problem is exacerbated by increased extractions and/or dams upstream.	
Prediction CC (2050)	Drought and mean annual temperature rise: 1.7 to 3.2 degrees C. Decline in mean annual rainfall of 4%, crop and fodder growing periods may shorten by an average of 20% (varies by sub-regions: northwest drier, northeast wetter, south unchanged). Floods	Drought and mean annual temperature rise: 0.6 to 3.9 degrees C. East Africa: 5–20% more rainfall in the "short rains" October-December and February, and 5–10% less rainfall from June to August. Increasing drought is also occuring, particularly in the lowlands of Ethiopia.	Drought and mean annual temperature rise: 1.5 to 3.5 degrees C. Decline in mean annual rainfall of 5%, crop and fodder growing periods may shorten by an average of 20%.
Vulnerability to drought	High due to unimodal rainfall. • 155.5 million people exposed to drought and other shocks	Less than in the other two regions; if one of the bi-modal rainy seasons fail the impact is less severe than for areas with one rainy season. Rainfall is of different reliability and amounts for each season. • 150.6 million people exposed to drought and other shocks	High due to unimodal rainfall. • 105.6 million people exposed to drought and other shocks
Climate change effect on human population	Projected to experience severe impacts on food production, including through declines in oceanic productivity, with severe risks for food security and negative repercussions for human health and employment.	Higher risk of flooding and concurrent health impacts and infrastructure damages.	Sees the strongest decrease in precipitation with concurrent risks of drought. Sea-level rise puts at risk a growing number of densely populated coastal cities, whose population is set to increase and may receive yet more in- migration as a result of rural livelihood degradation.
Population dynamics	Population rapidly increasing in and around rural centres but decreasing in more remote areas.		
Income and hunger risk	• Low income and high hungerrisk throughout the region except Nigeria.	• Low income and high hunger risk throughout the region, especially in the Horn of Africa.	• High income in the Southwest countries. • Low income in the northeast especially in Mozambique and Madagascar.
Livestock density and system	Changing composition towards more smallstock. Large-scale users more largestock (large livestock owners contracting herders to look after their animals. Livestock species are ruminants and camels. Donkeys and horses are used for transport and ploughing. Sahel and West Africa home to 25% of the cattle, 33% of the sheep, 40% of the goats and 20% of the camels of the entire Sub- Saharan Africa region.	Changing composition towards more smallstock. Large-scale users more large stock (Ranchers, large-scale absentee livestock owners contracting herders to look after their animals).	In Namibia there has been a shift from dairy production to beef to game, as rangeland degraded.

Source: African Union 2012; Kihara et al. 2015; Cervigni and Morris 2016; Serdeczny et al 2017; Zougmoré et al. 2018
http://climateanalytics.org/files/ssa_final_published.pdf
http://www.geocurrents.info/geographical-education/free-customizable-map-of-africa-for-download
https://www.oecd.org/swac/publications/41848366.pdf

Land deals Africa

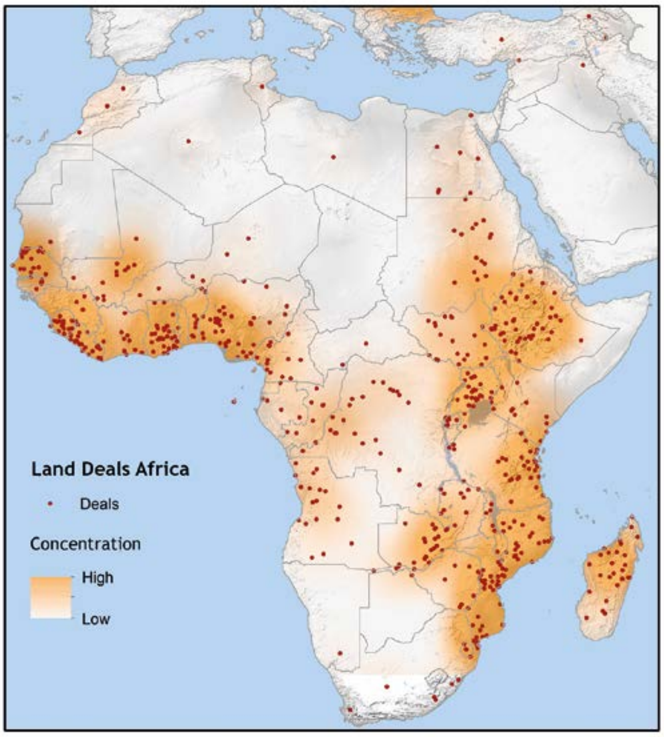


Figure 2.9: African heat map of land deals contained in the Land Matrix with the concentrations of land deals highlighted in intensity from light to dark orange. The map is limited to large-scale transnational deals in the agricultural sector. Source: Land Matrix 2016. Map: Manuel Abebe.

In recent years, the formalisation of property rights has allowed for small-scale and large-scale land acquisition often nicknamed "land grabbing" (Figure 2.9, Box 2.2). Africa remains by far the most targeted continent accounting for 42% of all global agricultural deals (422 concluded) and 37% of the area (almost 10 million hectares) (Nolte et al. 2016).

The map shows a concentration of land acquisitions in West and East Africa. It highlights the patterns of concentration of land deals within countries. This gives an indication of the factors that may influence the choice of location for a land deal. For example, the area along the River Nile is visible, indicating that in a dry area, agricultural land deals are concentrated where water is available. This effect can also be observed in northern Senegal, where a large number of land deals have been completed along the Senegal River, and in Mali along the River Niger. The countries targeted are those with a high Global Hunger Index, those where the agricultural sector is a particularly important part of the economy, and those where tenure security is weak. The land targeted by such deals in Africa were formerly used as smallholder agriculture (36%), forestry (29%), commercial large-scale agriculture (23%), conservation (7%) and pastoralism (5%) (Nolte et al. 2016).

Large-scale acquisition of land for agricultural and forest products by foreign investors has increased since the 2007-2008 world food price crisis, which prompted a renewed interest in foreign lands as a means to achieve food security, and as a financial investment. The governments, agribusinesses and investors that have bought or leased these lands are using them for the cultivation of food crops that are then exported, and for the production of cash crops and biofuels[6].

Box 2.2: The Maasai struggle for land access in Loliondo

> **"You cannot cross this land, it belongs to the government, you cannot cross this land it belongs to investors"**

Loliondo is very close to the world-renowned Serengeti National Park in Tanzania. The struggle over land access has simmered for almost 20 year because of the government's leasing of land to a foreign hunting company. That company claims exclusive access rights to the allocated area. In 2009, the Government of Tanzania evicted several hundred Maasai households from the area. A study by the International Work Group for Indigenous Affairs (IWGIA), a Danish NGO working with local communities, estimated that 185 homes were burned in an act of forced eviction, leaving thousands homeless and their livestock scattered. The Government argued that it held the ultimate authority, and that the rights to the land, claimed by the Maasai, were nowhere documented. Furthermore, it was asserted, the sheer numbers of animals kept by Maasai constituted an environmental threat. International media coverage was intense at the time and the heat of the arguments has simmered on – with no sustainable solutions found to-date. The latest developments are that on 21th September this year – 2018 – residents from four villages in Loliondo have filed a case with the East African Court of Justice in an attempt to stop further evictions. At the heart of the matter are questions about the Government's rights to attract investors and allocate land – and the concern of the Government about the future of pastoral livestock production.

https://www.theguardian.com/global-development/2017/oct/16/land-means-life-tanzania-maasai-fear-existence-under-threat

Loliondo Division of Ngorongoro District, Arusha Region (https://www.iwgia.org/en/tanzania/2502-tanzania-forced-evictions-of-maasai-people-in-loliondo)

It has been argued that land-grabbing displaces local communities and small farmers to replace them with large-scale agriculture and that this will ultimately increase, instead of diminishing, food insecurity in the "global south", while further deteriorating the environment and causing both livelihood impoverishment and biodiversity loss.

2.1.6 Conflicts

The Sub-Saharan rangelands seem to be loaded with fuel for hidden and open conflicts. Such conflicts have been concentrated in the rangeland crescent, particularly in the regions across West and East Africa: currently mainly in Mali, Nigeria and South Sudan. The highest intensity involves "remote violence" (e.g. bombings and explosions) and open battles (Figure 2.10).

[6] https://www.globalpolicy.org/images/pdfs/The-21st-century-African-land-rush.pdf

The World Development Report 2011: Conflict, Security, and Development (WB 2011) gives an insight into the theory of conflict drivers, which illustrates security, economic, and political stresses, and is particularly relevant to the Sahel. Table 2.2 summarizes the main types of conflicts, their key defining factors, causes/ drivers, and consequences.

There are a number of conflicts related to rangelands which include those fuelled by ethnic mistrust, dwindling natural resources, poor land management, population growth, insecurity and banditry. Any kind of conflict, irrespective of the reasons, poses multiple threats and constraints to rangeland management and food security – while further limiting the pursuit for progress and development. Conflicts can have different origin and reasons:

- Geo-political interests can contribute to conflicts over borders, access to resources like water and grazing lands, to strategic places such as the sea (e.g. in East Africa conflict between Sudan and South Sudan over land access in Abyei administrative area; FAO 2018).
- Insecurity: National governments' neglect of marginalized areas, in which rangelands are generally found, has sometimes resulted in the absence of a security framework and basic services, creating a power vacuum that has in some cases been filled by armed groups. An increasing recent proliferation of arms in pastoral communities[7] has escalated cattle rustling – which previously served specific purposes of restocking or cultural rituals amongst the Turkana and Karamoja[8] – into open conflict.
- Environment and natural resource scarcity due to desertification and droughts is creating land and water shortages that continues to exacerbate conflicts[9]. In the Sahel, recent reports show that as droughts become more frequent, pastoralists are not staying within traditional transhumance routes, thus leading to conflicts with settled farmers. Symbiotic relationships that existed between pastoralists and farmers, such as exchanging manure for crop residues, has weakened and has also been a cause of conflict in the Sahel as farmers start keeping livestock and some pastoralists embark on crop farming.
- Conflicts related to land rights, privatization of land and population increases can also contribute to conflict.

Conflict can interfere with traditional mobility routes leading to land degradation during the dry season. In the Horn of Africa, armed groups such as Al-Shabaab, restricted movements of people and livestock during the 2009-2010 droughts leading to degradation of resources, loss of lives and property[10].

Political conflicts

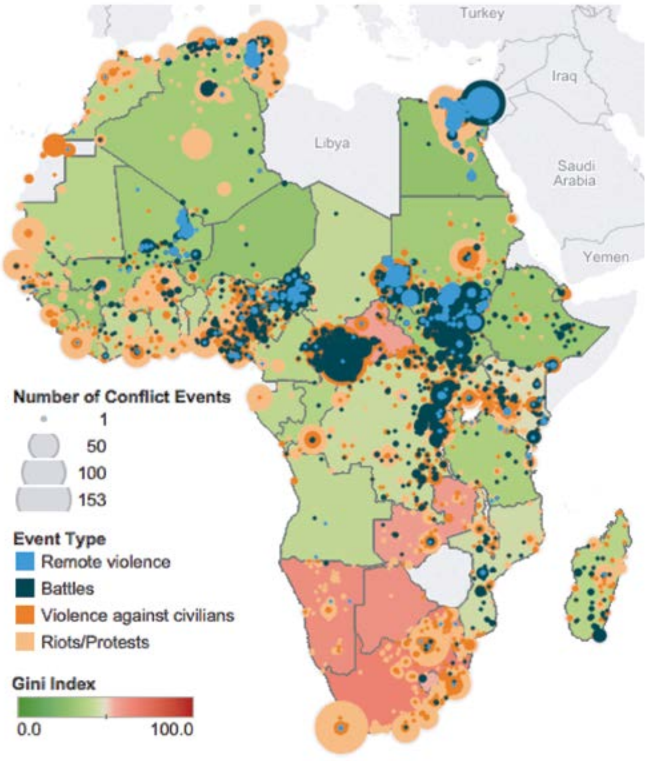


Figure 2.10: Political conflict and inequality as measured by Gini index in Africa. 2014-2015. Source: ACLED 2015.

2.1.7 Wildlife and biodiversity conservation

While rangelands may be dominated by livestock, they also include areas exclusively inhabited by wildlife, or areas that contain a mix of wildlife and livestock. Rangelands represent some of the most important areas of biodiversity globally. In East and Southern Africa especially there exist large areas inhabited by very high concentrations of wildlife including the large herbivores – elephant, rhino, buffalo, giraffe and zebra, and carnivores – lion, leopard and cheetah, sometimes termed 'charismatic megafauna'. Figure 2.11 shows the highest species richness in the rangeland crescent with a concentration in East and Southern Africa.

But it is not only the megafauna, it is also the unique landscapes, the vast savannahs stretching to distant mountains, the rivers and patches of wetlands, that fascinates and touches those who have the opportunity to visit and experience these ecosystems. These areas are of vital importance in terms of biodiversity, but simultaneously in terms of economic value for their countries. This has led to large

Table 2.2: Typology of conflicts, their defining factors, causes and consequences

Type of conflict	Key defining factors	Causes/ drivers	Consequences
Localized conflicts over resource access.	Demography, climate (drought).	Limited access to dry season grazing and water for lifestock, crop damage by livestock.	Can upscale to broader conflicts.
Criminal activities.	Level of risk and attractiveness of payments, social status.	Poverty and inferior perspective of other sectors.	Destabilize social cohesion in pastoral societies, upset management.
Rebellion and irredentism.	Strength of social cohesion in group, hierarchial structure.	Neglect or repression by central authorities, combination of localized alliances and grievances.	Disruption of central services (for example animal disease control), interruption of migratory husbandry practices by other groups.
Religious extremism.	Weakness of social cohesion, degree of infiltration of other extremist group.	Lack of livelihood prospects for future.	Destruction of social services, accelerated trends in criminal activities.

Source: de Haan et al. 2016.

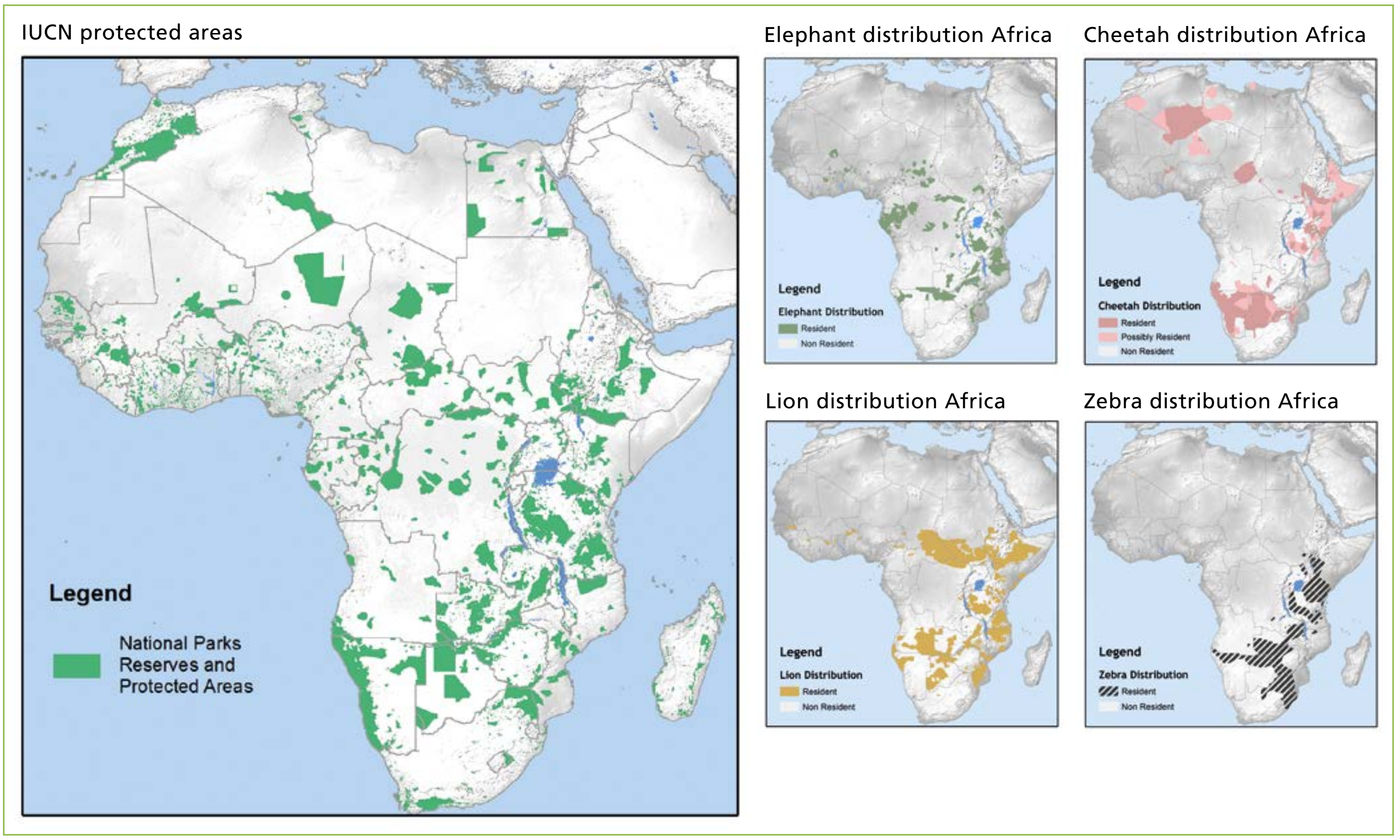


Figure 2.11: Protected areas and distribution of selected species of the charismatic megafauna in Africa, such as elephant, cheetah, lion, zebra. Data source: World Database on Protected Areas (WDPA) 2018 and IUCN Red List 2019.

parts of the SSA rangelands being designated as protected areas, for the preservation of wildlife and for tourism. The density and the size of the protected areas has increased in the rangeland crescent of SSA. Analysis shows that 17.4% of the rangeland area is currently under some state of protection, compared to 13.2% of protected land outside the rangelands. The percentage of protection is lower in the grasslands and shrublands – the drier parts of the rangelands, where it is around 10%, and the highest in the woodland and savannah – the wetter parts of the rangelands, reaching almost 20%. Adding up all protected areas in woodlands and savannahs shows that they host more than three quarters (78%) – and the savannah alone more than half (52%) – of all protected areas of the rangelands in SSA.

Figure 2.11 illustrates the wildlife and associated with it the biodiversity richness of the SSA rangeland crescent. The 'charismatic megafauna' species are clearly more abundant in East and Southern Africa, while the Sahel has less extended areas, and for some of these species only pockets remain (e.g. elephant, lion, cheetah) and some have almost disappeared (e.g. zebra).

Despite some conservation gains, overall biodiversity is declining and human-wildlife conflict is increasing. Recognizing that wildlife require far more space than the protected areas offer, and that most biodiversity resides in human-modified landscapes, conservation efforts are turning to rural landscapes where people directly manage the land. Biodiversity conservation in these areas hinges on landowners accommodating wildlife, and resolving the human-wildlife conflict that undermines their willingness to conserve. Recent studies have led to a conclusions that "devolving the rights and responsibilities for biodiversity conservation from national to local levels calls for reviving the incentives and skills for making wildlife an important component of livelihoods, based on maximizing the benefits and minimizing the costs and conflicts. Paradoxically, such devolution draws the focus of conservation back to the skills and methods of coexistence traditionally residing in communities which is not available to, or considered by, national agencies and NGOs" (Western et al. 2015).

2.1.8 Wildlife and livestock interaction

Wildlife may offer opportunities for supplementary – or even main – income generation and may provide an alternative to livestock production. But for rangeland users, competition between wildlife and livestock can pose a set of challenges: ecological and economic amongst others. It is in East and Southern Africa that most livestock-wildlife interaction occurs.

A rich diversity of wildlife is found both in protected areas and outside. The interaction 'issue' between livestock and wildlife is concentrated outside the protected areas. The type of this interaction is now altering due to a changing landscape, with more competition for resources (water, pasture and migration routes) leading to increased contact between wildlife and livestock (Osofsky et al. 2005). The underlying problem is the decline in wildlife habitats. The impact of this can be increased wildlife-livestock-human conflicts arising from damage caused by livestock, humans and wildlife to each other (African Union 2015).

[7] http://www.smallarmssurvey.org/fileadmin/docs/G-Issue-briefs/SAS-AA-IB3-Traditional-Practices.pdf

[8] https://www.files.ethz.ch/isn/124873/Pastoral%20conflict.pdf

[9] Economist. 2018. https://www.economist.com/middle-east-and-africa/2018/06/07/fighting-between-nigerian-farmers-and-herders-is-getting-worse

[10] IUCN-WISP: https://www.iucn.org/content/food-crisis-sahel-2012-somali-d%C3%A9j%C3%A0-vu

Figure 2.12: Foraging habits of giraffe (left) and camels (centre) in northern Kenya: studies show that there is little competition as they use different feeding heights (O'Conner et al. 2015). Cows graze the grass and herbaceous layer up to a few centimetres and sheep to a few millimetres above the soil surface (right) (Hanspeter Liniger). The different grazing heights of wild or domestic animals have implications on the recovery of the vegetation and the soil cover especially after heavy grazing.

Despite the importance of this interaction for the economic and environmental futures of the region, there has been little scientific progress in understanding the nature of livestock–wildlife competition in pastoral landscapes. However, grazing by different ungulate species on the same "patch" may not effectively be sharing the same resource. Contrary to popular impressions, the presence or absence of dietary or habitat overlap is insufficient to claim competition between livestock or wildlife. Such thinking not only leads to over-estimations of competition, but also leads to land-use decisions that exclude grazing wildlife from pasturelands or livestock from protected areas – decisions that will increase the vulnerability of the whole wildlife–livestock–grassland system (Butt and Turner 2012).

One standard practice in livestock production on rangelands, espoused by commercial ranchers and subsistence pastoralists alike, is the eradication of large, indigenous herbivores that are believed to compete with livestock for food. These eradication efforts have increasingly problematic implications for biodiversity conservation. In an East African savannah renowned for its large herbivore diversity, it was revealed that cattle do indeed compete with herbivores such as zebras and gazelles during the dry season, when food quantity is low. In contrast, during the wet season, when food quantity is high, grazing by wildlife actually benefits cattle by improving the quality of forage. These findings highlight ecological processes that support the promotion of coexistence among large herbivores in grasslands and savannahs, and hence could be useful for conservation (du Toit 2011). Additionally, as rangelands undergo irreversible changes caused by invasions of undesirable plant species and "climate forcing", the future perspective favours a proactive shift in attitude towards the livestock–wildlife interface, from problem control to asset management (du Toit et al. 2017) (Figure 2.12).

Competition between wildlife and livestock is hard to quantify, and the evidence for the magnitude and type of competition is weak (Prins 2000 and Young et al. 2005 in Niamir-Fuller et al. 2012).

2.1.9 Fire

Fire has always been part of rangelands whether natural (through lightning strikes) or ignited by humans. Thus, fire is an important ecological phenomenon in rangelands. Burning has, over millennia, shaped the species composition and structure of flora in rangelands, and has helped to create and maintain a mosaic of vegetation. Fire alters the balance between woody and herbaceous plants across the landscape, tending to reduce the prevalence of woody vegetation and increase the occurrence of herbaceous cover – and thus forage availability. The distribution of reoccurring fires shows that the areas most affected are situated around the Congo Basin, from the wetter woodland areas to the savannah and shrublands and the north (Figure 2.13a). Fire incidence is high also in the whole of the Sudano–Sahelian zone, the entire northern and eastern part of Southern Africa, inclusive of Madagascar. Savannah zones are generally subjected to the most fires: only along the driest northern fringe of the grasslands with their sparse cover are fires less common. The Horn of Africa and Kenya are the least affected. This could indicate heavy grazing and removal of the grass biomass, reducing the amount potential fuel and creating a patchwork of grass cover – meaning fires are less likely to catch or spread. In well-conserved areas like in the Serengeti National Park in Tanzania and the W-Arly-Pendjari Biosphere Reserve in West Africa, enough fuel builds up and fires are more frequent than in the surrounding areas. Reduced fire frequencies can have negative consequences, especially increased encroachment of woody plants, which suppress grazing species. The impact of fires on productivity and habitat heterogeneity and biodiversity, and the use of fire in the management is further discussed in Chapter 3.1.3).

In the World Atlas of Desertification (WAD 2018), five major global fire regimes, are distinguished in terms of their size, frequency and intensity (Figure 2.13b). Frequent Intense Large (FIL) and Frequent Cool Small (FCS) fires occur largely in grassy systems. Rare Intense Large (RIL) fires, where an entire forest canopy can burn with a very high intensity, means that the forest takes considerable time to regenerate. Rare Cool Small (RCS) fires occur where conditions are not often flammable: this is the case on the fringe of dryland and deserts. Intermediate Cool Small (ICS) fires are also found in wetter

Frequency of fire

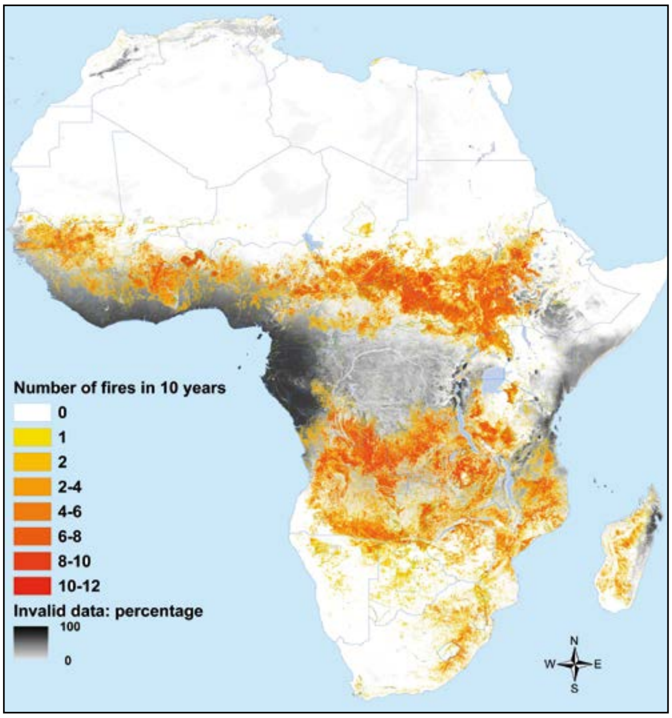


Figure 2.13a: Frequency of fire in Africa: May 2000 to April 2010. Source: WAD 2018 based on Council for Scientific and Industrial Research (CSIR), South Africa, 2011.

Fire regime

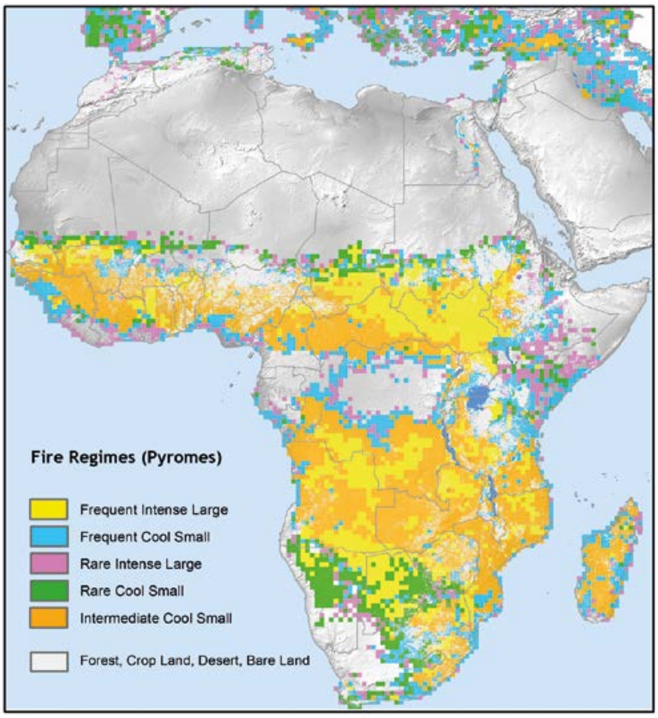


Figure 2.13b: Fire regimes in Africa: FIL: Frequent Intense Large; FCS: Frequent Cool Small; RIL: Rare Intense Large; RCS: Rare Cool Small; ICS: Intermediate Cool Small. Data source: WAD 2018, based on Archibald et al. 2013.

parts of the world, but are closely associated with people, who tend to increase fire frequency. Switches from one fire regime to another are often associated with degradation of the ecosystem, because organisms (notably vegetation) are adapted to particular fire regimes (Archibald et al. 2013).

2.1.10 Land degradation and desertification

Land degradation in the Sub-Saharan rangelands is omnipresent (Box 2.3). The Millennium Ecosystem Assessment found that degradation was actually worse in semi-arid and sub-humid areas – due to population pressure, overuse of the vegetation and thus expose of denuded soil to erosion by wind and water – whereas arid areas were not so degraded.

One of the ways of assessing land degradation is to analyse land productivity change over previous decades. Decreasing land productivity occurs in 22% of African rangeland (WAD 2018). Satellite image analysis permits the interpretation of the greenness of the land and the vegetation biomass – and the monitoring of any change. Severe declines have been mostly recorded at the drier fringe of the rangeland crescent: in Southern Africa, especially in the central part (e.g. Botswana); along the south-eastern coast; in the southwest of Madagascar; in East Africa, especially Kenya and Tanzania; in the Horn of Africa, notably the north-western part of Ethiopia; South Sudan; and smaller pockets distributed over the drier Sahelian zone of West Africa. The regions becoming greener and increasing in productivity are mostly located along the wetter fringe of the rangelands: that is the woodland to savannah zone (Figure 2.14).

The scale of land degradation – and potential solutions – have been hotly debated for more than 100 years. And the debate continues intensely. This is partly due to lack of agreement on what constitutes land degradation and its spatial extension, coupled with lack of rangeland monitoring, although this is changing. According to the African Union (2012) 75% of Africa's drylands, most of which are rangelands, are considered affected by desertification. The extent and degree of land degradation remains unclear, even after the launch of the World Atlas of Desertification in 2018 (WAD 2018). The atlas does not provide an updated version of previous global desertification and land degradation maps. It presents an assessment and maps on "global change issues", which have been identified to play key roles in desertification and land degradation. In total 14 issues were analysed, including decreasing land productivity, reoccurrence of fires, change in aridity, population density and change, and livestock density (Figure 2.15a). The more overlap of the issues in the same area, the higher the probability of land degradation/ desertification: this is termed "convergence of evidence". Figure 2.15b shows that the highest number of global change issues are found in parts of Senegal, Sudan, South Sudan, Somaliland, Mozambique, southwest Madagascar and Botswana.

Box 2.3: Definition of land degradation by WOCAT

Land degradation: *Degradation of land resources, including soils, water, vegetation, and animals.*

In the FAO/ LADA project land degradation is defined as a change in the land's health resulting in a diminished capacity of the ecosystem to provide goods and services for its beneficiaries (Bunning et al. 2011).

Desertification *is land degradation in dryland areas.*

The most common problematic issues in these areas are aridity, population change, income level, population density, livestock density, fire and decrease of land productivity (Figure 2.15a). Interestingly, at the northern fringe of the rangeland in the Sahel, in north-western Kenya, in south-eastern Ethiopia to northern parts of Somalia in the

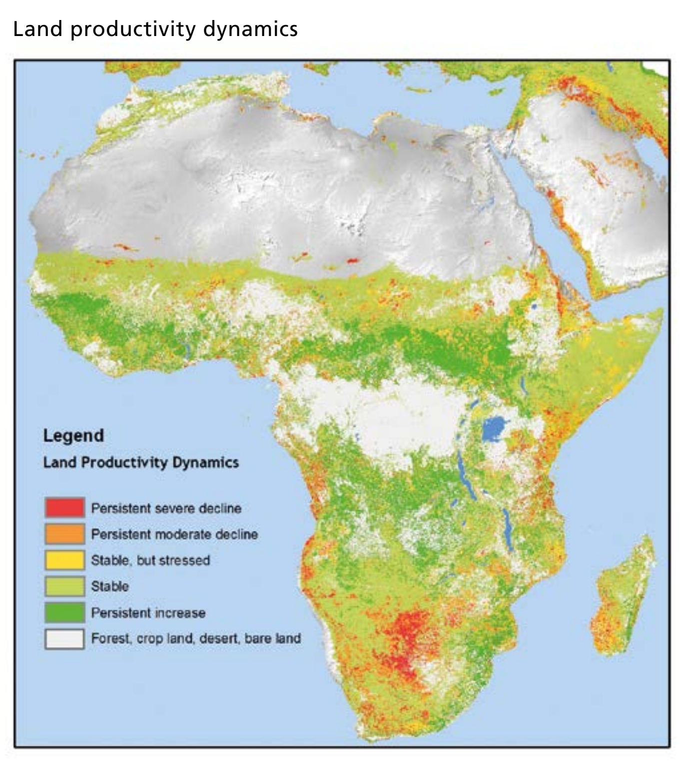


Figure 2.14: Land productivity dynamics in rangelands of Africa over 15 years from 1999 – 2013. Data source: WAD 2018.

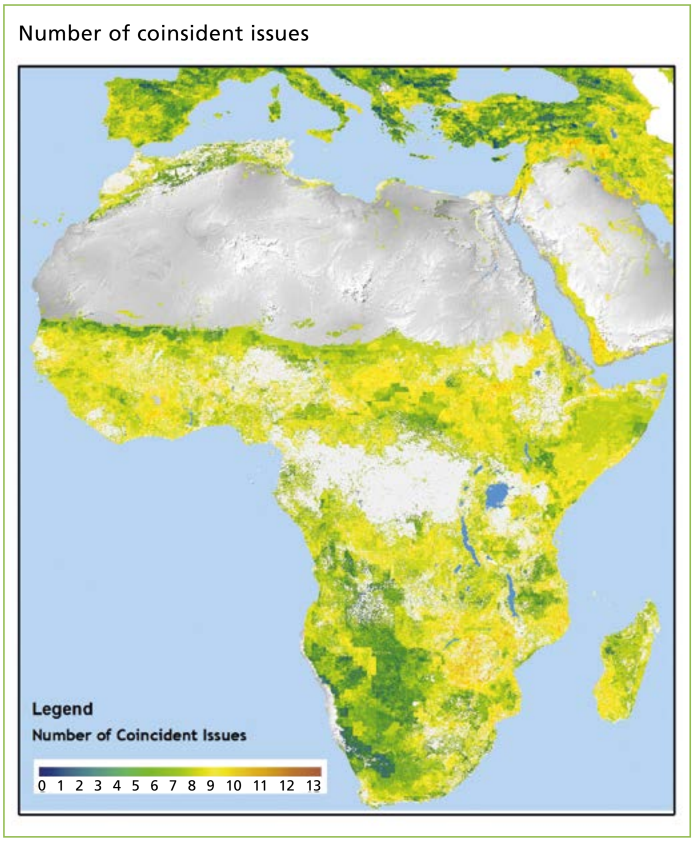


Figure 2.15b: Convergence of evidence in rangelands of Africa. Source: based on WAD 2018.

Horn of Africa, and in the western regions of South Africa, Botswana and Namibia, the green colours indicate only a few of the issues mentioned above (Figure 2.15b). Some of the "global change issues" leading to land degradation and that were found to be prominent in SSA were soil erosion by water and wind, as well as a change (decrease) in surface water.

The map in Figure 2.16 illustrates rates of **soil erosion** by water divided into seven classes according to the European Soil Bureau classification. The colour gradation from green, with a low and acceptable annual soil loss of less than one tonne per hectare, to red with a severe annual loss of over 50 tonnes per hectare, indicates the intensity of the predicted erosion rates (Borelli et al. 2017). Within SSA the areas most affected are characterized by sloping land and crop production systems. Even though, at the continental scale, soil erosion modelling results do not show a severe problem on rangelands, soil erosion has been reported one of the main degradation types under the cases analysed in this book. It must be noted that land relief has a strong influence on erosion and its modelling. However, vegetation cover is the main determinant in soil degradation through erosion. Steep slopes with dense cover do not have erosion problems, while gentle slopes with sparse/ practically no grass cover – at least at the start of the rainy season – are common in rangelands and these do experience high local rates of degradation. As most of the soil erosion is caused by water runoff, this indicates another major issue: loss of soil moisture and groundwater and change of surface water availability.

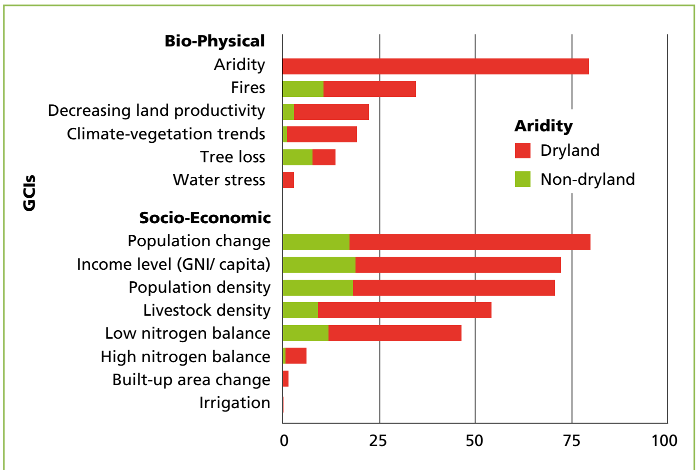


Figure 2.15a: Global change issues (GCI) in African rangelands in percentage of drylands and non-drylands (WAD 2018).

Sand and dust storms occur when wind mobilises exposed, loose soil (Figure 2.17). These conditions are common in semi-arid and arid regions. Sandstorms typically occur relatively close to the ground surface, but fine dust particles may be lifted high into the atmosphere (several kilometres) where strong winds can transport them vast distances across oceans and continents (WAD 2018). Most dust storms in the Sahara and Kalahari deserts are natural phenomena. Although anthropogenic sources currently constitute only 25% of global dust emissions, the potential for increasing this is great. In SSA, the areas mostly affected by human-induced sand and dust storms are along the driest zone of the Sahel from Lake Chad to Niamey, in southern Mali and Mauritania, southwest Madagascar and the Northern Cape of South Africa. Dried-up water surfaces (e.g. Lake Chad) pose a corresponding increased risk of sand and dust storms. This drying is due to water withdrawals and/or changed land use with reduced vegetation cover because of unsustainable land use and land degradation, especially in arid and semi-arid areas. This may be exacerbated by prolonged droughts and increased fire occurrences.

Soil erosion

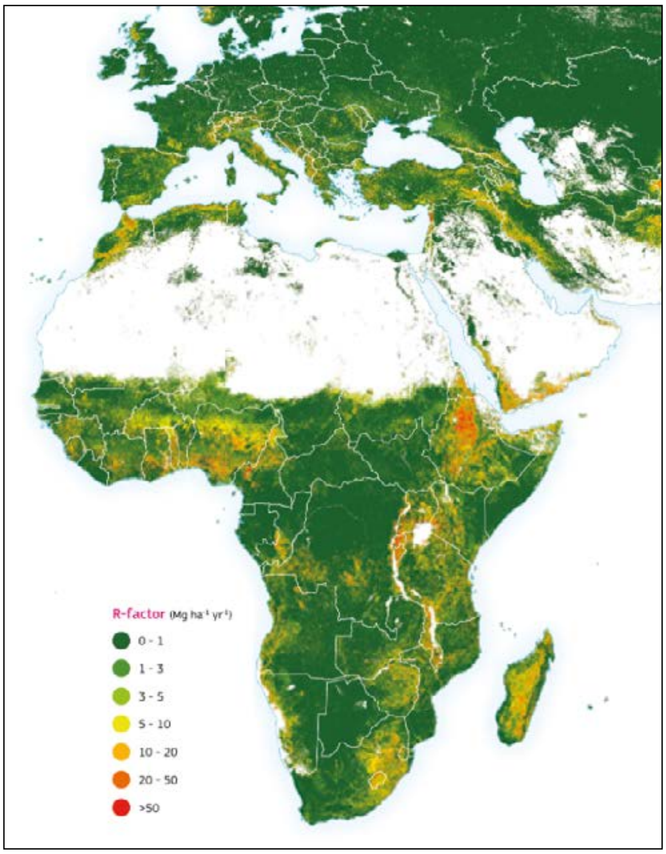


Figure 2.16: Soil erosion by water in Africa. Source: WAD 2018.

Dust emmissions

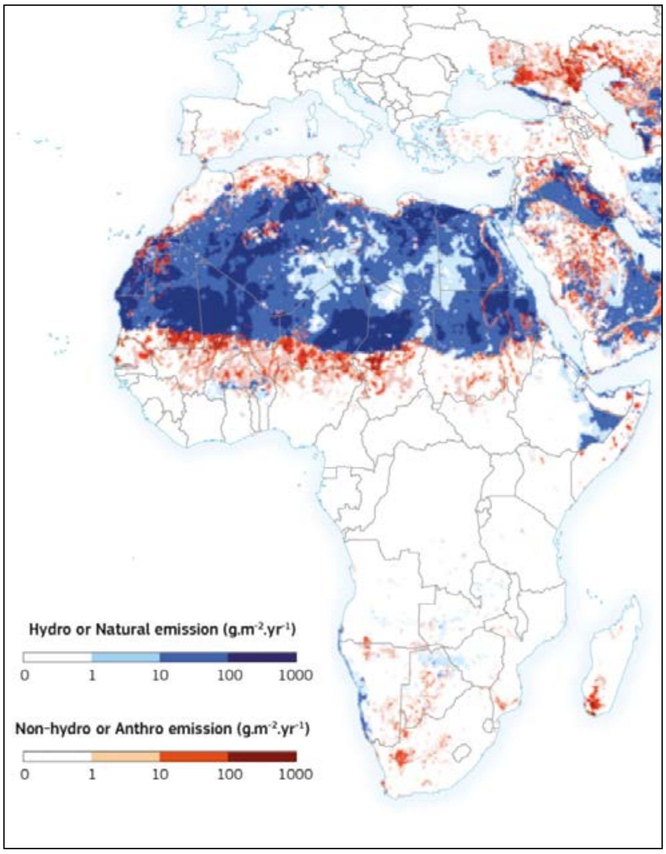


Figure 2.17: Dust emissions in Africa and causes: mainly natural (blue) or anthropogenic (red). Source: WAD 2018.

Surface water change in rivers and lakes is crucial because this constitutes the most accessible form of water for people and animals. Figure 2.18 illustrates the loss of permanent and seasonal surface water (red and pink) in Africa, and the new permanent and annual water (dark green and light green). Major rivers in the eastern part of Africa, and also in South Sudan, appear to be decreasing in flow, changing from permanent to seasonal flow – or even disappearing altogether in the dry lowlands. This provides a major challenge to rangeland communities and their livestock, as they depend closely on these permanent or seasonal rivers. In the West African Sahel, there is evidence of increase rather than decrease in surface water – due to greater occurrence of flooding.

In Sub-Saharan Africa, there have been changes in surface water (river water and lakes) but they do not conform to a simple pattern (Figure 2.18). These changes may be the result of three factors, separately or combined: (i) climate change – that is altered rainfall within the watersheds leading to more, or less, surface water. However, there is little evidence that this is the main cause; (ii) direct water abstractions and water use, mostly for irrigation purposes along the rivers, diminishing river flows and water availability downstream. This is a major reason for change in larger watersheds, where the rivers originate in wetter areas (especially mountains) and flow into increasingly dry lowlands. Examples are the Tana River in Kenya, the Juba River in Somalia, and the Senegal River, where the upper stretches show increasing water surfaces (due to irrigation) while the lower reaches of the river are drying up. High and increasing rates of water withdrawal by crop producers in the drylands are resulting in decreasing surface water and reduced river flow in the lowlands and their rangelands; (iii) when rangelands are overused and the vegetation cover is reduced, higher rates of surface runoff occur, less water infiltrates into the soil and more erratic river flows result, with more incidences of flooding demonstrated by seasonal surface water – as in West Africa. The very variable pattern of changes means that in some locations surface water is disappearing, while in others it is emerging: this seems to be the result of the high variability in water abstractions and in runoff, which in turn mainly reflect complex land use changes within the watersheds (Aeschbacher et al. 2005, Liniger et al. 2005, Notter et al. 2007). At the local level, surface water availability and its seasonal, as well as long-term, change is key to the management of the rangelands. These rivers are the lifeblood of the drylands; their flow is crucial for people, livestock, wildlife and ecosystems along the rivers and in wetlands. Large-scale dam projects for irrigation of hydropower generation, mass abstraction of water for irrigation combined with land use change affecting surface runoff and climate change – all these combined have a profound effect on river flow, including peak flows and floods as well as base flows during the dry season when water is most precious.

The rangeland characterisation of West, the Horn and East, and Southern Africa shown in Table 2.1 and 2.3 is general and not definitive. It is a broad categorisation that is also dynamic because the degree of human interference, either directly (e.g. through gradually changing land use) or indirectly (e.g. climate change) has a continuous impact. Thus, what were once pastoral rangelands may now be being converted (in part) into game hunting areas, seasonal cropping is sometimes turning into permanent systems, and large-scale commercial plantations are emerging.

Change in surface water

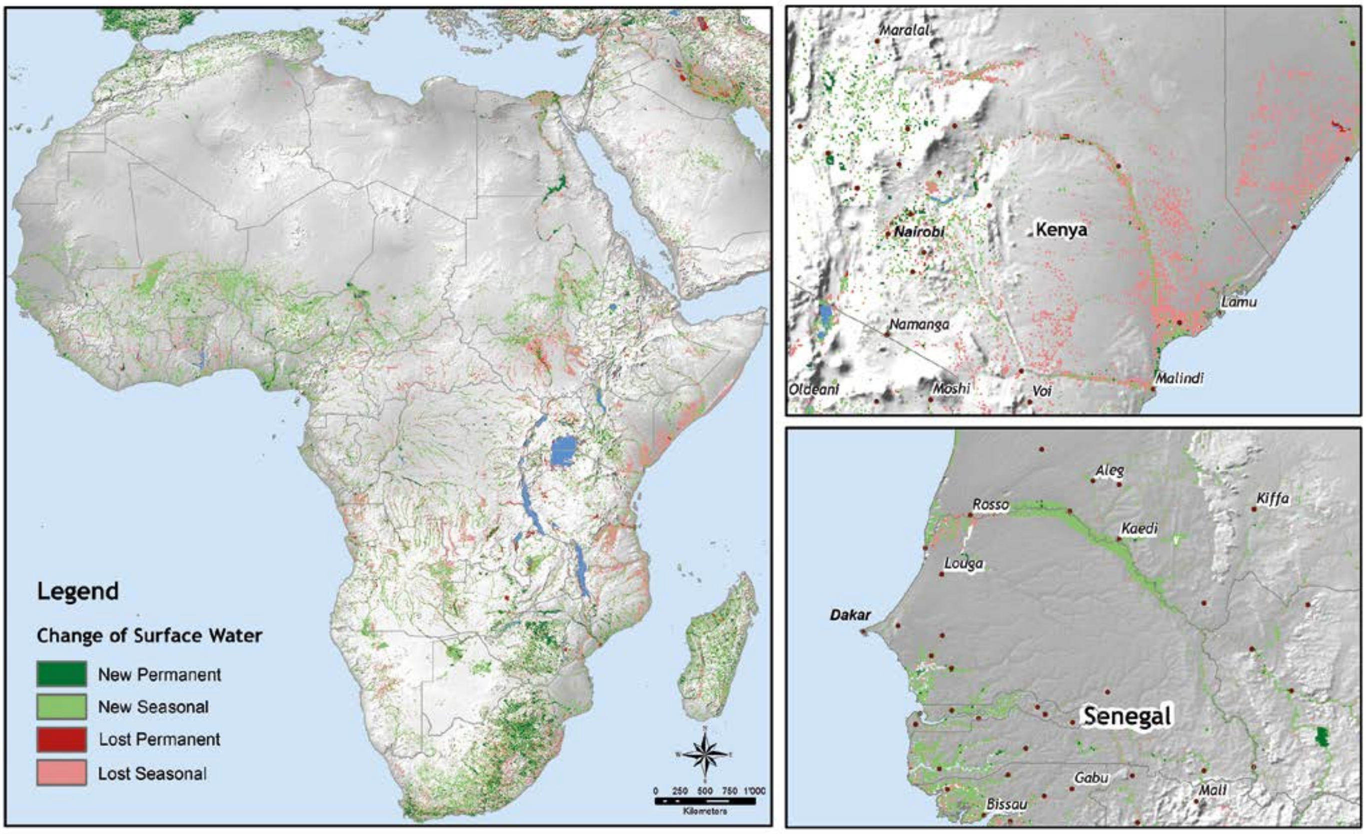


Figure 2.18: Surface water change in Africa (1984-1999 to 2000-2015). Data source: WAD 2018.

Take-home messages

In much of SSA, grazing lands and use of rangeland resources, water resources and forage resources have historically been governed under traditional common property regimes.

It has been argued that land-grabbing displaces local communities to replace them with large-scale agriculture that will ultimately increase food insecurity.

Despite some conservation gains, overall biodiversity is declining and human-wildlife conflict is increasing.

Conservation efforts are turning to landscapes where people directly manage the land. Biodiversity conservation in these areas hinges on landowners accommodating wildlife.

Contrary to popular impressions, the presence or absence of dietary or habitat overlap is insufficient to claim competition between livestock or wildlife.

Fire has helped to create and maintain a mosaic of vegetation.

The MEA found that degradation was worse in semi-arid and sub-humid areas – due to population pressure and overuse of the vegetation – while arid areas were not so degraded.

According to the African Union (2012) 75% of Africa's drylands, most of which are rangelands, are considered affected by desertification.

Gentle slopes with sparse/ practically no grass cover – at least at the start of the rainy season – are common in rangelands and experience soil erosion.

Major rivers in the eastern part of Africa, and also in South Sudan, appear to be decreasing, with flow changing from permanent to seasonal.

High rates of water withdrawal by crop producers are resulting in decreasing surface water and reduced river flow in the lowlands and their rangelands.

Reduced vegetation cover leads to higher rates of surface runoff and more incidences of flood.

Rivers are the lifeblood of the drylands; their flow is crucial for people, livestock, wildlife and ecosystems.

2.2 Why are rangelands in SSA important?

Rangelands cover a significant part of Sub-Saharan Africa's land area (62%) and host a significant proportion of the African population (38%) and livestock (56%). With current demographic trends, rangelands and all drylands in general will continue to experience increasing population and settlements as growth demands more space – and that is most clearly available in the drylands. In addition, rangelands represent diverse ecosystems, natural resources, people/ societies and multiple uses and functions and are therefore vital for the ecological, environmental, economic and social functions they play. Rangelands support life for those living within them, and also for those living outside. Key economic activities supported by rangelands include livestock production, wildlife conservation and related activities – and to a lesser extent crop farming, mining, production of cosmetics and handicrafts. For many countries with high proportions of savannah-based rangelands, especially in East and Southern Africa, wildlife tourism ranks amongst their top income generators. Kenya, for example, received 1.5 million tourists in 2017, contributing to 9.7% of total GDP and 3.4% of total employment (WTTC 2018).

Rangelands occupy a strategic position at the centre of the zones in SSA where some of the most pressing challenges for human development and security are being played out. When there are problems in the marginal border territories of the Sub-Saharan rangelands – such as droughts, breakdown of markets, insecurity, conflicts – all of these create major set-backs to development. Over the past decades, many of the responses from national and international agencies have been ineffective in securing food security, peace and improvements in the livelihoods of people. This is largely because they have ignored or not sufficiently used the potential for positive roles to be played by the range-

Table 2.3: Characteristics of Sub-Saharan rangelands according to regions: additional key characteristics for countries in regions

Sub-Saharan rangelands			
Region **Characteristic**	**West Africa**	**Horn and East of Africa**	**Southern Africa**
Most prominent rangeland use system	• Agropastoralism and pastoralism	• Agropastoralism • Communal and private ranches (bounded systems), parks and reserves and small-scale settled pastures	• Private ranches (bounded systems) and agropastoralism
Land rights/ tenure	• Communal rights • Open access rights • State rights	• In East Africa, mostly community land with some private ranches. Kenya: 2016 introduced Community Land Bill, likely to change rights of community land	• Freehold or communal
Land deals concentration	• Most deals in Southern part of the Sahel (Senegal)	• Almost the whole region of Ethiopia and Sudan, has a high number of land deals.	• Zambia and the west coast countries and Madagascar have high concentrations
Wildlife nature reserves	• Not very common • Famous are: – W-Arly-Pendjari – Giraffe conservancy • Lower area coverage than in East and Southern Africa	• Natural reserves, parks, private and communal conservancies • High numbers of various sizes • Famous parks include: Serengeti, Maasai Mara, Amboseli, Tsavo	• Large-scale parks and reserves. • In the northern part of Southern Africa • Famous parks are: Krüger, Moremi, Chobe, Etosha, Selous, Luangwa
Fire incidence	• Medium prominence in the Sahel. High in Chad	• High to medium numbers of fire incidence, especially south Sudan, west Ethiopia	• Mostly high incidence in the northern part (woodland zone and savannah)
Convergence of global change issues (as a proxy of land degradation)	• Medium to high number of coinciding GCIs (in the whole Sahel except the northern fringe)	• Medium number of coinciding GCIs	• Low to medium in the southwest and medium to high in Botswana and southwest of Madagascar

land people themselves – the inhabitants of these regions. Yet, these are the very people who know these critical areas best, because they live in and depend on them for their livelihoods.

More recently, there has been a growing realisation that engaging positively with the rangeland societies and institutions can help to unlock the knowledge and potential of the populations of these areas. The local institutions and actors can then be enabled to play their natural roles in surveillance of the landscape and their natural and human resources, securing and managing the vastness of their rangelands and regulating the flows of people and commodities that traverse them.

Normalizing relations between communities and neighbour states is recognized as one of the greatest development challenges in the rangelands across the region[11]. There are many shared challenges in these inter-country border zones where droughts are frequent and often devastating to livestock and people. In the direst situations, emergency food-relief camps are established: and while lives are saved, these settlements may leave psychological and environmental scars that take decades to heal. Sustainable rangeland management practices and approaches enable communities to respond to these challenges, working together to conserve and share scarce pasture and water to the benefit of all – building relations, reducing clashes, rebuilding contemporary institutions and securing the foundations of forward-looking devolved government in African states.

Rangelands have been dismissed and devalued as degenerate and degraded spaces and societies where insecurity is perennial. Numerous governments in Sub-Saharan Africa continue looking at rangelands through narrow 'economic-productive' functions/ perspectives and reason that the production potential of rangelands is inferior to the high-potential croplands. The various massive economic, environmental and socio-cultural functions that rangelands fulfil include many that are unperceived and do not have a marketable price – and are therefore often insufficiently included in development plans.

Several recent developments are influencing the potential value of rangelands and the perception of actors towards rangelands:

1. Growing recognition of the economic value of livestock production that has often escaped national statistical services, due to subsistence economies and informal or illegal cross-border trades (King-Okumu et al. 2015).

2. Increasing importance of the value of tourism enterprises based in the rangelands: this give them special importance.

3. Better understanding of the economic value of non-marketed services provided by the rangeland environment. It is only since the concept of 'ecosystem services' gained international prominence at the turn of the century that rangelands are looked at from an 'environmental service' and 'cultural values' angle. They are thus beginning to be reassessed for their importance in providing a wide range of ecosystem services, although this is not yet sufficiently recognized and appreciated (Davies et al. 2015). This includes the intrinsic value of biodiversity and marketing of carbon.

[11] See p 9 of: http://documents.worldbank.org/curated/en/740111505365636082/pdf/119690-WP-FightingLandDegradationatLandscaleScaleinAfrica-PUBLIC.pdf

4. Increasing knowledge of the amount of mineral and energy resources in the rangelands and the possibilities of exploring, exploiting and transporting them. While this may create opportunities for improved livelihoods and the economic status of rangeland users, it also challenges traditional rangeland commmunities and their historical use of the land.

As the stakes are growing higher in the rangelands, the controversies about what is or is not "sustainable rangeland management" – and how best to achieve it – are growing. The misunderstanding or misapplication of the theories, concepts and paradigms of rangeland management have often in the past provided excuses for external actors to pursue agendas that have marginalized, oppressed and blocked development of societies in the rangelands. There exist various controversial and unresolved issues in the rangeland sector in Sub-Saharan Africa. The competition for land and water, population increase in many African states and pastoralist societies, impacts of land degradation on the rangelands' health exacerbated by climate change, land tenure and land/ water use rights, poverty, security and conflicts are all having a significant influence on defining and implementing sustainable growth in the rangelands.

Box 2.4: Sub-Saharan African rangelands at a glance

- Size 14.1 million km^2 or 62% of SSA
- Population is 384 million or 38% of SSA
- Cattle: 138 million of heads or 57% of SSA
- Goats: 144 million of heads or 55% of SSA
- Sheep: 123 million of heads or 56% of SSA
- Protected area: 17.4% of the rangeland of SSA
- SSA rangelands include 22% woodlands, 47% savannah, 25% open shrublands, 6% grasslands.

(Source: Calculations from WAD 2018, Copernicus, IUCN, FAO, OECD)

- Rangeland systems spread out in a rangeland crescent spanning from West Africa to the Horn of Africa, East Africa and Southern Africa, positioned largely between the tropics of Cancer and Capricorn.
- Approximately 25 million pastoralists and 240 million agropastoralists in Sub-Saharan Africa depend on livestock as their primary source of income (AU-IBAR 2012, FAO 2018).
- Between 2000 and 2010, production of livestock increased by 3% in SSA (Milne and Williams 2015), a relatively small increase compared to the rising demand driven by an annual human population growth of 2.7%.
- Rangelands are currently being lost due to land degradation, conservation projects, to crop and urban land and other factors at an alarming rate (Milne 2016).
- Pastoral and agropastoral systems in the Sahel contribute more than 80% of the animal product supply. Pastoralism accounts for 70% to 90% of cattle rearing and 30% to 40% of sheep and goats. Transhumant pastoralism supplies an estimated 65% of beef, 40% of mutton and goat meat, and 70% of milk (ECOWAS 2008).
- Animals that have traveled more than 450 miles from southern Somalia to the markets in Nairobi account for 26% of the beef eaten in Kenya and 16% of the beef eaten in Nairobi. Traditional herding in Tanzania is the source of 70% of national milk production, which totalled 770 million literes in 2006 (Grandval 2012).

Multiple claims from land use change and/or intensified agricultural and animal production, setting aside rangeland areas for nature conservation as well as for carbon sequestration, large land acquisitions for investment of various kinds, mining of minerals, oil and water resources as well as controversial and competing policy directions are likely to lead to an increase in the vulnerability of ecosystems and livelihoods and dubious development strategies. Increasingly Sub-Saharan rangelands are not "marginal lands" any longer as they have been termed for decades in the past. Rangelands have become objects of interest for survival, for livelihoods, for investments, and for climate change mitigation (Box 2.4).

Take-home messages
Rangelands occupy a strategic position where some of the most pressing challenges for human development and security are being played out.
Rangelands have been dismissed and devalued as degenerate and degraded spaces and societies where insecurity is perennial.
Rangelands are beginning to be reassessed for their importance in providing a wide range of ecosystem services.
Increasingly Sub-Saharan rangelands are not "marginal lands" any longer – as they have been termed for decades in the past.

2.3 Changing rangeland concepts over the last century

Rangelands in Sub-Saharan Africa have been perceived as a problem for over a century. These areas have been talked about as being inhospitable, fragile and on a one-way path to inevitable degradation. To many observers, rangelands used by pastoralists under common property regimes present a perfect example of the "tragedy of the commons": free-for-all grazing triggering a downward spiral towards desertification. Various remedies have been suggested. Often these followed ranching models. But failures in rangeland development projects have been commonplace.

As a result range ecology and processes were re-examined, and in the 1980s a new thinking emerged. This embraced the concept of enhancing livestock movement and respecting traditional knowledge and "opportunism". But little seems to have been translated into action – and new challenges have emerged, notably increasing population pressure, livestock-wildlife conflicts, and climate change. New ideas have followed. This section explains these different, evolving and often conflicting, attitudes towards the "problem" and the "solution".

Early 20th century: Fears, warnings and the "mainstream view"

It was early in the 20th century that concerns were first voiced about land degradation in Africa's rangelands. The South African Drought Commission, established as a result of the widespread livestock losses of 1919/20, gave dire warnings in its 1923 report about the dangers of overstocking. It predicted "a newly-created South African desert" (Beinart 1984). Rangelands in Sub-Saharan Africa indeed constitute vast expanses of drylands prone to drought, livestock mortality and, potentially, desertification. Little wonder then that there have been fears about their future – popular views which have changed remarkably little over the last century. The jargon and narrative has also remained remarkably constant: fragile lands exploitation by pastoralists through overstocking with herds of emaciated cattle and goats, destroying vegetation and exposing the soil to wind and water erosion. A mid-20th century review of rangeland management in East Africa (Heady 1960) confirmed the common position that "range deterioration has assumed alarming proportions in many areas". This was referred to by Sandford (1983) as the "mainstream view". It saw severe and rapid desertification on the horizon, was distrustful of traditional institutions, and above all perceived the central problem as being overgrazing by too many, mismanaged, and unproductive livestock maintained often as symbols of wealth.

Mid-20th century: Colonial responses by governments and development agencies – seeking equilibrium

This "mainstream view" therefore held that control of livestock numbers was the key to action. Thus destocking followed by grazing management schemes comprised the central initiative put forward for East Africa. Pratt and Gwynne (1977) in their standard text entitled "Rangeland Management and Ecology in East Africa" talked of systems that would restore "order out of chaos". Their remedy to the problem of the communal rangelands was to introduce ranch-style models which would achieve an 'equilibrium' or steady state – in other words an even, steady balance between livestock numbers and vegetation (Mwangi and Ostrom 2009). But stocking rates were not simple to set, and even more difficult to enforce. To create and fence large ranches in landscapes with a diverse mixture of lowlands and hills, areas with swamps and other zones with only wet-season water available proved practically impossible. Furthermore this meant cutting across traditional routes of movement, and age old rights to grazing. Naturally this model could work – but only in those few cases where natural and social conditions permitted it. For example on the wetter fringes of dryland areas where private ownership (whether by individuals or groups) was possible. Some group ranches have proved indeed viable. But they are the exception. Large-scale settlement of nomadic pastoralists, however desirable it seemed to governments, for ecological, developmental and (often) national security reasons, has proved impractical. As Behnke and colleagues observed "few range management schemes in dry Africa have had a discernible and permanent impact on the way communal rangeland is used" (Behnke et al. 1993).

Late 20th century: The concept of "opportunistic management" – non-equilibrium state

The proceeds of a seminal meeting held in 1990 sought to get to the root of the problem. The "mainstream view" was held to be flawed (Behnke et al. 1993). The basic misunderstanding, they pointed out, was that the pastoral rangelands didn't act in equilibrium like many agricultural ecosystems; they behaved in an unpredictable way. This means that a strict balance between animal numbers and fodder was simply not possible to maintain, and no fixed carrying capacity could be calculated. Neither were rigid stocking rates applicable. The whole ecology of the drylands is, and always has been, subject to high variability with extremes like droughts and floods – as well as outbreaks of livestock sickness and mortality. Over millennia, pastoralists have learnt to ride these highs and lows, to cope with periods of drought and livestock losses, and most importantly to "bounce back" rapidly by rebuilding herds and using their mobility to seek out grazing where vegetation had recovered.

While the ecological, social and political systems vary considerably from East to West to Southern Africa, the basic arguments and principles are similar. For instance for West Africa a World Bank publication arrived at the conclusion that to counter desertification pastoralist associations could be an effective new instrument – and very importantly that the users of any new land management system must also be its managers: traditional principles of land rights needed to be recognized (Falloux and Mukendi 1988). In Southern Africa, where the apartheid regimes have grossly distorted land tenure regimes and traditions of communal land use have been eroded, the discourse is even more difficult. This has been compounded by the need to reconcile the often conflicting aims of game tourism and community livestock-based livelihoods, and to seek ways of integrating the two (e.g. Madzudzo 1995).

This new approach, termed "opportunistic management", began to emerge during the 1980s – which was a watershed decade in sustainable land management with the new emphases on participatory approaches, appreciation of indigenous knowledge and the merging of conservation and production strategies. The aptly titled book "Living with Uncertainty" (Scoones 1994) sums up the opportunistic management school of thought. It embraces the principles of recognizing the objectives of pastoralists and their traditional management practices based on flexible and responsive mobility in the face of an ever-changing, non-equilibrium, landscape. There are strong cultural affinities and bonds between these groups, their livestock and the landscape: these must be respected. This is not to say that help and assistance aren't required: but they need to be tailored to acceptance of this reality. Thus marketing infrastructure was held to be vital, as was veterinary support. In terms of management, devolution of decision making to the land users was looked upon as vital.

There have been many other theories and ideas regarding rangelands and their development. Most have come and gone, but there is one that has persisted since the early 1980s and continues to be supported by some followers of the founder, Allan Savory: namely 'holistic management' (Savory 1983; 2013). The fundamental principle is that a large herd grazed very intensively in one area – then moved on to another – will make better use of vegetation than allowing livestock to graze selectively. Savory holds that, in many ways, the problem is undergrazing rather than overgrazing. Chapter 5 reflects on some of the (mixed) experiences with this system as documented in the case studies in Part II of these guidelines.

21st century: Current realities, new challenges and a broader perspective

Moving on to the 2000s this concept of non-equilibrium models and opportunistic management has further evolved into making use of "heterogeneity". Owen-Smith (2004), Fryxell et al. (2005), Hopcraft et al. (2010) re-emphasise the fact that transhumance pastoralism is optimally adapted to accessing critical resources in the highly seasonal, unpredictable and extensive landscapes of African savannahs. Despite the new concepts of the 1980s and 1990s, the continued trend in government policies has been to privatize land and sedentarize pastoralists (Homewood 2009, Western et al. 2009b, Lovschal et al. 2017), which fragments key ecological gradients and large landscapes, reduces pastoral mobility and their ability to adapt to seasonal changes in forage resources, which will be further compounded by the effect of climate change. Moreover, sedentarization of pastoralists is destructive to wildlife (Western et al. 2009a, Groom and Western 2013). The functional heterogeneity concept is also relevant to the management of livestock on ranches, where enabling animals to make decisions facilitates adaptive foraging options. Thus the continued, popular approaches to rangeland management, which are regularly advocated by international development agencies, violate key ecological principles (Fynn et al. 2017).

It must be pointed out that the debate continues. The notion of non-equilibrium models has been contested by Illius and O'Connor 1999, who note that animal numbers are indeed in equilibrium – with more reliable key resources in the system that provide critical forage for survival during drier periods – and have the potential to degrade these key resources. This line of argumentation asserts that most rangelands in semi-arid regions clearly can be degraded by excessive livestock numbers, leading to loss of perennial grasses, reduced grass production and soil erosion (Milton et al. 1994, Fynn and O'Connor 2000, Fynn et al. 2017). However, in regard to discussions about the sustainability of pastoralism in relation to demographic growth and ensuing land degradation through overstocking, there is no linear relationship between demographic growth in pastoral populations and growth in the number of livestock. Demographic growth out of step with herd growth is more likely to lead to impoverishment than to land degradation through overstocking – although impoverishment can also lead to overgrazing by reducing mobility (Krätli et al. 2015).

Despite predictions, debates and theories about "new deserts" foreseen 100 years ago, there is still no consensus about how much land has actually suffered desertification. While there has been continued widespread land degradation in rangeland areas, and it's still a major concern, it has not matched the dire predictions of all those decades ago. Many areas have simply continued to ride the cycles of droughts and then recovery. While in some areas the natural resilience of the drylands and its inhabitants has been largely underestimated, other areas suffered serious land degradation and demand large restoration efforts. In this context it is helpful to make some comments about the changing schools of thought, to set the perspective more broadly, and to bring the debate up to date.

First of all, much of the discussion in the concepts discussed above related almost solely to a narrow focus on transhumant pastoralists and their livestock. It also tended to focus strongly on East Africa. But the rangelands cover a much wider constituency. Many of its inhabitants are actually semi-settled, or even settled agropastoralists, who crop small areas of land opportunistically (see Chapter 3.1). After all, the drylands are where water harvesting for crop production has its traditional roots (Critchley et al. 1992). In a broad swathe across Sudan, Uganda, Ethiopia, Kenya and Somalia livestock holders also raise some crops – which even in a year of crop failure provide some fodder for livestock.

Concepts and theories are fine, but what is actually happening on-the-ground? This compilation of case studies in this book undercover myriad different initiatives – many of which help to point to a path forward, generally or at least for specific situations. The analysis of the ongoing changes and challenges, and the experiences – failures and successes made so far – will help directly in shaping guidelines for the future.

Take-home messages
To many observers, rangelands used by pastoralists under common property regimes present a perfect example of the "tragedy of the commons".
Failures in rangeland development projects have been commonplace.
A mid-20th century review confirmed the common position that "range deterioration has assumed alarming proportions in many areas". This became referred to as the "mainstream view".
The mainstream view supported control of livestock numbers through destocking followed by grazing management schemes to achieve an "equilibrium state".
But the "mainstream view" was flawed because pastoral rangelands didn't act in equilibrium; they behaved in an unpredictable way.
Despite efforts with creating large ranches and settling pastoralists – by 1990, few range management schemes in dry Africa had an impact on the way communal rangeland was used.
The new approach of opportunistic management recognises pastoralists' traditions based on flexible and responsive mobility in the face of an ever-changing, non-equilibrium, landscape.
Many other theories and ideas have come and gone, but one has persisted since the early 1980s namely "holistic management".
Moving on to the 2000s this concept of non-equilibrium models and opportunistic management has further evolved into that of making use of heterogeneity.
Despite the new concepts of the 1980s and 1990s, the continued trend in government policies has been to privatize land and sedentarize pastoralists.
The continued, popular approaches to rangeland management advocated by international development agencies, violate key ecological principles.
Despite predictions, debates and theories about "new deserts" foreseen 100 years ago, there is still no consensus about how much land has actually suffered desertification.
While in some areas the natural resilience of the drylands and its inhabitants has been largely underestimated, other areas have suffered serious land degradation and demand large restoration efforts.

Chapter 3
Rangeland use systems and their management

As might be expected there is a very broad range of both rangeland use systems and management practices in Sub-Saharan Africa (SSA). Therefore, unsurprisingly, there is considerable confusion about the different types of rangeland and the associated land management systems. This lack of clarity can prevent focused discussion on rangeland development and policies, and often leads to ill-informed decisions. This confusion furthermore underlies the difficulties in arriving at informed approaches and strategies to guide good rangeland management under the current dynamic situation that prevails.

Based on the documentation of rangeland management practices, of which a selection is presented in Part 2, a literature review and expert consultations, criteria were identified to help define the classification of rangeland use systems and their management.

3.1. Rangeland use systems classified

In Chapter 2.1 the following definition was proposed: "Rangelands are spatially defined ecosystems that are dominated by grasses, grass-like plants, combined with various degrees of bush and tree cover that are predominantly grazed or browsed, and which are used as a natural and semi-natural ecosystem for the production of livestock and safeguarding of wildlife and additional ecosystem services." The classification accommodates all the common land use systems that will be defined and addressed in this chapter.

3.1.1. Key characteristics and considerations

As rangelands cover a wider variability in different natural conditions and uses, three key characteristics and considerations must be kept in mind to guide the identification and definition of rangeland use systems. These are mobility, boundaries, combined crop and wildlife management.

Mobility and scale

The mobility of livestock within the Sub-Saharan rangelands has been a central element of management for thousands of years. Traditionally, rangeland systems were open areas and vast spaces were interconnected. Mobile and semi-mobile livestock production systems are the most prominent traditional uses of rangelands. These systems are dynamic and responsive, giving herders the potential to react to changing rangeland conditions through the seasons. Mobility relates to livestock managers and livestock. Mobility is a logical method of accessing water and pastures in order to maximize animal productivity, reach markets and escape risk – including diseases, conflict with other herders, and wildlife. Many of these factors that dictate the movement of pastoral herds are similar to the forces that drive wildlife in search of fodder and water.

Mobility of livestock and their managers ranges from fully mobile nomadic, semi-mobile nomadic systems along opportunistic or clearly regulated routes (transhumance), partial family/ livestock movement, to fully sedentary systems.

The mobility of livestock is characterized by:

- The type of movement: from opportunistic to well-defined routes; across climatic and ecological different zones (e.g. from dry north to wetter south; from plains to hills). Opportunistic grazing movements enable access to heterogeneous and unpredictable pasture resources to make best use of spatial and temporal variation of the resources.
- The timing or seasonality of movement: from following a fixed calendar to remaining flexible according to prevailing conditions.
- The distance of movement: this may vary considerably year-on-year depending on seasonality, rainfall, resource availability and 'freedom'/ boundaries to movement. Distances can range from a few kilometres (small-scale) to hundreds of kilometres (large-scale).

Enabled mobility is of key importance for rangeland management, be it for daily or seasonal movement of animals, Somaliland (Christoph Studer).

- The guidance of the livestock: managed by hired herdsmen, family members, the whole family or groups within a community. Mobility relies on effective social organization and networks.

- The reason for movement: whether movement is to access high quality grazing, high quantity grazing (or to seek any available grazing), avoid diseases, or search for markets etc.

The mobility of rangeland users and wildlife is increasingly in conflict with the growing pressure on rangelands, where these are being converted to land uses such as cropland, protected areas, fenced-off areas, and urban expansion – all of which limit free movement. Such restricted mobility is one of the major challenges facing livestock keepers on rangelands.

Boundaries
The extent of rangelands and their use is defined or limited by various boundaries. These comprise climatic conditions (mainly rainfall, temperature), topographic boundaries (mountains, rivers, lakes, the sea), access to resources (distance from water points, availability of forage and grazing grounds), as well as areas affected by diseases. Furthermore, there are boundaries with other land users and land uses (cropland – rainfed or irrigated – settlements, national parks, mining areas, forests etc.). Boundaries are also influenced or defined by tenure, including user rights: some users claim exclusive use and have formal users' rights or even title deeds, others claim customary or communal rights. Boundaries are also created by political and administrative borders which often limit the mobility of livestock and rangeland users.

With and without crops
Even though the focus is on rangeland, some of the livelihood systems include crop production, to varying degrees, as a complementary part of rangeland management. Cropping can be important not just as a supplementary source of food and income for households, but also as a means of mitigating risks. The type of cropping system depends closely on the climatic zone and availability of labour. In some areas cropping can be reasonably reliable – in others it is simply opportunistic.

With or without wildlife
Wildlife have always been an integral part of rangeland systems, as this forms their natural habitat, and rangelands have evolved alongside the indigenous fauna that they support (see Chapter 2.1.7). Wildlife can be part of a livestock production system without providing any additional benefit (e.g. where wildlife comes and goes), or in co-existence with managed livestock within the same area, increasing overall benefits (e.g. where they make use of different forage resources and are harvested), or they can be in competition for the same resources (e.g. through grazing the same vegetation). The nature of wildlife–livestock interactions vary across rangelands, and the impact of competition, disease transmission, and human-wildlife conflict also vary, based on the characteristics of the human and natural context. In the best case scenarios, wildlife can be managed non-competitively alongside livestock, and can offer an additional form of income to rangeland users through both consumptive use (e.g. hunting and cropping for game meat), and non-consumptive use (such as tourism). Additionally, the costs of coping and interacting with wildlife can be reduced through a variety of management practices. In many areas across SSA, livestock are completely excluded from rangeland for the conservation of wildlife in strictly managed protected areas (see Figure 2.11a).

3.1.2 Rangeland use system categories

Here a typology of rangeland use systems (RUS) is proposed to aid analysis, and in the planning of rangeland management interventions. For purposes of developing a manageable and helpful categorization system, the focus is on scale, boundaries, mobility, inclusion of cropping within the system, and the approach to wildlife management. Based on the case studies documented and described in Part 2 and international discussions and debate on rangelands, six categories are differentiated (Figure 3.1). The attempt to subdivide rangelands into different use systems fully recognizes the variation across, and complexity within, each of these systems as well as 'fuzzy borders' between them. While such a categorization always runs the risk of oversimplification, the aim is to differentiate and focus the discussion on the main, broad types of rangeland uses – and still respect complexity – to help in the analysis of practices and informed decision-making. Furthermore, rangeland managers my shift between different rangeland use systems according to seasons and emergency situations as an adaptation strategy to challenging conditions particularly during droughts or conflicts. The classification is presented in Figure 3.1 and key characteristics of the different RUS are summarized at the end of the chapter in Table 3.1. The main categories of RUS are as follows:

1. Large landscape pastoral rangelands **(pastoral)**
2. Large landscape agropastoral rangelands **(agropastoral)**
3. Bounded rangelands without wildlife management **(bounded without wildlife)**
4. Bounded rangelands with wildlife management **(bounded with wildlife)**
5. Parks, wildlife & nature reserves **(parks & reserves)**
6. Small-scale settled pastures **(pastures)**

Large landscape pastoral and agropastoral rangelands
In rangeland use systems (1) and (2), people and livestock move over large landscapes. Movement is driven by multiple factors: rainfall gradients which influence the availability and quality of forage, availability of water and mineral resources, security, disease, availability of markets and related services, and grazing and water rights. They tend to follow natural gradients of quality and quantity of pastures and water availability, and are commonly founded in historic community traditions. This movement may be across rainfall and altitudinal gradients, or in and out of wetlands and swamps. It may include transhumant systems where movement typically takes place across different ecological zones and along predictable routes. Or they may be more opportunistic, nomadic or semi-nomadic movements following patchy rainfall and better forage, such as after fire.

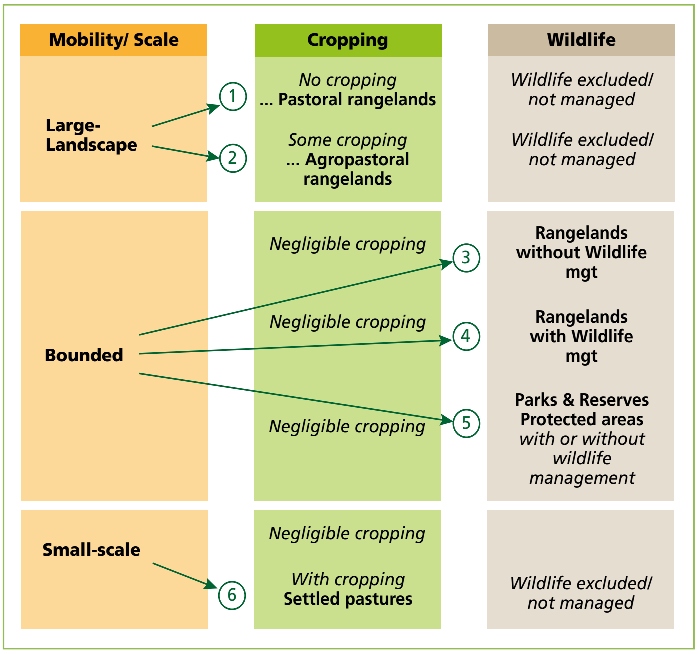
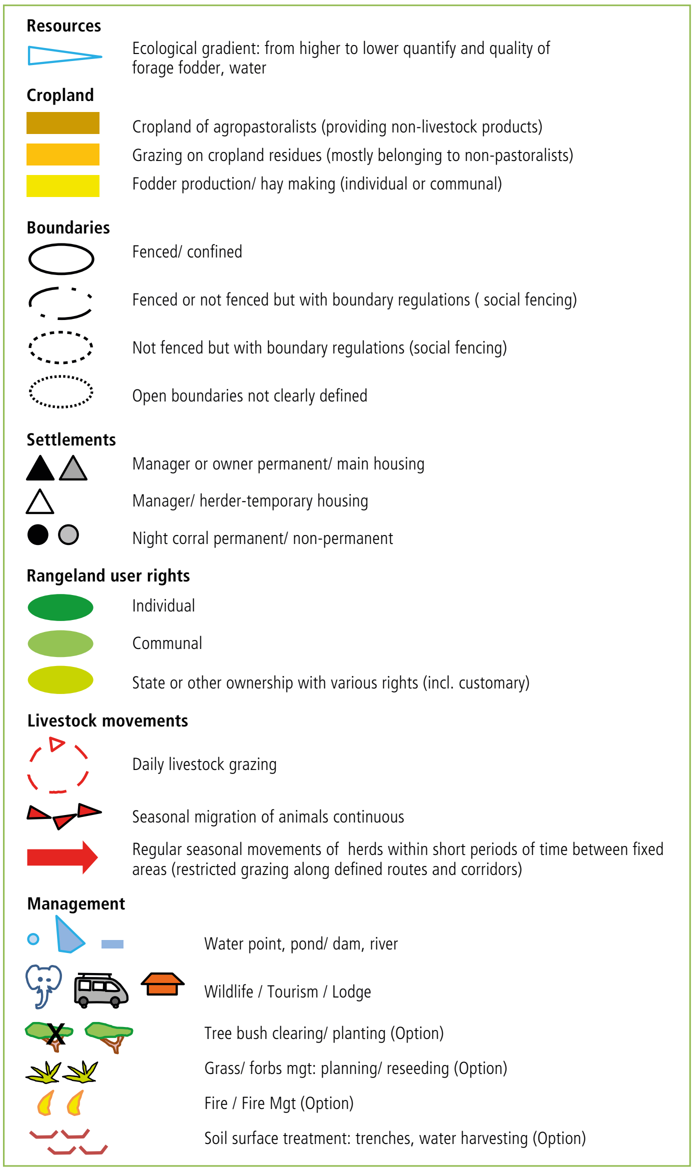


Figure 3.1: Classification of rangeland use systems.

Legend for the RUS Figures 3.2–3.7



left: Pastoralists and agropastoralist rangeland use systems with a high mobility, Northern Samburu rangelands in Kenya (Hanspeter Liniger).

centre: Mobility is confined and regulated in bounded rangeland systems often by fences, Botswana (Hanspeter Liniger).

right: Former rangeland is being subdivided and settled: small-scale grazing is restricted to areas that are not yet converted to crop production, Kenya (Hanspeter Liniger).

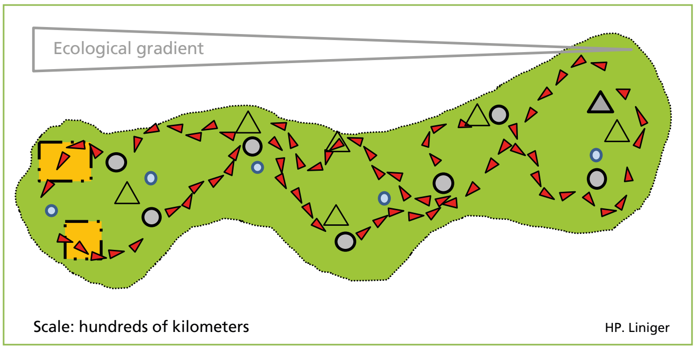


Figure 3.2a: Large landscape pastoral rangeland system: full mobility (Legend page 39).

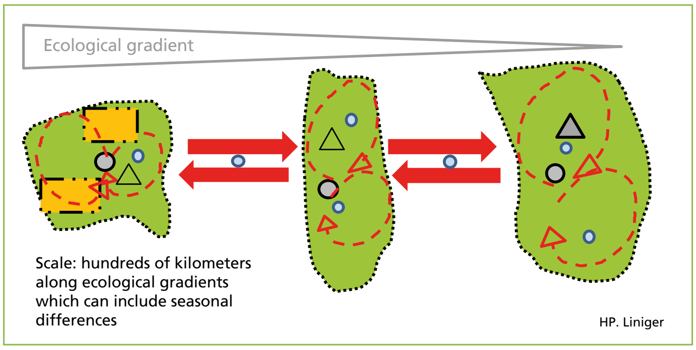


Figure 3.2b: Large landscape pastoral rangeland system: transhumance (Legend page 39).

1. PASTORAL RANGELANDS

These are systems in which the majority of the population are pastoralists, whose livelihoods are overwhelmingly based on mobile livestock keeping.

Pastoral systems are defined as grassland-based, where more than 90% of dry matter grazed or browsed by livestock is from grasslands and rangelands, and more than 50% of household income is from livestock (as defined by de Haan and Cervigni 2016). They are found mainly in the more arid zones of SSA.

Pastoralism is an animal production system – and lifestyle – which is adapted to the heterogeneity of rangeland environments, where key resources of pasture and water for livestock become available erratically and unpredictably across both space and time. Animal and livestock manager movement may be more or less constantly opportunistic throughout the year (full nomadism). Seasonal movement may be according to fixed routes, where herds are driven – with often little grazing along the route – from one grazing ground to another before returning home (transhumance) (Figures 3.2a and 3.2b).

Characteristics of large landscape pastoral rangelands:

- Distances between the night corrals covered during the year: hundreds of kilometres. Area used: tens to hundreds of square kilometres.
- Livestock move with no permanent night resting place/ enclosure (fully nomadic) or with a season-long resting place for livestock and herders (semi-nomadic, transhumance).
- Animals and herders are mobile along flexible routes, grazing may be planned or opportunistic, and no regular crop cultivation is practiced (nomadic, semi-nomadic). Transhumance systems involve regular movements of herds between fixed areas in order to opportunistically exploit the seasonal variability of climates, pastures and water. Typically they have distinct grazing areas that are used during specific periods, and animals are moved within short periods of time along clearly defined routes and corridors to avoid conflicts and reach other designated grazing grounds. At times this movement may even be carried out by trucks.
- There are basically two types of movement: one following the rains and the ecological gradients north-south (e.g. West Africa), the other following ecological gradients from the drier lowland to the wetter highlands and mountains (e.g. East Africa).
- Livestock owners/ managers may have a main residence. Herders (owners, managers, family members or hired herders) move with the livestock according to seasonal cycles. Some of the family, and some livestock, may remain at the home-base all year.
- Pastoral large-scale rangeland systems are practiced on open access and communal land. Livestock owners and herders in most cases do not own the grazing land, but they almost always have (often complex) customary grazing and water rights.
- Purely nomadic systems are on the retreat. Some systems still remain in West Africa in Sudan and Somalia. However, a recent development is the growing number of contract herding systems, where absentee livestock owners contract herders to manage their livestock on rangelands, despite the fact that they may not have water or grazing rights.
- Herd sizes range from tens to hundreds of livestock (cattle, camels and donkeys – but also goats and sheep).

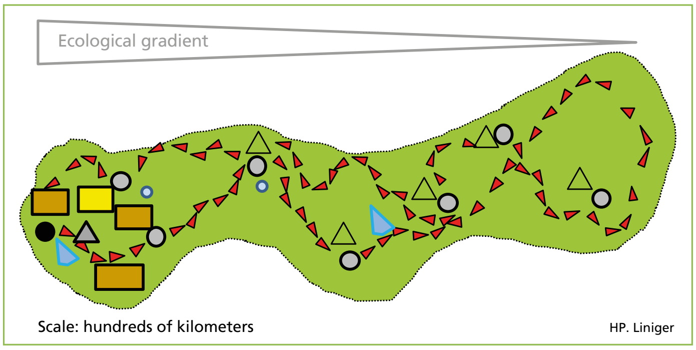


Figure 3.3a: Large landscape agropastoral rangeland system: seasonal mobility (Legend page 39).

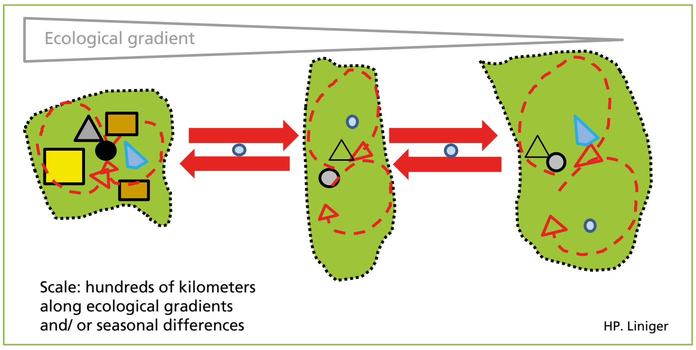


Figure 3.3b: Large landscape agropastoral rangeland transhumance (Legend page 39).

2. AGROPASTORAL RANGELANDS

Agropastoral systems are those in which livestock keepers derive a considerable part of their agricultural income from crop farming – and in which crop residues can make up a significant share of the livestock ration. Generally more than 10% of the dry matter fed to animals is derived from crop by-products/ stubble and more than 10% of the total value of production comes from non-livestock farming activities (as defined by de Haan and Cervigni 2016). They are found mainly in semi-arid zones and subhumid zones.

Agropastoralism combines cropping close to the main household with mobile herds of livestock (Figures 3.3a and 3.3b). It has long been a common security strategy in Sahelian and Sudanian zones because of the high level of complementarity between the two activities. The distinction between pastoralists and agropastoralists is becoming more and more blurred, as pastoralists are increasingly engaging in opportunistic planting of small plots in wetter areas or years as a diversification strategy. This is currently the most frequent security strategy in Sahelian and Sudanian zones because of the high level of complementarity between the two activities (Grandval 2012).

Characteristics of large landscape agropastoral rangelands:

- Distances covered between the night corrals during the year: tens to hundreds of kilometres. Area used: tens to hundreds of square kilometres.
- Herders/ livestock managers have a seasonal or permanent place of residence, and land for cropping which yields agricultural produce for household consumption and fodder for livestock. They may engage in haymaking and local improvement of pastures.
- Livestock have a seasonal night corral during (during the wet season) but move part of the year without a fixed corral.
- Grazing is mainly practiced on communal land (grassland, shrublands and woodlands) but livestock keepers have rights to land for fodder and crop production.
- Livestock are mainly dependent on natural forage complemented by crop residues. Crop production may be substantial but is complementary to, and integrated with, grazing and livestock management.
- Herds may range from tens to hundreds of animals (cattle, goats and sheep – sometimes camels and donkeys also). These herds are, on average, smaller than other pastoral systems, explained by the fact that rangeland users in this category do not rely solely on livestock.

'Bounded' rangelands

The next three categories are rangelands that are bounded and clearly delineated – thus rangeland use primarily takes place within a defined area. These are 'Bounded rangelands without wildlife management', 'Bounded rangelands with wildlife management' and 'Parks, wildlife & and nature reserves'. The borders of the area may be enforced with physical fences, and/or social fences such as agreed limits to user/ grazing rights between communities, and/or delineated administrative boundaries. Movement out of the area to pastures elsewhere across the larger landscape, especially during dry seasons or during droughts, may sometimes take place.

left: Pastoralists moving a long distance to reach a spring to water their animals. The grassland around the source of water is heavily overused. After watering the animals pastoralists have to search for good grazing grounds away from a water point, Samburu, Kenya (Hanspeter Linger).

centre: Pastoral systems combined with wildlife management can provide an additional source of income from tourism. Even if not "used" for tourism, many of the pastoral areas also have wildlife such as zebra, gazelle, antelope which may compete for the same pasture resources. Avoiding or reducing human-wildlife conflicts poses a special challenge for rangeland management (Hanspeter Liniger).

right: Cattle grazing crop residues in agro(silvo)pastoral system, Niger (William Critchley).

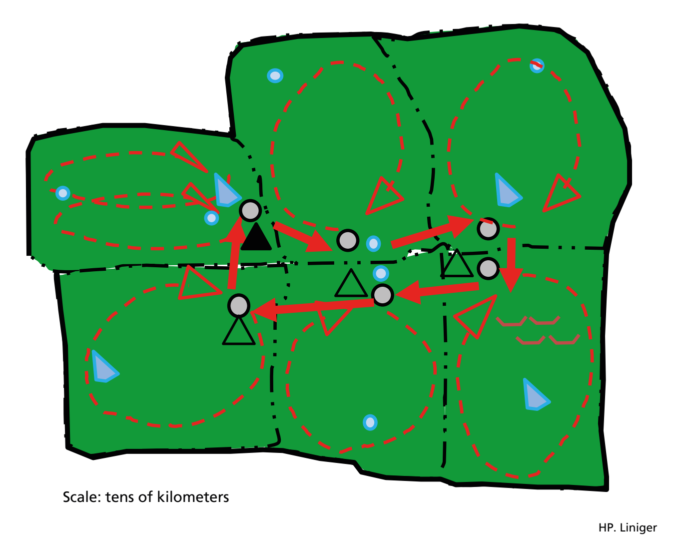


Figure 3.4a: Bounded rangelands without wildlife management: private ranching with rotational grazing (Legend page 39).

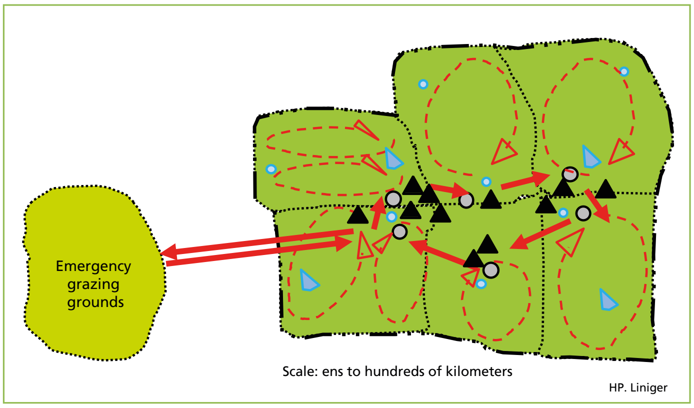


Figure 3.4b: Bounded rangelands without wildlife management: community ranching with rotational grazing (Legend page 39).

3. BOUNDED RANGELANDS WITHOUT WILDLIFE MANAGEMENT

These systems may be privately or communally owned. While they often have a significant amount of wildlife present, commercializing the wildlife is not part of the management system (Figures 3.4a and 3.4b). In the arid and semi-arid zones of East and Southern Africa many of these systems are found as "community ranches" or, where owned by individuals, "private ranches". Ranches are also found in the humid zone of Central and West Africa but are not common there.

In community ranches, land is owned under communal ownership and many have title deeds. A group of herders maintain agreed stocking levels, and while they manage their livestock collectively, they own individual animals. Community ranching in East Africa is implemented in various ways in different countries. For example, in Kenya, community ranches are termed "group ranches" and have been officially recognised under the recent Community Land Act, while in Uganda and Tanzania they are commonly referred to as "communal grazing lands" and "*ujamaa ranches*" (community ranches), respectively. The production focus is partly subsistence, and thus generally less market-orientated than private ranching. Land management practices including seasonal movement and rotational grazing may also be employed. Bounded systems are also found where official ownership rights are unclear, but social-cultural boundaries effectively create barriers.

Private ranches are generally commercial enterprises, with income generation being the primary function of the livestock raised. They specialise in one or more livestock species and produce mainly animals for slaughter (for meat, skins and hides), but also for wool and milk. Large private ranches in East and Southern Africa are generally owned by companies or family businesses. These enterprises use a variety of techniques for range management. Animal movement and pressure are often adjusted to the available forage within the ranch by controlled and rotational grazing, which is influenced – or even manipulated – by the distribution of water points. Herding patterns are closely adapted to the needs of different animal groups, and significant external inputs are required (labour, purchased feed, veterinary medicines etc.). In some ranches, monitoring of ecological and economic factors are also carried out as part of the management system.

Characteristics of bounded rangeland without wildlife:

- Distances covered between the night corrals during the year: several to tens of kilometres. Area used: tens to few hundreds of square kilometres.
- Livestock managers/ owners are often permanent residents.
- Management is either by individuals, or limited companies with private land ownership (private ranching), or by a group of land users (community ranching).

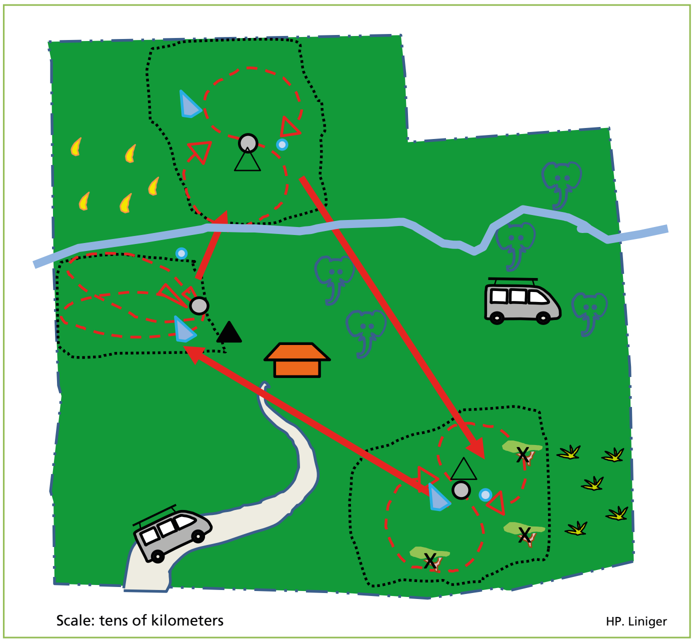


Figure 3.5a: Bounded rangeland with wildlife management: private ranching with wildlife conservancy (Legend page 39).

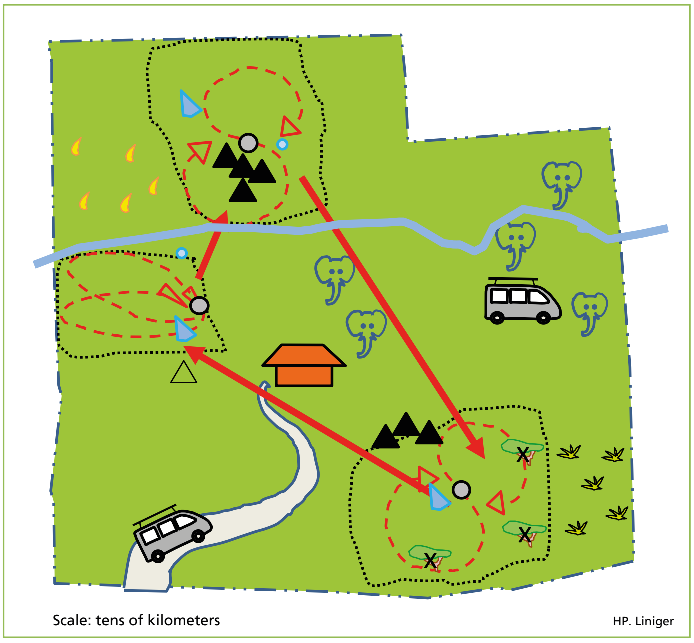


Figure 3.5b: Bounded rangeland with wildlife management: community ranching with wildlife conservancy (Legend page 39).

- Livestock movement is practiced but within the bounded areas.
- Livestock management usually includes rotational and seasonal grazing system.
- Community ranches (to varying degrees) and private ranches (generally) have emergency grazing grounds or the financial capacity to produce or purchase feed during times of drought.
- Common herd sizes under private ranches generally range from hundreds to thousands of animals (mostly cattle and sheep); under communal ranches there are usually several hundreds of mixed livestock: both smallstock (goats and sheep) and cattle.

4. BOUNDED RANGELANDS WITH WILDLIFE MANAGEMENT

In these systems, livestock keeping takes place alongside explicit management of wildlife and biodiversity (Figures 3.5a and 3.5b). The objective of the wildlife management may be conservation for its own intrinsic value (sometimes funded by voluntary conservation donations and/or dedicated organizations), or for commercialization through non-consumptive uses, such as wildlife viewing and tourism and/or consumptive uses, such as hunting.

Community and private ranches with wildlife and tourism host significant proportions of East Africa's (especially Kenya's) large mammalian wildlife populations (see Figure 2.11). Some ranches in East and Southern Africa have declared themselves 'nature or wildlife conservancies', and work towards enhancing ecologically and economically thriving landscapes that simultaneously support people and wildlife. Conservancies typically have a multi-faceted development approach aiming at (i) building a rangeland governance structure, (ii) improving rangeland management, (iii) boosting income generation activities and, (iv) supporting wildlife and biodiversity conservation.

Conservancies on private land are usually individually owned and fenced. However, this is not always the case, and some conservancies – such as those surrounding the Maasai Mara in Kenya – are not fenced, and are managed by groups of private landowners. Private conservancies tend to support a low population density of people, since tenure is generally individual and production is labour-extensive.

left: Private ranch split in four paddocks around a water point. Heavy seasonal grazing in two paddocks (left front and right back) while the other two paddocks are rested. In the following season the grazed areas will be closed and the rested areas opened for grazing. Ghanzi, Botswana (Hanspeter Liniger).

centre: Healthy rangelands with scattered tree and good grass cover being grazed by sheep in the Highlands of Eastern Africa (Hanspeter Liniger).

right: Private ranches combining cattle production and wildlife. Laikipia, Plateau (Hanspeter Liniger).

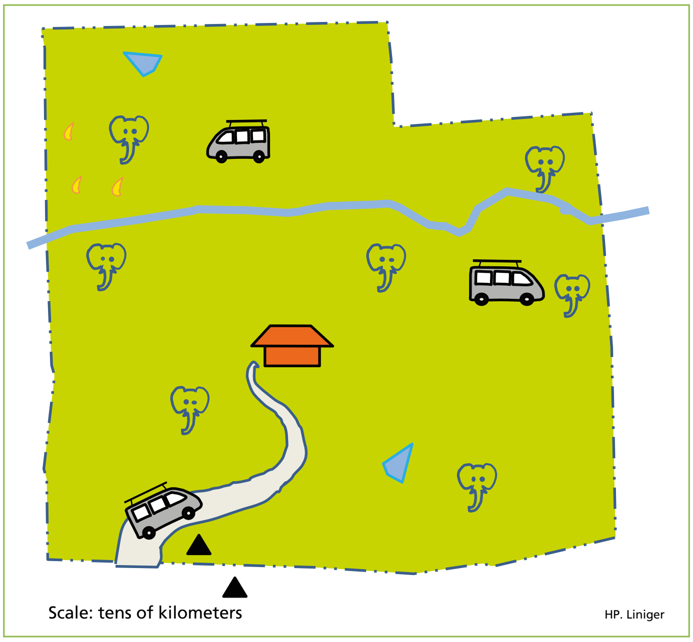


Figure 3.6: Parks, wildlife and nature reserves (Legend page 39).

Due to the reduced mobility of herds, private ranches are obliged to have high quality management standards for livestock and wildlife. Key is management of pasture and water – making sure there is established access to additional fodder and feed during droughts. Many of these private, fenced ranches are found on higher productivity, lower variability areas, which makes this intensive form of management easier.

Characteristics of bounded rangeland with wildlife are:

- Distances covered between the night corrals during the year: several to tens of kilometres. Area Used: tens to few hundreds of square kilometres.
- Livestock managers are often permanent residents.
- Management is either individual with private land ownership (private ranching) or by a group of land users (community ranching).
- Livestock movement is practiced but within delineated areas.
- Livestock management may include rotational and seasonal grazing system.
- Community ranches (to varying degrees) and private ranches (generally) have emergency grazing grounds or the financial capacity to produce or purchase feed during times of drought.
- Wildlife is "managed" by translocation, by the strategic management of resources to influence the functioning of the ecosystems, and marketed through tourism, commercial culling and/or game hunting. This requires extra infrastructure (water, roads, extra reinforced and high fences, security, lodges, etc.) and specialised management capacity.
- Managing potential conflict, and competition for resources, between wildlife and livestock is a major challenge for this rangeland use system.
- In East and Southern Africa this rangeland use system is often termed "conservancies", with a variety of different management models.
- Typically herd sizes in private ranches are in the range of several hundreds of animals (mostly cattle and sheep); in communal ranches up to several hundreds of mixed livestock: both smallstock (goats and sheep) and cattle. In both cases the numbers of wildlife vary enormously. Furthermore with migration of some species of wildlife, numbers are not static either.

5. PARKS, WILDLIFE & NATURE RESERVES

Protected areas situated within rangelands are generally parks or various kinds of reserves (Box 3.1, Figure 3.6). These conservation areas receive protection because of their recognized natural, biodiversity, ecological or cultural values. Within these areas livestock are usually not permitted. However if livestock are allowed, they are regulated in terms of numbers and periods, and are restricted to specific zones.

There are several kinds of protected areas, which vary by level of protection depending on the specific laws of each country, or the regulations of the international organizations involved. The International Union for Conservation of Nature (IUCN), and its World Commission on Protected Areas (WCPA) define a protected area as: "A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley et al. 2013). Protected areas are essential for conservation of threatened or endangered species – both fauna and flora – providing protection from habitat loss, hunting or poaching.

As much as 17.4% of the rangelands in SSA have been declared protected areas such as national parks, reserves, wilderness area (Box 3.1, see Chapter 2.1.7). This classification does not include conservancies. There exist a number of different categories of protection associated with management regulations.

Box 3.1: Protected areas

IUCN defines a protected area as: "A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values."

The definition is expanded by six management categories:

Ia Strict nature reserve: Strictly protected for biodiversity and also possibly geological/ geomorphological features, where human visitation, use and impacts are controlled and limited to ensure protection of the conservation values.

Ib Wilderness area: Usually large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, protected and managed to preserve their natural condition.

II National park: Large natural or near-natural areas protecting large-scale ecological processes with characteristic species and ecosystems, which also have environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities.

III Natural monument or feature: Areas set aside to protect a specific natural monument, which can be a landform, sea mount, marine cavern, geological feature such as a cave, or a living feature such as an ancient grove.

IV Habitat/species management area: Areas to protect particular species or habitats, where management reflects this priority. Many will need regular, active interventions to meet the needs of particular species or habitats, but this is not a requirement of the category.

V Protected landscape: Where the interaction of people and nature over time has produced a distinct character with significant ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.

VI Protected areas with sustainable use of natural resources: Areas which conserve ecosystems, together with associated cultural values and traditional natural resource management systems. Generally large, mainly in a natural condition, with a proportion under sustainable natural resource management and where low-level non-industrial natural resource use compatible with nature conservation is seen as one of the main aims.

Not applicable: Any protected area that is not legally/officially designated or proposed (e.g. World Heritage Sites and UNESCO MAB Reserves) or does not fit the standard definition of a protected area.

Not assigned: The protected area meets the standard definition of protected areas but the data provider has chosen not to use the IUCN Protected Area Management Categories.

Not reported: protected areas where an IUCN category is unknown and/or the data provider has not provided any related information.

www.iucn.org/pa_categories; UNEP-WCMC 2017

The management and use of protected areas varies considerably, ranging from heavily restricted access, to game watching, to areas where guided walks are permitted, to game hunting under license. Access and use of protected areas spans low budget facilities and activities to exclusive high-end luxury camping venues. The level of human and livestock use of natural resources in a protected areas varies, from strictly wilderness areas free of human influences (IUCN Category Ia, Ib), to areas that can be used by local communities for natural resource management (IUCN Categories V, VI) (Box 3.1). Management is commonly by government or non-governmental organizations, but it may also be carried out under license by tourist enterprises or by individual owners of private land. Management of these areas in the absence of livestock largely relies on the culling and translocation of wildlife, the use of fire, and strategic location of water sources.

Characteristics of parks, wildlife & nature reserves:

- Area used: tens to hundreds and a few thousand square kilometres.
- Land is owned by state government, non-government organization and private owners.
- The areas are delineated and protected through restrictions on use by tourists, nature conservationists, researchers, hunters, and pastoralists, depending on the status of protection.

left: The Bandiagara Escarpment UNESCO World Heritage site in Mali. The geological, archaeological and ethnological interest, together with the landscape, make the Bandiagara landscape one of the most impressive sites of West Africa's rangelands (William Critchley).

centre: Elephants scooping for water. In the sand holes, the water stored during the floods is less saline than the surface water fed by groundwater from springs (Hanspeter Liniger).

right: It is not only the megafauna that attracts people from all over the world. The richness of habitats provides high biodiversity with a rich bird life. Secretary bird in Buffalo Springs National Reserve, Kenya (Hanspeter Liniger).

- Wildlife may be confined by fences or allowed to move outside the boundaries or to migrate into dispersal areas – and on to other parks or reserves.
- Area of specific importance for plant biodiversity may be given special, localised protection from grazing/ browsing/ fire etc.
- The land is predominately used by wild herbivores and carnivorous predators and, at least partially, permits their daily, seasonal and migratory movement.
- Access by livestock for grazing may be limited and regulated or prohibited.
- Management involves securing conditions that stop poaching, manage visitors/tourists, facilitate research, provide services and manage income.
- The range of wildlife species and numbers is so larger that it is impossible to give 'typical' numbers. There may be small numbers of particular wildlife species in specialised parks with defined limits, or at the other extreme, huge herds of thousands of wildlife in the larger parks (especially in East and Southern Africa).

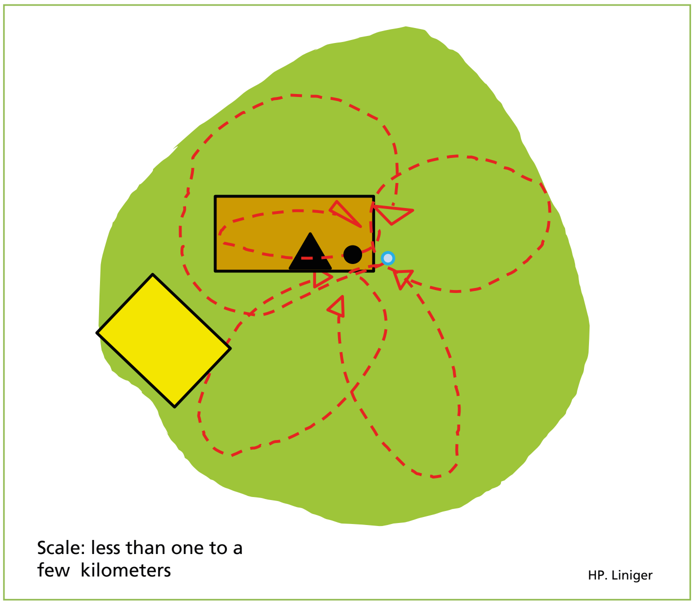


Figure 3.7: Small-scale settled pastures (Legend page 39).

6. SMALL-SCALE SETTLED PASTURES.

In these systems, where climatic conditions allow (high rainfall and lower variability), people and their livestock are permanently settled. Livestock movement is restricted, within small-scale pasture areas or "paddocks", which are managed in an intensive manner to produce more, and better quality, forage and fodder (Figure 3.7). Livestock graze these pastures and/or are fed in stalls, where fodder grown on pastures within the confines of their farmland – or gathered from common land – is brought to the animals under "cut-and-carry" systems. They may also graze stubble after crops have been harvested, or fed hay which has been produced on the farm holdings. Crops and pastures are integrated on predominantly small-scale farms, with relatively small herds/ flocks of higher quality livestock.

Commonly, animals are grazed on pastures but also partly fed on crop residues (stover/ stubble grazing, etc.) and may be given hay during the dry season. Crops and livestock have the same owner. These systems are widespread in higher rainfall areas, and form the backbone of smallholder agriculture. They predominate in humid and sub-humid agro-ecological zones but as population pressure increases they are also increasingly found in the semi-arid tropics of East and West Africa (Bationo et al. 2015, Krätli et al. 2015). In the Sahel and in many agricultural areas in East/West Africa, this system can be a sub-component of pastoral, agropastoral and bounded systems. In these cases part of the herd – sick animals, lactating females, young livestock, but also particular animals targeted for sale or slaughter for special occasions (e.g. rams in the Sahel) – are stall-fed or graze on nearby pastures for a variety of reasons.

Characteristics of small-scale settled pastures are:

- Area used: less than one to a few hectares.
- Night corrals are permanent, only daily movement of animals. Area used: Less than one to a few hectares.
- Animals are kept permanently or part-time in shelters/ stalls and any movement is confined to nearby pastures.
- In sub-humid and humid zones: pastures are usually small-scale, with individual land use rights; they are mainly fenced and may be sub-divided into paddocks with improved grassland.
- Livestock are moved strategically, either rotated between paddocks, tethered (pegged) to restrict movement and/ or kept in stalls. Apart from fodder provision and milking, most of the day they can be left unattended.
- In semi-arid zones: areas with pastures are usually small-scale, with individual or communal land use rights; but pastures and grazing lands are usually under communal rights or are open access, not fenced and without improved grassland.

- Livestock move short distances that are accessible within one day. Apart from grazing in pastures, they feed on crop residues, and may receive supplementary feed gathered from around the farm. Livestock need full-day attendance.
- Apart from grazing, animals are stall-fed with green or preserved fodder (i.e. freshly cut grass or hay), tree/bush leaves, residues from crop production and /or animal feed (harvested or processed). Sometimes fodder is collected from outside the farm.
- Common numbers of livestock holdings are a few cattle (usually improved breeds) and varying numbers of goats and sheep.

3.1.3 Characterization of rangeland use systems

The WOCAT database was used to better understand different rangeland use systems (RUS) and the practices implemented in each. In the following, the 111 relevant practices (69 technologies and 42 approaches) that have been compiled over the last 10 years, including 56 specifically for this book, are analysed and key insights are presented (see Table in Annex). This analysis is aimed at identifying "good practice" and thereby generating guidelines for good rangeland management.

Out of the 69 technologies analysed from the database, 25 (less than one third) pertain to the RUS 'pastures', around a quarter to 'agropastoral' (16), 13 to the 'bounded without wildlife' and 7 to the 'bounded with wildlife' systems, and 6 cases belonging to the 'pastoral' system (Figure 3.8). The low number of large-scale 'pastoral' systems reflects the difficulties in locating and recording these large-scale systems and identifying successful practices amongst them. Documenting a single farm production system, and interviewing one householder is considerably easier than researching a system that covers a community that is on the move in semi-arid areas with mixed herds and complex, traditional rules and regulations. However, the preponderance of settled systems in the sample may also indicate a trend towards loss of mobility, or a search for alternative or complementary livelihoods within increasingly settled pasture systems. In truth, many large-scale pastoral systems have traditionally relied on some sort of opportunistic crop production. But this new dynamic may indicate a trend towards the subdivision of land and intensification of animal production – especially near urban areas and the higher potential zones (e.g. Box 3.2).

Out of the 42 approaches, less than one third (16) pertain to the 'agropastoral' and around one fifth (9) to the 'bounded without wildlife', followed by 'bounded with wildlife' (6) and then the 'pastoral' system (5) (Figure 3.8). This confirms that projects tend to focus their attention on supporting agropastoralist systems to create better conditions for the implementation of sustainable rangeland management (SRM) practices. The least number of approaches, apart from 'parks & reserves' were documented for the 'pastures' (4). For the latter, the focus is rather on spreading various technologies that have proved successful. Some approaches support sedentarizing pastoralists and stimulating diversification and income from crop production on the one hand – while recognising mobility as an important aspect of sustainable rangeland and livestock management on the other.

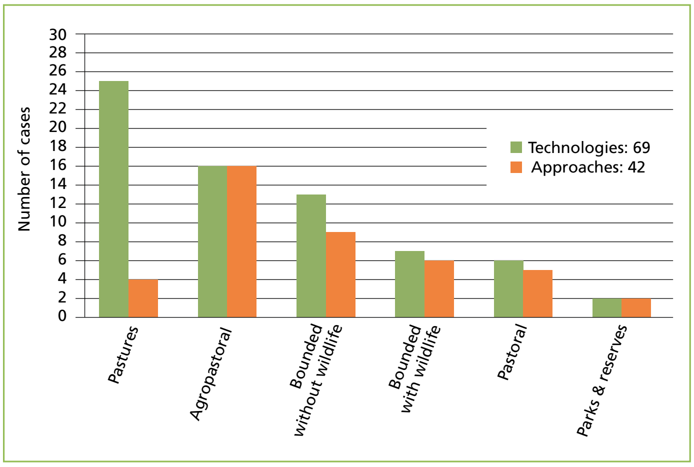


Figure 3.8: Distribution of rangeland management technologies and approaches by rangeland use systems (RUS) in SSA.

Cases of SRM technologies covering 'pastures' are mainly reported from the Horn & East Africa and West Africa whereas 'pastoral' and 'agropastoral' systems are mostly reported from West Africa – with few from the Horn & East Africa and Southern Africa (Figure 3.9a). This may be an indication of how widespread small-scale settled pastures systems are in the different regions, but it is more likely to show where development agencies are making an effort to promote SRM technologies. Interestingly, the number of documented technologies for 'pastures' is much higher than the different approaches, indicating that many SRM technologies can be implemented without specific investment into approaches. However, special efforts are evidently needed for planning and developing an enabling framework for the more demanding large-scale interventions: 'pastoral', 'agropastoral' and 'bounded' systems (Figure 3.9b).

left: A mixed herd of livestock of several small-scale farmers are being grazed on rangelands, towards the fringe of the forest zone, Kenya (Hanspeter Linger).

centre: A mixed herd belonging to several small-scale farmers being grazed on rangeland close to the forest fringe, Kenya (Hanspeter Liniger).

right: Farmer cutting and feeding napier grass to Friesian cows, Uganda (Kamugisha Rick Nelson).

Box 3.2: Promoting *bourgou* growing in agropastoralist system (Mali)

Bourgou or "hippo grass" (*Echinochloa stagnina*) improves the availability of fodder for livestock in the Niger river's inland delta region. Agropastoralism is taking precedence here over pure pastoralism, and is helping reduce conflict with agriculturalists. There are some interesting initiatives in terms of fodder production techniques: *bourgou* culture is one of these. Given the lack of forage and pastureland for livestock, land users have taken to replanting and cultivating this indigenous grass. Bourgou pastures can produce up to 30 tonnes of dry matter per hectare in one year, possible due to the wet conditions in the delta. The regeneration techniques used are layering and transplanting of bourgou cuttings or splits. Bourgou has good prospects for the future in areas where it can be grown – based on its nutritional value and yield during the 'lean' season. There is keen interest within the Central Niger Delta – and this forage is in high demand by local livestock keepers.

https://qcat.wocat.net/en/summary/1638/; E. Botoni pers comm.

(Malian Ministry of Environment)

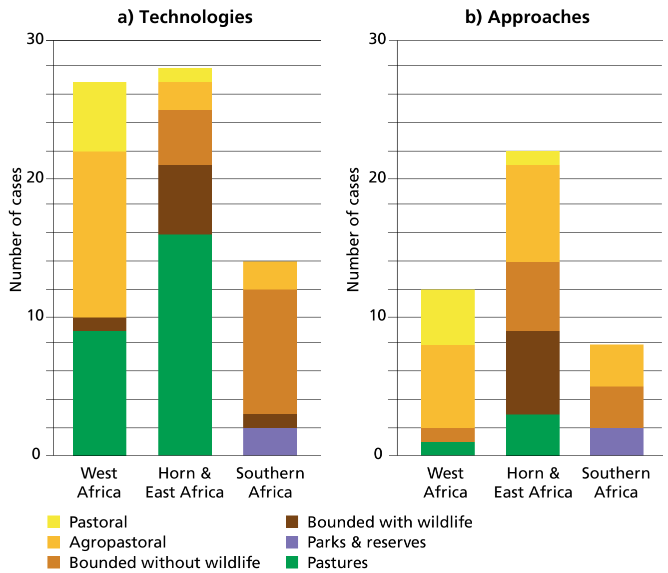


Figure 3.9: Distribution of rangeland use systems (RUS) in regions of SSA: West Africa, Horn & East Africa and Southern Africa. Figure (a) for documented SRM technologies and Figure (b) for documented SRM approaches.

For technologies, 'bounded with or without wildlife' systems have been mostly documented from Southern Africa and the Horn & East Africa (Figure 3.9a). Approaches for 'pastoral' systems have principally been documented in West Africa (Figure 3.9b). Few 'parks & reserves' are documented, and these are exclusively from Southern Africa; none from East Africa even though this region has a large number of 'parks & reserves'.

More than 70% of the documented cases, whether technologies or approaches, were introduced or promoted by projects and research (Figure 3.10). This is most likely to be because projects tend, naturally, to document their own achievements rather than to invest in identifying existing traditional and innovative practices and documenting them. For all RUS, about 20-30% of the cases, can be assigned to land users' traditional knowledge or recent, independent innovation such as in the 'agropastoral' system with the approach of 'Empowering traditional Dedha institutions, Kenya' (Box 3.3) and making 'Arrangements to convert degraded rangeland, Namibia' (Box 3.4).

Natural environment

In the following, the natural environment of SRM technologies implemented in different RUS is characterized with respect to rainfall, agro-climatic zone, slopes, soil organic matter, biodiversity, availability of surface and groundwater (Figure 3.11). Note that 'parks & reserves' have been omitted from the graphs because the very small sample size (2) distorts the data.

Rainfall regime and agro-climatic zone: In three RUS, namely 'pastoral' and 'agropastoral', 'bounded with wildlife', more than 80% of the SRM technologies are reported from areas with less than 500 mm annual rainfall (Figure 3.11b). For the same systems, more than three quarters are categorized as lying in the semi-arid to arid zones (Figure 3.11c). Looking at the rainfall map provided in Chapter 2 (see Figure 2.2b), it can be seen that they are concentrated in the northern part of the Sahelian region of West Africa, in the north-eastern lowlands of East Africa and the western parts of Southern Africa. These areas comprise grasslands, open shrublands and savannahs. Even though 'pastoral', 'agropastoral' and 'bounded with wildlife' systems may cover a wide range of rainfall regimes, the practices documented are located in low rainfall areas. Practices in 'bounded without wildlife' and 'pastures' systems are mainly recorded from drier regions, but some are documented from subhumid and humid areas.

Topography is illustrated by **the slopes** on which the SRM technologies are implemented (Figure 3.11d). The cases documented are generally found on flat and gentle slopes. 'Bounded without wildlife' and 'pastures' systems – latter mainly from Ethiopia – are also recorded as being on hilly and steep slopes. 'Pastoral', 'agropastoral' and 'bounded with wildlife' systems are typified by moderate to rolling slopes. Even though the majority of the land used by single practices is in flatter areas, livestock have access to hilly and mountainous areas, generally with higher rainfall and forage resources, and animals can then move between different topographic environments. However, in the 'pastures' system, cases are generally restricted to a single topographical category.

Soils and soil organic matter: Soils in the rangelands vary considerably with respect to soil organic matter – which is an indicator of productivity (Figure 3.11e). The documented practices are from areas that have low to medium organic matter content, indicating that they are either from areas with less developed and fertile soils (marginal lands) or from areas affected by high land degradation (as assessed in Chapter 2.1.10). An extended study in the rangelands of South Africa revealed that soil organic carbon (SOC) content of topsoils ranged from less than 0.5% to more than 4% (Du Preez et al. 2011). Only 4% of the topsoils contained more than 2% SOC, whilst 58% of the topsoils contained

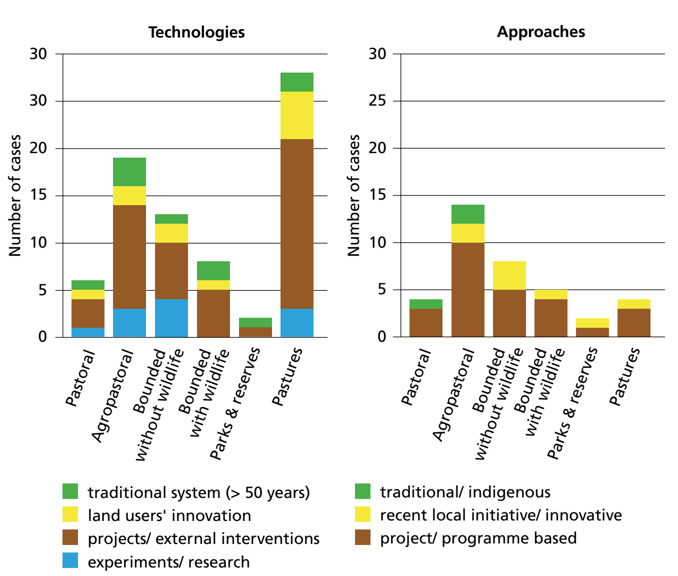


Figure 3.10: Origin of (a) Technologies and (b) Approaches documented by rangeland use systems (RUS).

less than 0.5% SOC, and 38% contained between 0.5% and 2% SOC. The study concluded that the rangelands of South Africa are characterised by topsoils with very low organic matter levels. The main natural factors influencing the organic matter content in the cases throughout SSA were listed as rainfall, vegetation cover, topography and parent material. However, particular management practices such as heavy grazing and burning tend to decrease the level of soil organic matter (and thus carbon). Because of the low levels of soil organic carbon in rangeland soils, there is good potential for sequestering carbon in the soil from the atmosphere through better perennial vegetative cover.

Biodiversity: In systems with wildlife management, species diversity of fauna is high – in terms of richness that is the number of different species (see Chapter 2.1.7). In the others, species diversity is mostly medium to low (Figure 3.11f). It is low particularly in systems where crop cultivation is prominent such as within the 'pastures' system. Biodiversity in rangelands especially in relation with wildlife management is an important issue, however not addressed sufficiently as the limited examples and data confirm. Moreover biodiversity does not just relate to wildlife, but to vegetation also – and to organisms within the soil which help to drive ecosystem function. The data available in the case studies do not, and could not be expected to, give a full assessment of biodiversity status.

Surface water availability: Surface water availability in rangelands is poor to medium (Figure 3.11g). Other than in the 'pastures' system, which can receive high amounts of rainfall (750 to 1500 mm), surface water availability is estimated to be medium. In 'agropastoral' systems, which are generally practiced in areas with less rainfall than in 'pastures', there is less surface water available.

Groundwater availability: In many areas, rangelands do have potential groundwater supplies, but wells often have to be drilled to 50 m or more. An exception is under 'pastures', where groundwater tables are at 5–50 m: these are situated in the wetter regions with better surface and rain water availability, whereas the other systems not only have less rainfall and less surface water, but also deeper aquifers (Figure 3.11h).

Box 3.3: Empowering traditional *Dedha* institutions in governing the natural resources of Isiolo agropastoral rangelands, Kenya

The *Jarsa Dedha* is an indigenous institution, through which customary laws and provisions guide the management of natural resources. The Boran of Isiolo County, Kenya, like their kin in southern Ethiopia, derive their customary laws from an overall supreme general assembly called the Gadha – under which the *Jarsa Dedha* falls. The Gadha governing council preserves traditional laws and codes of conduct, as well as issuing amendments and additions based on the evolving environmental, social and cultural context. The system has a set of laws and provisions (*seere*), customs and culture (*aada*), and norms and values that govern society.

The traditional system, which was devised by the Boran pastoral community and honed over centuries to suit the challenges of the rangelands, has been steadily eroded by external factors and formalised systems after the emergence of the nation-state. This approach – driven by communities and supported by various agencies – aims to revive and strengthen the traditional natural resource management institutions of Boran pastoralists in Northern Kenya.

https://qcat.wocat.net/en/summary/4013/

(Ibrahim Jarso)

Human environment
In the following, the human environment of the of SRM technologies implemented in different RUS is characterized with respect to land and water use rights, land size, market orientation and off-farm income (Figure 3.12).

Land and water use rights as indicators of land tenure: For 'pastoral' systems, communal rights apply to all of the practices reported, and in over 60% of the cases, with respect to water (Figure 3.12b and c). 'Agropastoral' systems are under communal (organised) and open access (unorganised) regimes, and this is true of rights to water also (e.g. 'Forage Christine, Burkina Faso'; page 263). However, land use rights may also be individual or leased, particularly where crops are cultivated (e.g. 'Assisted natural regeneration, Niger'; page 205). In 'bounded without wildlife', and 'bounded with wildlife' systems the proportion of individual & leased and communal land and water use rights are almost the same; there is no open access to land and in only about 10% is there open access to water. In the 'pastures' systems, land use rights are individual in just under half of the cases, whereas water use rights are almost 80% communal or open access. Again, there are cases such as in 'Grass reseeding, Kenya' (page 215), where land and water use rights can be either individual or communal.

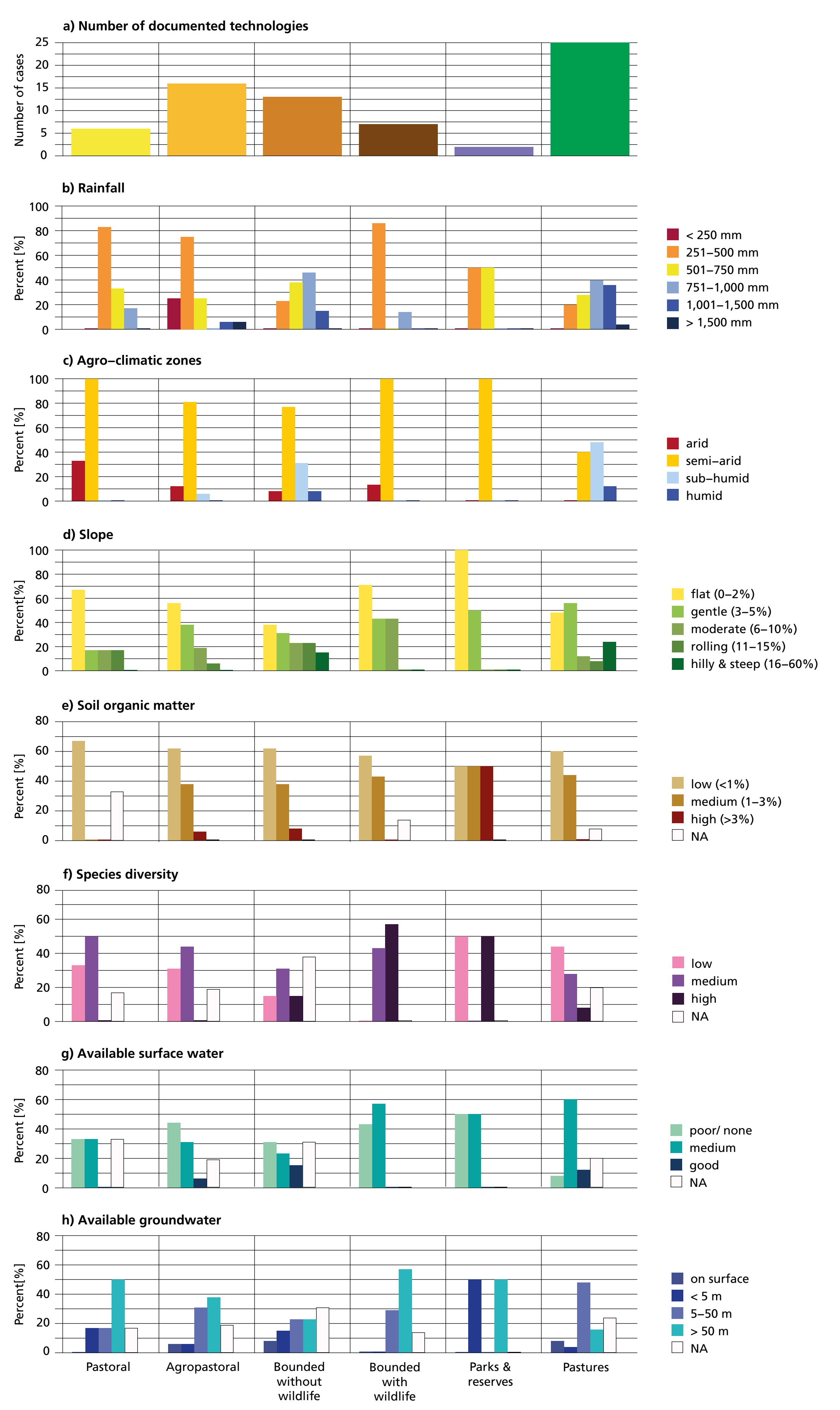


Figure 3.11: Natural environment of SRM technologies implemented in different rangeland use system (RUS). (b) to (h) are shown in percent of each RUS. Several answers possible per documented technologies. NA = data not available.

Box 3.4: Innovative arrangements to convert degraded agropastoral rangeland into fruitful landscape, Namibia

Arrangements between a commercial farmer and agriculture students have been made to raise the productivity of rangeland – through managing runoff to grow multipurpose trees and bushes. The objective is to share knowledge and experiences gained by the land user to grow valuable woody plants, grass and herbs, which students can then apply elsewhere. Trees included large canopy species, shorter thornless types for "chop and drop" mulching and those that produce fruits or edible leaves. While the banks become crucial fertile patches in this arid landscape, they also act as broad barriers to sheet flow, slowing it down and increasing infiltration rates locally. Thus degraded "leaky landscapes" turn into "sponge landscapes" and restore deeper and more persistent soil moisture.

https://qcat.wocat.net/en/summary/3410/

(Ibo Zimmermann)

Box 3.5: Lolldaiga Hills ranch: Rotational grazing and boma-based land reclamation, Kenya

Lolldaiga Hills ranch is a private ranch and conservancy. Livestock production is managed under an extensive grazing system for dairy, beef, sheep and camel production, with strategic fattening and selling, in harmony with conservation principles. The conservancy is dedicated to the sustainable conservation of critical habitat and wildlife. Rotational grazing is used to manage livestock on semi-arid lands with limited water resources. Bare land is recovered by a boma technology – strategic corralling of animals overnight on degraded land.

https://qcat.wocat.net/en/summary/4027/

(Michael Herger)

Land size and scale of land use: In the systems where crop cultivation is an integral part of the system, land use is mainly declared as being small-scale; for 'pastures' systems, and for 'agropastoral', 70% and 60% respectively of reported practice are small-scale (Figure 3.12d). This is unexpected for the 'agropastoral' system, however examination of the data shows that land users only referred to their cropland. The 'bounded with wildlife systems' are more than 55% large-scale, compared with 30% in the 'bounded without wildlife'. Conservancies and ranches that include wildlife have, in general, to be large in order to sustain and feed wildlife and livestock.

Market orientation and production focus: In the systems where crop production is involved ('agropastoral' and 'pastures') land users have a mixed (subsistence combined with commercial) or subsistence market orientation (Figure 3.12e). According to the examples documented, 'pastoral' systems (e.g. 'Securing pastoral mobility, Chad'; page 127) mainly follow a mixed market orientation. Pastoralists earn money by selling their livestock for slaughter. In 'bounded' systems, production is to a large extent for the market, particularly when wildlife is part of the system and tourism provides revenues (e.g. 'Il Ngwesi Holistic Management, Kenya' (page 157). Where wildlife is not part of the system, subsistence farming is also common.

The market orientation of the different rangeland use systems differs considerably, and includes the following products: meat, milk, cheese, blood, hides, honey, medicinal and cosmetic-producing plants (gum arabic, shea nuts, aloe etc), charcoal, and draught animals for hire. There are also incidences of raising and keeping animals as insurance and 'mobile banks', as a statement of wealth, social prestige, and for cultural value. One production focus is income from tourism or grants from agencies for keeping and enhancing wildlife biodiversity – and from protection of endangered species. For the different production systems, herd composition of large stock, small stock, a mix between grazers/ browsers and wildlife plays an important role in marketing and income generation. All of this illustrates the wide variety of different products and markets that rangeland users are involved with; both subsistence and commercial, and both livestock products and non-livestock rangeland products (NLRP).

Off-farm income and alternative source of income

Off-farm income is defined as income not directly from the rangelands, such as part-time employment in business (other than marketing agricultural rangeland products). In all rangeland use systems, except the 'bounded with wildlife' system, off-farm income is usually less than 10% of all income, indicating that a high proportion of rangeland users depend almost entirely on their rangelands (Figure 3.12e). In 'bounded with wildlife' systems, off-farm income of 10-50% is reported in more than half of the cases. In 'Rangeland restoration, Kenya', and 'Grass reseeding, Kenya'; pages 221 and 215) off-farm income is even larger than 50%. In these cases the main income is from employment in tourist lodges or in providing transport for livestock and products.

Emergency feed and drought

For the characterization of the rangeland use systems, emergency feed and drought need to be considered. All RUS can, and are, affected by unpredictable droughts with growing frequency (see Chapter 2.1.2). The systems with the highest levels of mobility rely on rights and access to supplementary dry grazing grounds, usually integrated into the system, which means adaptation through mobility ('pastoral' and 'agropastoral' system). For the 'bounded' systems livestock and wildlife need fodder and the ability to store emergency

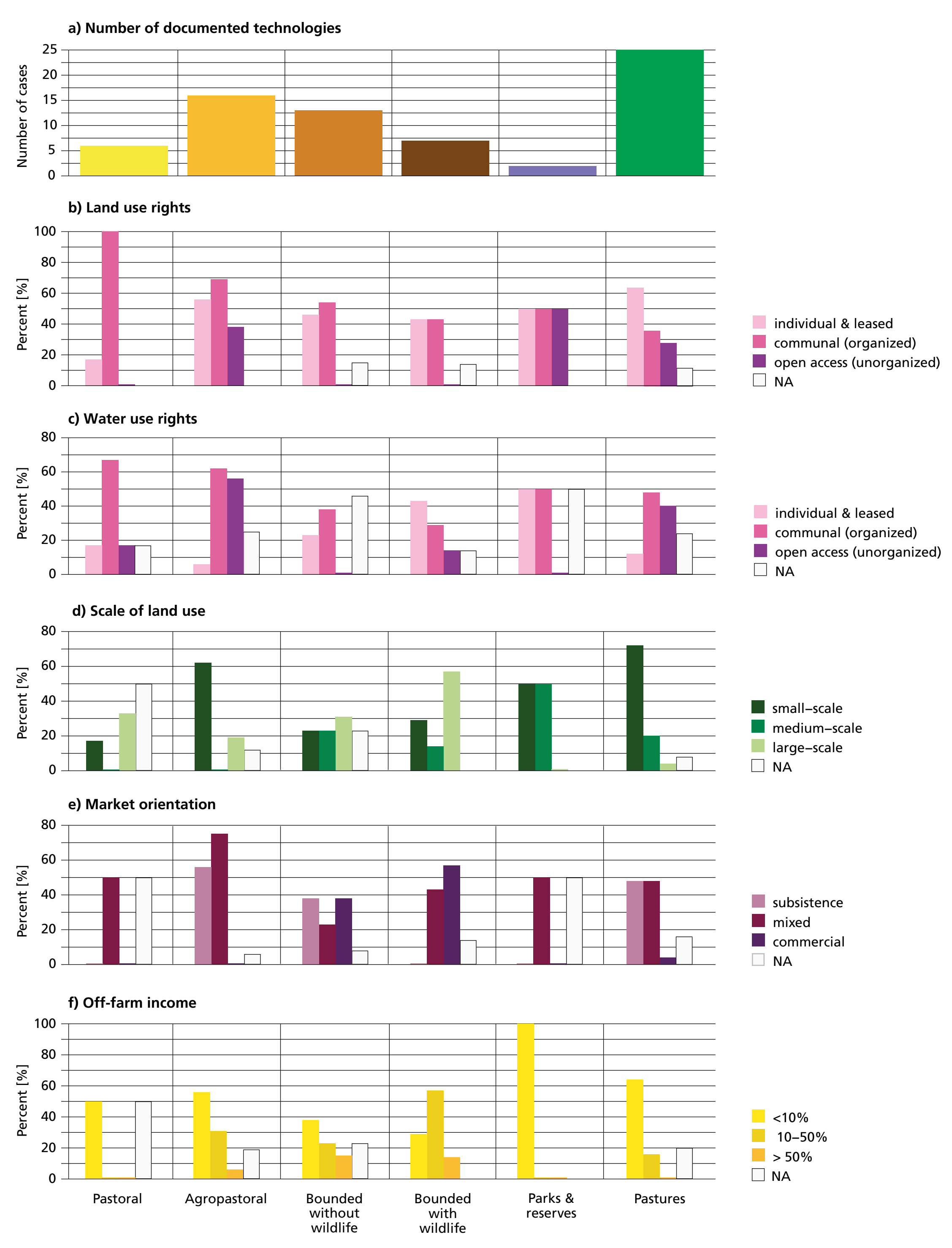


Figure 3.12: Human environment of SRM technologies implemented in different rangeland use systems (RUS). (b) to (f) are shown in percent of each RUS. Several answers possible per documented technology. NA = data not available.

fodder and feed – or access to a market for emergency feed. Another option is escape to additional dry period or drought grazing grounds (emergency areas) such as in 'Lolldaiga Hills Ranch, Kenya' (Box 3.5), where the ranch allows neighbouring group ranches access to their land for fattening purposes, but mainly as a grass bank during droughts (sometimes charging a small fee). During dry spells, they host on average 500–1000 head from other communities. Access to surface water or groundwater during emergency periods also needs to be secured. Permanent small-scale settled pasture management systems also need emergency preparedness measures similar to bounded systems, but these are generally on a smaller scale. 'Parks & reserves' characteristically cover larger areas, allowing at least some migration, seasonal movements and access to dry season grazing grounds. Park management may – in extreme cases – provide emergency feed and additional water to wildlife.

Fire: natural or managed

Regulated fire can help control woody species and create space for grassland regeneration – but uncontrolled fires can destroy useful vegetation (see Chapter 2.1.9). In 'pastoral' and 'agropastoral' systems, fires occur naturally at irregular intervals usually affecting only part of the large land surface used under these systems. Use of firebreaks in areas with considerable accumulation of potential fuel – dry grasses, shrubs and trees – is one management tool, generally used in conjunction with back-burning to confine

Table 3.1: Rangeland use systems (RUS) classification and characterization in Sub-Saharan Africa. +++ very high and high; ++ medium, + low, – no

Range-land use systems	Key criteria for classification				Contextual criteria to characterize rangeland use systems								
Criteria	**Mobility**	**Boundary**	**Crops**	**Wildlife**	**Rainfall regime vegetation**	**Mountains and slopes**	**Water availability**	**Land- and Crater user rights**	**Scale of land use**	**Market orientation**	**Off-farm income**	**Drought refuge; Emergency feed**	**Fire: natural or managed**
Large landscape pastoral rangelands	+++	–	–	+	250 – 750 mm semi-arid and arid grasslands, shrublands and savannah.	Flat to hilly	Distributed over large landscapes, with different availability, access and user rights	Land: mostly communal Water: com-munal individual & leased, open access.	Large-scale	Mixed and subsistence	+	Facilitated by mobility	Natural
Large landscape agropastoral rangelands	+++	+	+	+	250 – 750 mm (up to 1,000 mm) Semi-arid, arid and semi-humid (savannah, woodlands and grasslands)	Flat to gentle and some mountains areas	Distributed over large landscapes, with different availability, access and user rights	Land: commu-nal, individual & leased, open access and regulated open access. Water: communal, open access	Small-scale Large-scale with points intervention	Mixed, subsistence	++	Partly facilitated by mobility and additional fod-der production or residues from crops	Natural
Bounded rangelands without wildlife management	++	+++	–/+	–/+	250 – 1,000 mm, semi-arid, semi-humid (Savannah, shrublands and woodlands)	From flat to hilly and steep	Medium, natural sur-face water and dams/ ponds	Land: communal, Individual & leased Water: commu-nal, Individual & leased.	Large- to medium scale	Subsistence, commercial + mixed	++	Stocking fodder, haymaking or access to mar-ket. Emergency escape to other area e.g. forests, parks, wetlands	Natural and managed (prescrip-tive fire)
Bounded rangelands with wildlife management	++	+++	–/+	++(+)	250 – 1,000 mm, semi-arid, arid, semi-humid (Savannah, shrublands and woodlands)	Flat gentle to moderate and some mountain areas	Medium, natural sur-face water	Land: individual, communal. & leased. Water: individual & leased, communal + open access	Large- to medium scale	Commercial, mixed	+++	Stocking fodder, haymaking or access to mar-ket. Emergency escape to others area e.g. forests, parks, wetlands, emergency sell-ing animals	
Parks & reserves	+++	+++	–	+++	250-1,000 mm. semi-arid (Savannah, grasslands and woodlands)	Flat gentle and some mountains areas	Medium to good, natu-ral surface water, often along rivers or swamps	Land: national, governmental & individual Water: mostly natural resource, communal	Mostly large to medium scale	Commercial and mixed	–	Open parks boundaries, allowing migra-tion in and out migration	Natural and managed (fire-breaks)
Small-scale settled pastures	+	++	++	–	500-1,000 mm sub humid, humid and semi-arid (woodlands mixed with croplands)	Flat to gentle hilly & steep	Medium to good: includ-ing water harvesting systems	Land: individual & leased communal, open access Water: communal, individual and open access	Small-scale	Subsistence and mixed	+++	Opportunistic grazing in the neighbourhood and supplemen-tary feeding, haymaking	Natural, accidental fires

spread of unwanted fire, as shown in examples 'Firebreaks, Niger' (page 195), 'Manual opening of firewalls, Mauritania'[1] and 'Firebreaks, Senegal' (Box 3.6). Grazing of dry grasses and removal of desiccated wood also reduces fires and the risk of large-scale uncontrolled spread. In national parks, occasional fires are part of the natural system. 'Pastures' systems are generally not affected by fire.

Table 3.1 summarises key ecological and socio-economic factors and parameters, which were identified, analysed and attributed to the various rangeland management groups.

3.2. Sustainable rangeland management classified

Apart from classifying the main rangeland use systems (RUS), the sustainable rangeland management practices – technologies and approaches – also need to be grouped to identify common principles and intervention strategies for improved management of the rangeland.

Sustainable rangeland management (SRM) is a subset of sustainable land management (SLM) and uses the same definitions with "land" being substituted by "rangelands" (Box 3.7). In total, 69 SRM technologies and 42 SRM approaches from 16 countries in SSA have been documented in the WOCAT database, and analysed in these guidelines. Out of those, 28 technologies and 28 approaches were documented specifically for these guidelines.

[1] https://qcat.wocat.net/en/summary/2090/

Box 3.6: Firebreaks, Senegal

Firebreaks are used on rangeland with rainfall between 150 and 300 mm per annum, and are employed as a precautionary measure – to protect forage on rangelands during the dry season following good grass growth. Bushfires are frequent on productive rangelands where there is over one tonne of standing biomass per hectare. Firebreaks cut continuous tracts of rangeland into smaller areas, thus containing and limiting damage in the event of fire. They may be established along traditional tracks, by broadening the width of the pathways. Firebreak gaps simultaneously make it easier to extinguish fires along these corridors, by facilitating rapid access. Preventing spread of fire is achieved through removing combustible material. There are two techniques for creating firebreaks: (i) manually and (ii) by machine. In both cases, a 10 to 15 m wide corridor is cleared, perpendicular to the prevailing wind direction.

https://qcat.wocat.net/en/summary/1616/

(GIZ)

Take-home messages
More than 70% of the cases documented, whether technologies or approaches, were introduced or promoted by projects and research.
About 20-30% of the cases, can be assigned to land users' traditional knowledge or recent, independent innovation.
More than 80% of the SRM technologies are reported from areas with less than 500 mm annual rainfall.
Cases documented are generally found on flat and gentle slopes.
Practices are from areas that have low to medium organic matter content, indicating that they are either from areas with less developed or fertile soils (marginal lands) or from areas affected by high land degradation.
Species diversity of fauna is high – in terms of richness (the number of different species).
Wildlife management is an important issue in rangelands.
Surface water availability in rangelands is poor to medium.
For 'pastoral' systems, communal rights apply to all of the practices reported.
The 'agropastoral' systems are under communal (organised) and open access (unorganised) regimes.
In the 'pastures' systems, land use rights are individual in just under half of the cases.
The market orientation of the different rangeland use systems differs considerably, and includes: meat, milk, cheese, blood, hides, honey, medicinal and cosmetic-producing plants (gum arabic, shea nuts, aloe etc.), charcoal, and draught animals for hire.
In all rangeland use systems, except the 'bounded with wildlife' system, off-farm income is usually less than 10% of all income.
For the characterization of the rangeland use systems, emergency feed and drought need to be considered.
Systems with the highest levels of mobility rely on rights and access to supplementary dry grazing grounds, usually integrated into the system.
Regulated fire can help control woody species and create space for grassland regeneration – but uncontrolled fires can destroy useful vegetation.

Box 3.7: Definitions of sustainable rangeland management and practices by WOCAT

Sustainable rangeland management *(SRM) is the use of rangeland resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term potential of ecosystem services.*

*An **SRM technology** is a physical practice on the land that controls land degradation, enhances productivity, and/or other ecosystem services within rangelands. A technology consists of one or more measures, namely agronomic, vegetative, structural, and management measures.*

*An **SRM approach** defines the ways and means used to implement one or more SRM technologies in rangelands. It includes technical and material support, involvement and roles of different stakeholders, etc. An approach can refer to a project/ programme or to activities initiated by land users themselves.*

3.2.1 Sustainable rangeland management technology groups

Following on from the definitions of SRM and of technologies (Box 3.7) and analysing the similarities and differences of the collected SRM technologies, it is possible to group the technologies according to their main focus in relation to three criteria: movement, forage and water availability. Thus the practices have been examined and the question asked: "what is the main technical focus?" and then the SRM technologies allocated within five groups. In some cases, a single practice may fall into two groups – where it was found to have two equally important focuses.

The documented practices were classified into the following SRM technology groups (TGs):

Enabled mobility (TG1) (including improved access): comprises practices that assist grazing over large areas or diverse zones to seek forage and water using traditional knowledge and innovations, or new technologies e.g. satellite image analysis, early warning systems at large-scale.

Controlled grazing (TG2) (including seasonal grazing): involves enclosures, physical or social fencing, rotations, grazing reserves (fodder banks), regulating grazing and mobility.

Range improvement (TG3) (including soil improvement): involves management of fire/ prescribed burning, firebreaks, enrichment planting, seeding of leguminous species, control of bush encroachment and alien invasive species, natural regeneration, soil fertility amendments (manure), erosion control, soil moisture (water harvesting micro-catchments), reducing evaporation losses.

Supplementary feeding (TG4) (including emergency feeding): may involve (a) fodder collection within or outside the rangeland areas: fresh fodder material, hay making, tree pod collection; (b) production or buying of processed or compound feed: silage, animal feed supplements (bales, pellets), urea and molasses blocks, minerals and salt licks, etc. Supplementary feeding can be applied for increased milk and meat production during normal years and as lifesaving strategy during emergency e.g. droughts.

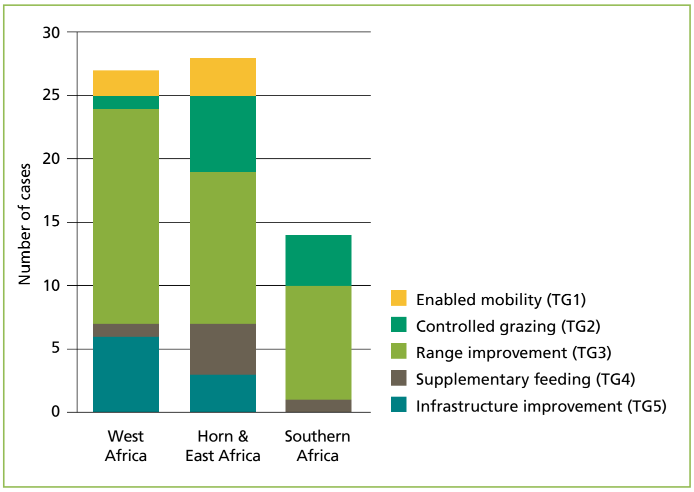


Figure 3.13: Distribution of SRM technology groups in SSA regions: West Africa, Horn & East Africa and Southern Africa.

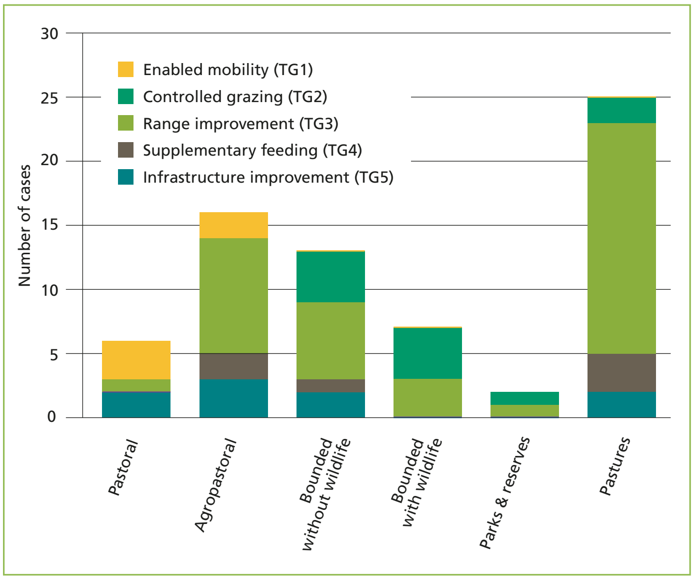


Figure 3.14: SRM technology groups represented in the different rangeland use systems (RUS).

Infrastructure improvement (TG5): includes the establishment of water points, wells, boreholes, ponds, pans and dams (macro-catchments), floodwater spreading, trenches, drinking water quality protection, livestock corridors, access roads and transport roads of animals and animal feed.

Note: the SRM technology groups above apply to livestock management but may also facilitate wildlife management

In the three SSA regions more than half of all documented SRM technologies (69) are characterized by 'range improvement' (Figure 3.13). One out of seven practices focusses on 'controlled grazing', followed by 'infrastructure improvement', 'supplementary feeding' and 'enabled mobility'. 'Enabled mobility' is missing altogether in Southern Africa – which is because there were no 'pastoral' systems reported from that region (see Figure 3.9a).

'Range improvement' practices dominate in almost all rangeland use systems (RUS) (Figure 3.14). 'Controlled grazing' is absent in the 'pastoral' and 'agropastoral' systems but is predominant in the 'bounded' systems, demonstrating that where space is limited, planning and small-scale settled pasture management are the key to improving rangeland management. Examples of 'Controlled grazing' in 'bounded without wildlife' systems are: (i) 'Split ranch grazing, Botswana' (page 165), which provides a full-year uninterrupted resting and recovery period for rangeland after grazing; (ii) 'Combined herding, Namibia' (page 173), where livestock from all households is combined every day into a single herd to be driven to different designated portions of the communal grazing area. An example of 'Controlled grazing' in 'bounded with wildlife' systems is the 'Lolldaiga Hills ranch, Kenya' (see Box 3.5) 'Supplementary feeding' has only been reported in 'agropastoral' (Box 3.8), 'bounded without wildlife' and 'pastures' systems (e.g. 'Supplementary fodder, Uganda', page 253) to guarantee that livestock has sufficient feed during dry periods or droughts. All other rangeland use systems have a built-in emergency strategy, where mobility allows access to emergency areas to search for fodder and water during droughts.

Further analysis of SRM technology groups is found in Chapter 4.2. Additionally, in Part 2, each group is distilled into a 2-page summary, entitled *"In a nutshell"*.

Box 3.8: Sustainable propagation of the fodder plant "*samata*" in Madagascar

In the semi-arid Mahafaly region in southwestern Madagascar, the local agropastoral population relies on livestock keeping. Possibly related to ongoing climate change with shorter rainy seasons and more droughts as well as increasing risks of cattle raids on the inland plateau, the return of the cattle herds to the coastal plain from their annual transhumance tends to start earlier each year. As a result, the grazing pressure on the fragile coastal vegetation increases. During the dry season, livestock keepers use the cut and latex-rich branches of a tree-like spurge locally named "*samata*" (*Euphorbia stenoclada*), an evergreen succulent, as a feed supplement for animals, especially for their zebu cattle. Propagation of "*samata*" through tree nurseries and compliance with recovery periods are important measures to sustain the local livestock system while reducing the pressure on natural vegetation.

https://qcat.wocat.net/en/summary/2154/; Liniger et al. 2017

(Johanna Götter)

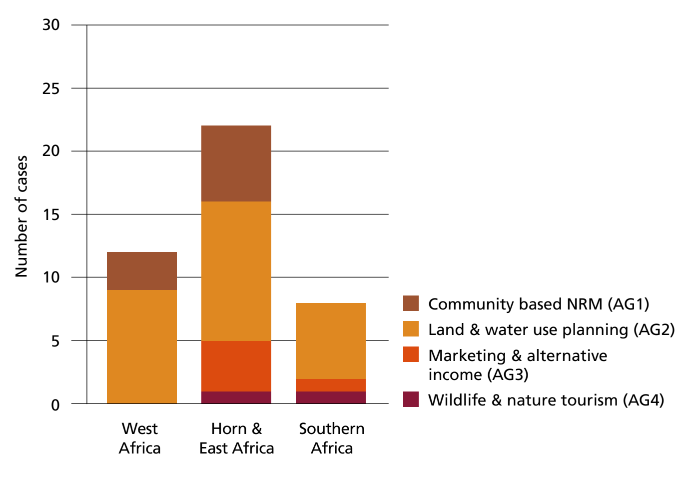


Figure 3.15: Distribution of SRM approach groups in SSA regions: West Africa, Horn & East Africa and Southern Africa.

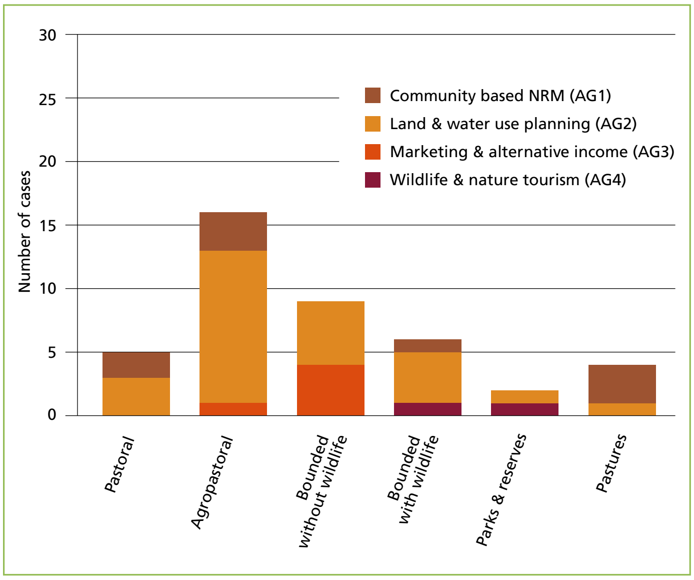


Figure 3.16: SRM approach groups represented in the different rangeland use systems (RUS).

3.2.2 Sustainable rangeland approach groups

The SRM approaches have been classified into four groups according to their main function. The three criteria used in this classification were the (i) scale of planning and intervention, (ii) market orientation and (iii) income generation.

The documented practices were classified into the following SRM approach groups (AG):

Community based NRM (Natural Resource Management) **(AG1):** involves community organisation, formation of savings groups and user groups to plan and govern improved management of the natural resources: vegetation, soil, water and animals (including land use planning at the small-scale).

Land & water use planning (AG2) (medium to large-scale): includes the establishment of concepts and management plans for conflict management, livestock and wildlife routes or corridors, set-up of water points, resting, rotation, facilitation of multi-level support, multi-stakeholder interaction and agreements, and support for improved medium to large-scale planning and implementation of rangeland practices.

Marketing & alternative income (AG3): promotes improved marketing to adapt the products and sales according to market information, through value chain development to shift to high-value (and origin-specific) labelled products (e.g. for 'naturally produced' grass-fed beef or game), to improve abattoirs and value of the meat; non-livestock rangeland products (NLRP), e.g. to legally produce charcoal, firewood, grass for thatching, fruits, nuts (e.g. for shea nut butter), gum arabic, medicinal plants, milk, and payment for ESS.

Wildlife & nature tourism (AG4): using and managing the "value of nature and wildlife" in parks, reserves and protected areas by providing and managing tourism and collecting revenues from tourists, protection of the land and animals against poaching or interference by other land uses and users.

In the Horn & East Africa almost half of the documented approaches, and in the other regions more than two thirds, fall into the group of 'land & water use planning'. One quarter of all cases are 'community based NRM' approaches, of which about two thirds are in the Horn & East Africa and one third in West Africa: there are none in Southern Africa (Figure 3.15). 'Marketing & alternative income' represent less than 10% of all cases, most from the Horn & East Africa. The group 'wildlife & nature tourism' constitutes only two cases, even though there are many known examples, especially in East and Southern Africa. In West Africa, examples pertaining to the SRM approach group 'wildlife & nature tourism' and 'marketing & alternative income' are missing, which does not mean that they do not exist – simply they are not common or widespread.

'Land and water use planning' predominates in all rangeland use systems, except for the 'pastures' system, where 'community based NRM' predominates (Figure 3.16). In 'agropastoral' systems, where crop production also plays a role, 'community based NRM' to some extent is also applied (e.g. 'Pastoralists field schools, Ethiopia', page 279). 'Marketing & alternative income' examples are mainly from 'bounded without wildlife' rangelands where a specialized market has been established and meat and milk are commercially sold e.g. 'NRT livestock to markets, Kenya' (page 351. One example of 'wildlife & nature tourism' was documented in the 'bounded with wildlife' system ('Holistic rangeland management and tourism, Kenya', page 359) and from 'parks & reserves' system ('Restoration of game migration routes, Namibia', page 367).

As with the SRM technology groups, further analysis of SRM approach groups is found in Chapter 4.2: additionally, in Part 2, each group is distilled into a 2-page summary, entitled *"In a nutshell"*.

Chapter 4

Sustainable rangeland management – drivers, impacts and continuous change

Rangelands have continuously undergone, and are still undergoing, changes – albeit at different rates and in different ways across the various regions of SSA. Although generations of rangeland users have lived with change, the current pace and scale is unprecedented (IIED and SOS Sahel 2010). The response from users has been to adapt livelihood strategies to cope with new political, economic, climatic and environmental forces – but the pace of this transformation has sharply accelerated in recent years (Krätli et al. 2014).

In order to identify causes of unsustainable practices and to help identify sustainable rangeland management (SRM) solutions, a conceptual framework is proposed to show drivers and impacts related to SRM (Figure 4.1). It focusses on drivers behind land management, their influence on the choice and implementation of rangeland management practices, on the health of the land and the resulting impacts on ecosystem services. This framework has, at its core, a cycle of changes and impacts where SRM is implemented. It illustrates that this is a dynamic process, where the impact of a land management practice in turn influences and changes its drivers. Thus, the altered drivers will lead to a different response, namely a change or adaptation of management, which in turn will have an influence on the state and impact – and so on. Additonally, the framework includes the interaction with external drivers such as global markets (for rangeland products, and rangeland ecosystem services including carbon sequestration), policies for conservation (e.g. support for protection of landscapes and animals), but it also includes the natural hazards of droughts and floods that are increasingly being brought by climate change.

4.1. Key drivers and shocks influencing SRM

Key drivers behind rangeland management (whether sustainable management or not) have been identified – those that influence policy and decision-makers, planners, investors, development agencies and land users in modifying (or maintaining) systems of land management. Table 4.1 provides an overview of these key drivers identified from the analysis of the SLM technologies and approaches and under discussion in current rangeland debates.

The drivers at global/ international level and local to national level can be divided into ecological, economic, political/ institutional and socio-cultural factors – and they are either enabling (stimulating) or hindering (constraining). Drivers at the global level, as well as external shocks (for example drought, pests and diseases, insecurity and conflict), have an effect at the local level and on rangeland users. However, since in most cases they cannot be effectively influenced by the rangeland users themselves, they have to be addressed by coping mechanisms.

4.1.1 Hindering and enabling environment

The analysis of approaches shows that the same condition (e.g. 'land governance') can constrain or stimulate an SRM practice (a specific approach or technology) depending on the situation and specific context (Figure 4.2a). For example, a law on rangeland use could support the implementation of a specific SRM technology, but the same law might hinder another. A comparison with the global WOCAT database – covering

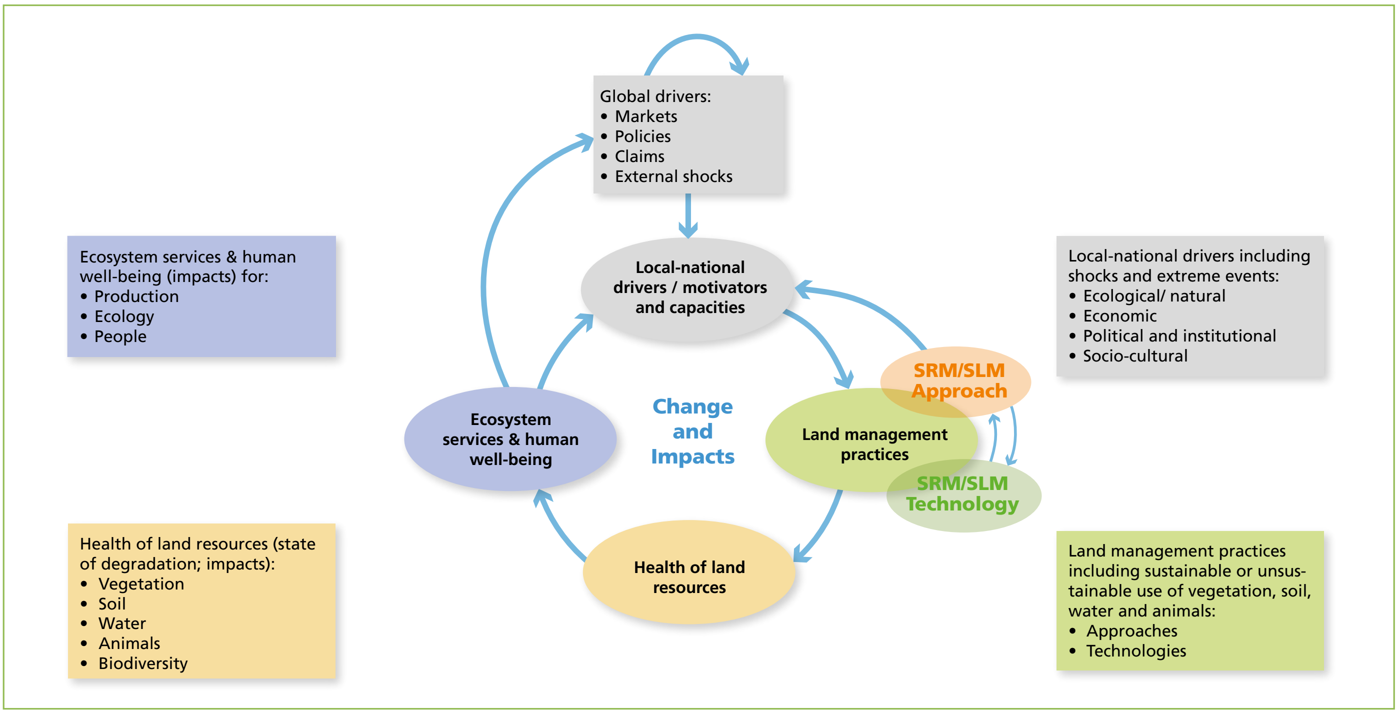


Figure 4.1: Proposed rangeland management framework (drivers-practices-health/ state-ecosystem services).

Table 4.1: Key drivers and shocks affecting rangeland management.

	Global/ international drivers	Shocks/ extreme events	Local – national drivers
Ecological	• claims on water (within trans-boundary watersheds) • claims for land (acquisition/ grab, nature protection)	• droughts, water shortage, pollution, floods, extreme rainfall events, volcanic eruptions • outbreaks of pests and diseases • fires	• changes in pasture biomass and quality • changes in water resources: rainfall, surface, groundwater • climate change • climate variability and change observed locally • diseases/ pests • wildlife interaction
Economic	• market for rangeland products • market for tourism	• market crashes	• market and access • alternative income (rangeland products, tourism/ wildlife) • access to financial resources and services
Political/ institutional	• transboundary policies • transboundary conflicts • land acquisition/ grab	• political instability • insecurity, wars • new laws, agreements	• legal framework: tenure, rights and land fragmentation • authorities and institutional setting • multiple claims • local – national governance: rules, regulations • conflicts and political unrest • infrastructure and services • interventions by development agencies
Socio-cultural	• transboundary migration of people and livestock	• outbreaks of ethnic and other clashes	• population change and migration • security and conflicts • livelihoods, poverty and market orientation • availability of manpower/ labour, and workload • norms and values • role of women, disadvantaged groups • knowledge, management capacity, and skills • collaboration and coordination of stakeholders

all land uses – shows that rangelands demonstrate similar hindering conditions: (lack of/ inadequate) 'knowledge about SLM', 'legal frameworks,' 'institutional settings' and 'social/ cultural norms' (Figure 4.2b). But, contrastingly, the same comparison indicates that rangelands are much more sensitive than cropland in relation to 'policies' (mentioned in more than 75% of the rangeland approaches compared with 8% of the global database), 'collaboration and coordination of actors' (68% / 4%), 'markets' (62% / 8%), 'land governance'(62%/ 8%), and 'workload, availability of manpower' (52% / 19%). It could be seen that, when the entire set of documented cases was analysed, these factors were mentioned much less often. Another clear difference is the specific mention of multiple factors enabling the implementation of SRM. In the global database (once again: covering all land uses and not only rangelands) it is only the 'legal framework' that is commonly mentioned as an enabling factor. These results highlight the fact that SRM is hindered by many more issues than other land uses; but also multiple factors are recognised as being favourable.

The most important hindering condition mentioned in the SRM approaches is 'policies' followed in importance by 'collaboration/ coordination of actors'. Misguided policies place straightjackets on rangeland management, by leaving little room for flexibility. Furthermore, rangelands with all the complex ecological and stakeholder interactions depend much more on collaboration and coordination of actors to be successfully managed. The same is true for 'land governance', 'institutional setting' and 'legal framework', all of which were mentioned as hindering the implementation of the technologies in more than 50% of the cases.

As shown in Figure 4.2a, socio-cultural acceptability, sufficient manpower, favourable policies, governance and legal frameworks, and access to markets for inputs and sales are preconditions for action. Any technology that reduces workloads – and with this requirements for labour – encourages diversification of investment and activities. Lack of knowledge and technical support, and financial resources, are also factors that strongly impede action. Often, exposure to new ideas and innovations, as well as training, trigger action and different kinds of financial support permit action in the first place.

Legal framework is mentioned amongst the top ranking factors as being hindering and/or enabling: whether it hampers or helps clearly depends on the specific nature of the legal framework. Even when rules and laws are in place, they are commonly not followed – as for example in 'Integrated approach, Tanzania'[1] and 'Initiative for animal water supply, Tanzania'[2]. Examples of an enabling legal framework are to be found in 'Community participation in GGW, Niger' (page 303), where securing access rights to land and water resources encourages investment in land restoration. The legal framework is also positive in 'Participatory mapping, Kenya' (page 311) and 'Joint village, Tanzania' (page 319). Tanzania's legislation, if implemented well, provides an enabling environment to secure community/ village rights for both individuals and groups. However, the same legislation allows village land to be transferred into public ownership if that is in the "public" or "national" interest: this then brings insecurity with respect to village land, and hinders SRM.

Depending on the technology to be implemented, funds ('availability/ access to financial resources') is often a limiting factor. However, where projects are involved, financial resources are invariably provided – either fully or partially – and hence this becomes an enabling factor, for at least as long as the project lasts. Social and cultural issues, as well as religious norms and values, are also named as hindering factors on the one hand, but contrastingly as enabling on the other. Examples are: 'Transboundary transhumance, Niger and Benin' (page 297), where the approach facilitates the arrangement of social agreements for securing land resources for livestock keeping, but there are still constraints related to the lack of knowledge by herders of the regulations on mobility across the border. 'Traditional pastoral management forums, Angola' (page 327) affirms that

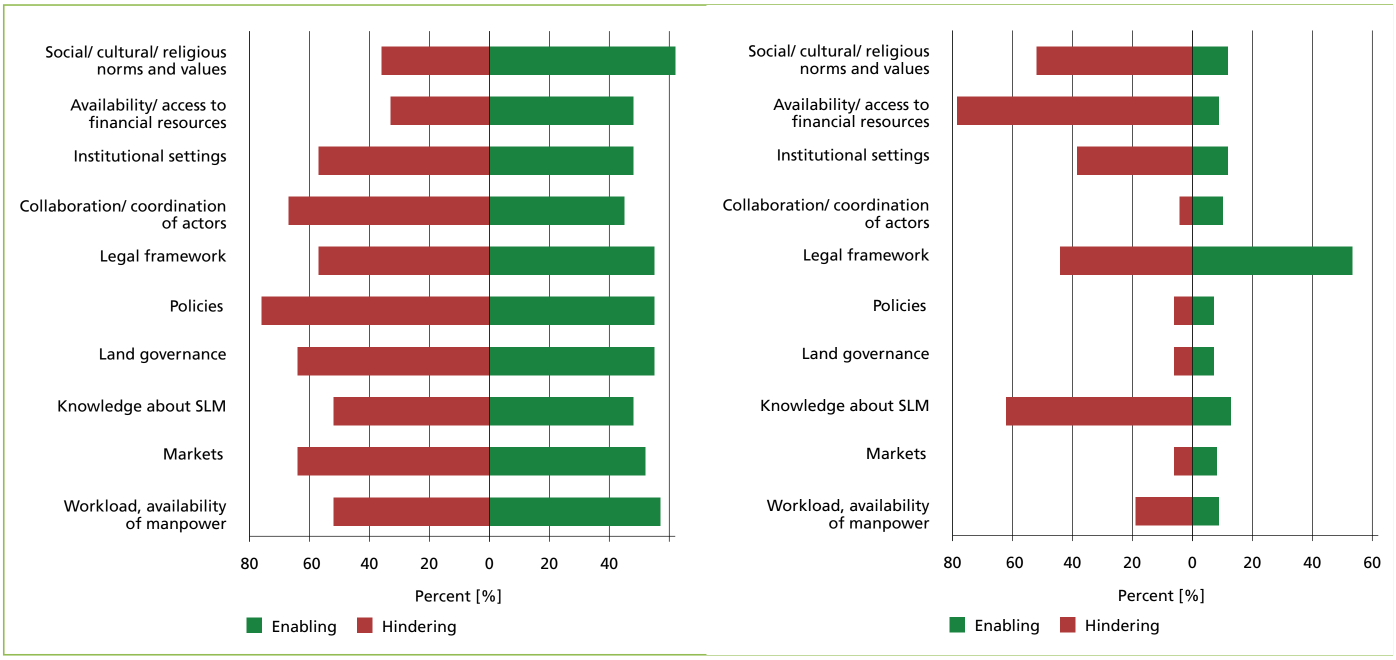


Figure 4.2: Enabling (green) and hindering (red) conditions for the implementation of the technologies applied under an approach in percent of total number of approaches. (a) over the 42 rangeland approaches (left) and, (b) over the 233 approaches in the WOCAT global database (right). Multiple answers are possible.

there is a clear understanding of the benefits of reactivating the traditional social structures and management systems. However, current cultural norms and socio-political systems hinder this, therefore adaptations need to be applied to make them viable under current conditions. 'Kenya Livestock Insurance Program (KLIP), Kenya' (page 337) shows that apart from being the main source of livelihoods, pastoralism is a cultural practice that has been passed on from generation to generation. Pastoralists aspire to protect their herds from all manner of perils, including drought. On the other hand, many of them believe that people should not interfere with God's will and doubt whether insurance is "halal" in the context of Islamic Shariah. Such challenges have been addressed by KLIP, through awareness creation and sensitisation in consultation with religious leaders, insurance companies and the local communities. In 'Bush control, Namibia' (page 229), norms and values are enabling factors, but the low level of cooperation and information exchange hinder its implementation. 'Joint village, Tanzania' (page 319) holds that the history of collective tenure, management and sharing of rangeland resources are part of SRM practices. However, marginalisation of pastoralists from decision-making processes at local and higher levels remains a hindering factor.

Take-home messages

SRM is hindered by many more issues than in other land uses; but multiple factors are also recognised as being favourable.

The most important hindering factors in over half of the documented practices are 'policies', 'collaboration', 'land governance' 'markets', legal framework', 'institutional settings', 'knowledge' and 'workload'.

If these multiple issues are addressed they can be turned into key enabling factors underpinning successful implementation of SRM.

4.1.2 Purposes for applying SRM

There are a wide variety of purposes cited for applying the technologies (Figure 4.3). Most of the SRM technologies (75%) indicate that taking action against land degradation is the main purpose – even above 'improve production' and 'create beneficial economic impact'. This is logical, since the practices described – especially those associated with projects – specifically address SRM. To be able to improve production, limiting factors such as land degradation have to be addressed first.

Around 20% of the cases mention 'adaptation to and mitigation of climate change', 'disaster risk reduction' and 'watershed protection' as specific purposes. These concepts may have been unclear to many respondents – or (in the case of watershed protection) not meaningful at the scale of the particular technology. Off-site impacts are, currently, not given adequate attention compared with on-site

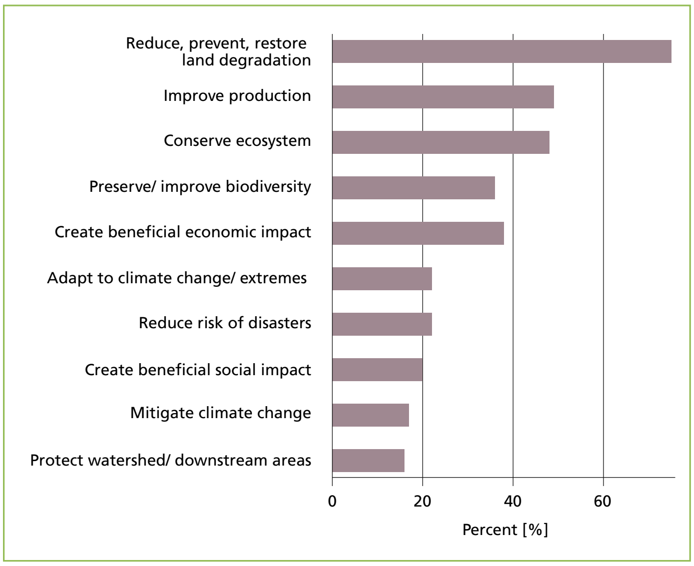


Figure 4.3: Main purposes cited for applying the technologies. Several answers possible per case.

[1] https://qcat.wocat.net/en/summary/2538/

[2] https://qcat.wocat.net/en/summary/2589/

effects, which are more immediately rewarding. On the other hand 'conservation of ecosystems' and 'protection of biodiversity' are evidently a real concern.

Take-home messages

Land users and specialist implementing SRM focus on the following key concerns in rangelands and related activities: addressing land degradation, improving production, conserving ecosystems, creating economic benefits and preserving biodiversity.

Many are also adapting to climate change and extreme events, mitigating climate change and protecting watershed and downstream areas.

4.1.3 Climate variability, change and extreme events

Analysis of the SRM technologies reveals the perceived drivers related to climate change that justify the adaptation or coping strategies offered by the particular technologies (Figure 4.4).

More than 90% of the cases report an increase in annual temperature, and more than 40% of cases a decrease in annual rainfall. A change in annual temperature increases evapotranspiration (higher loss of water from the soil surface, and a higher transpiration demand from the vegetation). Furthermore, as shown in Figure 2.2a, high temperatures can create heat stress, which interferes with plant growth and development. As the majority of rangelands are situated in the drylands, higher temperatures increase their aridity in most of Sub-Saharan Africa with major implications for productivity (Lovei et al. 2017, Serdeczny et al. 2017). The popular perception is that rainfall is decreasing across the rangelands. However, in Kenya, investigations in one dryland area generated long-term data that showed an increasing trend (Schmocker et al. 2015, Kihara et al. 2015, Zougmoré et al. 2018), despite the perception of land users that rain was becoming less. This apparent contradiction could be attributed to the reduced response of the land to rainfall, implying that despite the same, or better, rains the land appeared no greener – due to increased evaporation and greater runoff losses associated with degradation. These losses of water can be further exacerbated by a proven trend of increasing rainfall amounts and intensities within single storms and longer dry spells within rainy seasons (see Box 2.1). Of course, it might also be explained by the fact that people, by nature, tend to be pessimistic about the climate.

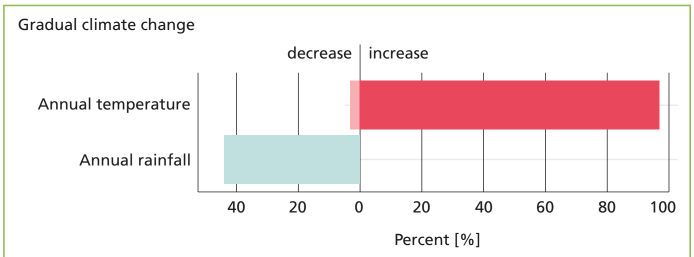


Figure 4.4: Percent of all technologies perceiving gradual climate change over the last 10 years.

In the last 10 years, 'droughts' are perceived as the most important and increasing climate extreme in the locations where SRM is practiced (>60%) (Figure 4.5). This trend is confirmed by the drought frequency map (see Figure 2.4). Sub-Saharan Africa in general will have to deal increasingly with, and adapt to, drought incidences and lengths in the future. The second most important climate extreme mentioned is 'local rainstorms' (more than 40%). Change in rainfall regimes and intensities were perceived

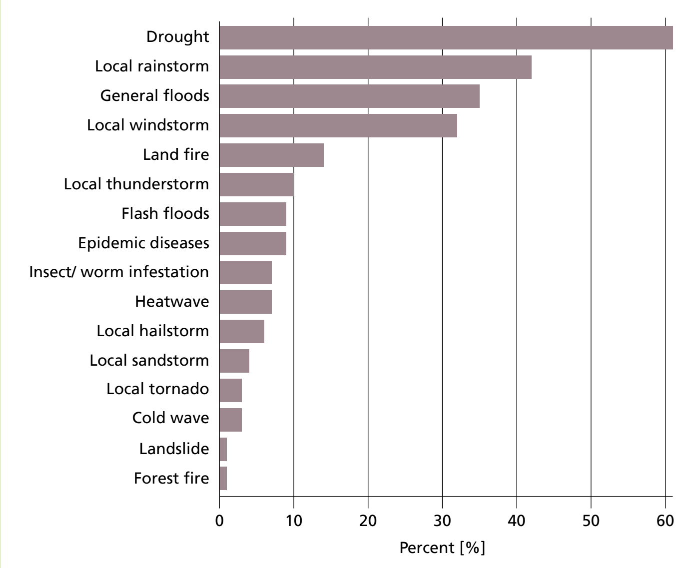


Figure 4.5: Climate-related extremes and disasters observed in the last 10 years where the technologies are applied.

to increase 'general floods' (30%), 'flash floods' (9%) and 'local hailstorms' (6%) – indeed all can be devastating when they occur in drylands. 'Local windstorms' (32%) and 'sandstorms' (4%) were also said to be increasing. Often combined with drought and heatwaves (6%), this can exacerbate 'land fires' (14%). Livestock disease in general ('epidemic disease' 9% and 'insect/ worm infestation' 7%) are relatively seldom mentioned as problems. Agricultural Sector Risk Assessment from Senegal are presented in Box 4.1. All these climate-related extremes and disasters can be considered as external shocks to land use and management.

Box 4.1: Senegal – agricultural sector risk assessment

In Senegal a risk assessment and prioritisation survey showed that the main risks in the livestock sector based on severity, frequency and impact ranks were: risks associated with bush fires (ranked 1st), followed by risks linked to animal health and diseases (2nd), rainfall (3rd), markets (4th), conflicts (5th) and plagues of locusts (ranked 6th and last) (Wane et al. 2016).

The impact of climate change is likely to lead to systemic changes in the Sub-Saharan rangelands, the nature and magnitude of which is currently only poorly understood. The projections with respect to growing aridity do not look promising for most of SSA. Increased aridity will inevitably put more stress on the rangelands, its resource – and its management (see Figure 2.5). The main strategies to cope with the impacts of climate change at local level are forms of adaptation through avoiding impacts or building resilience. Mitigation of climate change can only help at a regional or global level: nevertheless many adaptation measures simultaneously confer a degree of mitigation (see Chapter 5.2).

Take-home messages

Climate change, and climate-related extreme events are serious issues to be addressed in SRM

Thus a major aim is to increase the resilience against shocks and extremes: first and foremost are drought, floods and wind storms.

4.1.4 Markets, finances, infrastructures and services

Marketing diversity of livestock and non-livestock rangeland products: In the drylands of SSA, production systems are centred on the rearing and marketing of livestock and animal products. Some practices include commercialised forms of livestock-keeping oriented to large domestic and regional export markets, and smaller scale livestock-keeping for subsistence and local marketing combined with crop production and other rural activities. However, these systems are often complemented by a broad range of non-livestock livelihoods and productive activities. Not all rangeland user focus on animals alone – "non-livestock rangeland products" (NLRP) including the service sector (for tourism), and both cosmetic and medicinal produce, constitute a growing part of a wider political economy in the drylands (see Chapter 2.1.3).

Accessibility to attractive markets for buying and selling of livestock: Despite livestock production being key in SSA, markets for livestock in the region are faced with significant price disincentives. These disincentives arise from issues related to market inefficiencies, such as exploitation by middlemen, high transport costs, government taxes and fees imposed on cattle trekkers, lack of market infrastructure, financial and technical service constraints, and inadequate market information system (Aklilu 2002, Ahuya et al. 2005, Muthee 2006, Makokha et al. 2013). Given the challenges facing livestock markets and rural households to improve their livelihoods, rural households are likely to explore the possibilities of more profitable uses such as conversion to crop farming, land leases, or sales to immigrant crop farmers (Markelova et al. 2009).

Fair prices for all rangeland products: The ability of rangeland users to raise their incomes also depends on their ability to compete effectively in the market. For example in the approach 'NRT Livestock to Markets, Kenya' (page 351) a local, equitable and reliable market for a large number

Box 4.2: Mugie resource sharing and livestock to markets programme, Kenya

Mugie conservancy is a private company covering nearly 20,000 hectares. It is involved in ecotourism, wildlife conservation and livestock production. Selected livestock are bought from the communities, then fattened and marketed by the Mugie conservancy management on a 'resource sharing' basis – generating income for both the conservancy and the community. This encourages the development of local value chains and market-based incentives for better rangeland management and animal husbandry outside the conservancy area.

https://qcat.wocat.net/en/summary/3762/

(Henry Bailey)

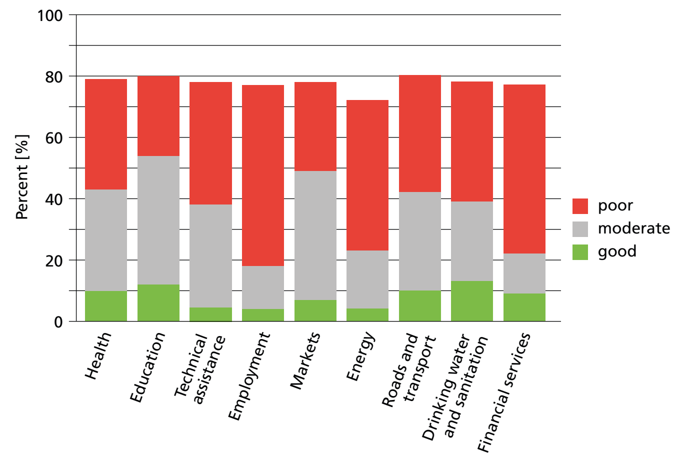


Figure 4.6: Access to services and infrastructure where the technology is applied.

of cattle has been provided to build resilient livelihoods for local pastoralists. The model works to first buy cattle from NRT-affiliated conservancies, these cattle are sold on weight and grade. It attempts to embrace a more market-driven approach. Another example of a livestock to markets programme is presented in Box 4.2.

Access to financial resources and services: For large landscape 'pastoral' and 'agropastoral' systems, livestock represent, overwhelmingly, the most important form of financial capital for pastoralists. They are the primary source of pastoral income, savings, loans, investments and insurance. Social networks assist in sharing, buffering and minimising risks related to this single-asset economic system under such uncertain conditions. Threats to the herd or to the clan are therefore serious blows to pastoral financial capital. Variations in market prices and problems also represent major financial threats. Lack of access to other sources of income – such as government employment – can also be perceived as evidence of injustice, as the Touareg rebellion in the 1990s attested (Nori et al. 2005). For 'bounded' and 'pastures' systems privately owned ranches and farms have more opportunities for access to financial resources.

Access to Infrastructure and services: According to the analysis in Figure 4.6, 'employment' and 'financial services' are poor and are seen to be the most pressing issues constraining the implementation of SRM. Only around 4 to 12% considered the situation of infrastructure and services to be good in the areas where the technologies are applied. Availability of 'drinking water and sanitation', 'education', 'health' and 'roads and transport' were rated slightly better than financial and technical assistance, or access to markets and opportunities for employment.

Take-home messages

Even though access to markets and improving marketing are a key factor in SRM – either hindering or helping – only a few documented practices have addressed and improved the market situation or facilitated access to financial resources. This needs further attention.

Infrastructural services in rangelands are only rarely considered good. Improvements in infrastructure are a prerequisite for the future of SRM.

4.1.5 Policies, claims, tenure and rights

As noted already, polices – or their absence – hinder the implementation of SRM in 75% of the practices analysed under these guidelines, though in 55% of cases they were seen to enable implementation (note: in some case various policies had different effects, thus the total adds up to more than 100%). Lack of policies, existing policies not effectively implemented, or new policies that are in direct contradiction to traditional and customary systems and not consistent with the needs of different rangeland users, all hinder SRM. Two critical issues underlie the problem of missing policies: a knowledge gap and power imbalance. Lack of knowledge hinders an objective view of the merits and demerits mainly of existing pastoral systems, while the power imbalance is responsible for pastoral people not being sufficiently organised and therefore unable to advocate their arguments (ODI 2009).

National and transboundary policies

Policies are not just applicable locally or nationally: international transboundary agreements are increasingly needed to regulate rangeland use across different countries. The reduction and hindrance of transboundary movements and livestock corridors has served to stimulate the creation of various pastoral codes at national and sub-regional levels, supported by clear land use rights (AU-IBAR 2015). In recent years, a number of pastoral laws or "codes" have been introduced defining pastoralists' rights in several countries. These laws recognise mobility as a key feature of the large landscape 'pastoral' and 'agropastoral' systems. However, these laws have a spin-off on the 'bounded, 'parks & reserves' and 'pastures' systems. Implementation of the laws and codes has often lagged behind, however, constrained by cumbersome bureaucracies and weak enforcement mechanisms (de Haan and Cervigni 2016). The African Union has also developed its "Livestock Development Strategy for Africa 2015 – 2035". However, here the prevailing trend is towards commercialisation; some call it 'modernisation' in livestock production (AFSA 2017).

Although policy direction is important, implementation of policies is a fundamental problem. With increased political presence and lobbying, stronger laws centred around good grazing management structures may emerge. However, much of the movement to preserve pastoral rights and the sustainable management of rangelands is encouraged through civil society organisations or local government, without the backing of national policy or law. Different regions are now considered in the following.

West Africa
Several Sahelian countries have passed pastoral laws or codes that support mobility and cross-border transhumance and define the rights of pastoralists, including Mauritania (2000), Mali (2001), Burkina Faso (2003), and Niger (2010) and the Economic Community of West African States (ECOWAS) Decision A/DEC.5/10/98 and Regulation C/Reg.3/01/03 (Dyer 2008).

The *'code pastoral'* (pastoral code) of Niger attempts effective regulation of pastoral production on rangelands. However, there are reservations that this pastoral code of Niger, meant to regulate rangeland management in the mainly pastoral areas, has not been effective, and was implemented too late (Oxby 2011). On the positive side however, pastoral codes: (i) give herders rights over the common use of rangelands and priority rights over resources in their "home areas"; (ii) provide greater recognition of customary tenure arrangements; and (iii) reduce the need to manage conflict at the local level. Niger's pastoral code recognises that: "mobility is a fundamental right of herders and transhumant pastoralists". Rights in pastoral lands generally remain precarious and are not recognised by many institutions (HLPE 2011), especially those rights that govern the strategically important areas of lowlands, riparian zones, valleys and wetlands, forests, and pastoral reserves (Ickowicz et al. 2012). For example the approach 'Transboundary transhumance, Niger and Benin' (page 297) aims at the appropriation and application by the multiple stakeholders of the community legislation on transboundary transhumance – as adopted by the Economic Community of West African States (CEDEAO). Issuing International Certificate of Transhumance (CIT) help to create the conditions for conflict-free access to resources for livestock keeping in Niger and northern Benin.

East Africa
Several efforts have been made by implementing projects and programmes to promote the use of the African Union (AU) Policy Framework on Pastoralism, the Framework and Guidelines on Land Policy in Africa, and the Voluntary Guidelines on the Responsible Governance of Tenure as key reference documents for pastoral policy development.

Issues that need to be addressed as priorities are improved tenure security, a closer role for pastoral communities in rangeland management, equal access to pastoral resources for women and other vulnerable groups, the establishment of processes for the resolution of cross-boundary disputes, and improved resource-use technologies and promotion of participation of pastoral communities in decision-making processes (African Union 2013).

In Kenya, the most recent policy change, with the acknowledgment of community land in the national Constitution and the adoption of the Community Land Act (2016), provides positive direction for the management and tenure of the remaining community grazing areas. Within the act there is provision for the sustainable management of grazing, while encouraging broader movement of pastoralists within and between community areas through reciprocal grazing agreements among communities. In addition, the Wildlife Act of 2013 includes provision for wildlife conservancies, which across much of Kenya have been a key tool in encouraging the improved use of natural resources, including grazing management. However, despite recent strides, much of Kenya's broader strategies and policy direction relating to country-wide development, such as the National Land Strategy and the LAPPSET (Lamu Port, South Sudan, and Ethiopia Transport Corridor) developments, do not acknowledge the importance of pastoralists and livestock production for the local or national economies. Under these plans, many pastoral areas are labelled as 'undeveloped' and embrace large-scale planned infrastructural and development projects (Mwangi and Ostrom 2009).

In Uganda, national policy has taken strides towards supporting pastoral production systems, yet the implementation and detail is missing. For example, the current government has effectively subsidised the conversion of rangelands into agricultural areas through the provision of free tractors and materials to farmers. There is some positive policy in Uganda: Section 47 of the National Environment Act (1995), for example, provides for the sustainable management and use of rangelands, and The National Land Policy (2013) provides for the establishment of appropriate agro-ecological zones, pastoral resource areas and maintenance of an equitable

Box 4.3: Transfrontier conservation areas: 'Peace Parks'

Transboundary collaboration is becoming increasingly important as evidenced by the increased number of Transfrontier Conservation Areas (TFCAs) and transboundary protected areas (TPAs) throughout Africa (for example in the Great Lakes Region), extensive transborder ecosystems (West-Arly-Pendjari Ecosystem (Burkina Faso, Niger, Benin); Karamoja Ecosystem (Uganda, Kenya, Ethiopia and Sudan), and the Somali Ecosystem (Somalia, Ethiopia, Djibouti, and Kenya) and transborder wildlife conservation initiative such as the Serengeti-Maasai Mara Ecosystem (SMME) (AU-IBAR 2015) and Kavango-Zambezi Transfrontier Conservation Area (TCA) (Angola, Botswana, Namibia, Zambia and Zimbabwe).

The Southern African Development Community (SADC) Protocol on Wildlife Conservation and Law Enforcement of 1999 defines a TFCA as "the area or component of a large ecological region that straddles the boundaries of two or more countries, encompassing one or more protected areas as well as multiple resource use areas". The Protocol commits the SADC Member States to promote the conservation of shared wildlife resources through the establishment of transfrontier conservation areas.

"I know of no political movement, no philosophy, and no ideology which does not agree with the peace parks concept as we see it going into fruition today. It is a concept that can be embraced by all. In a world beset by conflict and division, peace is one of the cornerstones of the future. Peace parks are building blocks in this process, not only in our region, but potentially the entire world." Nelson Mandela, 1997

http://www.peaceparks.org/story.php?pid=100&mid=19; https://www.peaceparks.org/about/our-journey/

West – Arly – Pendjari, whc.unesco.org (Namoano Georges, © Parc National d'Arly).

Kavango Zambezi Transfrontier Conservation Area (www.kavangozambezi.org).

balance between use of land for pasture and agriculture. However, this has not yet been implemented under the National Development Plan (Byakagaba et al. 2018).

In Tanzania, policy and legislation differ over the rights and importance of pastoral production and livelihoods. The National Strategy for Growth and Reduction of Poverty (2004) acknowledges pastoralism as a livelihood, and encourages efficient utilisation of rangelands resources – empowering pastoral institutions. However, other policy, such as the Rural Development Strategy (RDS) 2001, pushes for the sedenterisation of pastoralists. In addition, more recent policy, such as the National Livestock Policy (2006), under Vision 2025, urges the commercialisation of livestock production in the pastoral sector. This has also encouraged sedenterisation and individual pasture ownership. Additionally, *Kilimo Kwanza* ("agriculture first"), the Tanzanian plan to transform the agricultural sector has little support for pastoral management of rangelands. Furthermore, governmental initiatives to confiscate cattle from Kenyans in northern Tanzania, coupled with the registration of Tanzanian pastoralists, may further reduce mobility and decrease pastoral resilience.

Southern Africa

Policies (and to some extent, legislation) can be in direct conflict with the customary systems of management upon which rangeland management is based. Control of access to, and management of, dryland resources under traditional institutions has, over time, been weakened mainly by unsupportive national policies.

International regulations, such as those imposed on import of beef into the lucrative EU market, have resulted in the erection of veterinary cordon fences that disrupt wildlife migration and have contributed to rangeland degradation. This is further exacerbated by the carving up of communal land into leasehold ranches and the segregation of land use into well-intentioned but poorly thought-through zoning as part of land use planning. On the positive side, the partial devolution of wildlife and forest resources to conservancies and community forests has reinstated some incentives for improved management of natural resources.

Rangelands span local and national political boundaries, necessitating sharing of resources and ecosystem services. This implies the crucial need for integrated land use planning at various scales and links to be drawn with transboundary agreements.

Transboundary natural resource management is important, not only in promoting sustainable natural resource management, but also for stronger regional and subregional integration and cohesion, as well as reducing cross-border tension: hence the alternative name of 'Peace Parks' (used especially in Southern Africa). The core purpose of the Peace Parks Foundation is to enable a balance or harmony between conservation and consumption, between man and nature (Box 4.3).

Multiple claims and land acquisitions/ 'land grab'

Increasing pressure on rangelands from internal and external investors and the diversity of interests between various

Box 4.4: Jatropha as a biofuel

Between 2005 and 2009, there was keen global enthusiasm for the shrub jatropha, which many investors, government actors and NGOs perceived as a 'miracle' crop. The reason was simply that plant-based alternatives were looked upon as the answer to shortages of fossil fuels: these were the "biofuel boom years". Thus jatropha was ideal: rich in hydrocarbons, it thrived in dry environments and could readily be processed into biodiesel. Plantations were established on a large-scale in Kenya, Mali, Mozambique and Tanzania. Ghana generated a great amount of interest too. Here, a number of private companies were ready and eager to make substantial investments in jatropha farming. Indeed Ghana was set to host a million hectares of plantations under agreements between the government and foreign-owned companies. But, as with many such speculative enterprises, the sector collapsed – failing to realise the initial over-optimistic projections. A start was made, but unforeseen hurdles and barriers proved insurmountable. The lands acquired through the traditional authorities and Ghanaian middlemen were fertile lands that were, in most cases, under active use by the community for grazing and crop farming: thus conflict could not be avoided. Furthermore, very considerable initial capital was needed, high volumes had to be rapidly achieved, and to compound this, the global financial crisis of 2008 led to many investors pulling out due to lack of funds and fears of volatile oil prices. Low levels of learning and knowledge-sharing between jatropha niche actors in the country, alongside weak public R&D support, reduced access to locally specific technical and managerial information. Rather than land users being involved they were alienated. All-in-all the jatropha 'mirage' in Sub-Saharan Africa proved to be a salutary lesson in how not to develop the drylands.

Nygaard and Bolwig 2017; http://news.trust.org//item/?map=jatropha-biofuel-push-in-ghana-runs-up-against-protests; https://beahrselp.berkeley.edu/blog/land-grabbing-and-jatropha-boom-in-ghana/

12-months-Jatropha plantation – Smart Oil (Pietro Fabeni).

Jatropha seeds from Ghana (Jatrophaworld.org).

actors at various levels, and between interests in conservation (for 'green' purposes) and exploitative investments, can lead to conflicts and constraints on rangeland management (Box 4.4). Of all the concluded agricultural deals in Africa, 70% are in SSA, out of which a substantial share is in the rangelands (see Chapter 2.1.5). This underlines the importance of large-scale land acquisitions as a driver of land use change in the rangelands.

The loss of large parts of the rangelands to outside players represents a systematic, increasing, weakening and fragmentation of pastoral systems that has important consequences well beyond the pastoral economy as such (Krätli et al. 2014).

Tenure, rights and land fragmentation

Figure 4.2a shows that around 55% of the documented approaches consider land tenure and rights ('legal framework') as enabling and 58% as hindering to the implementation of SRM technologies. In a particular context, certain rights can be both beneficial and adverse – for example in 'Restoration of game migration routes, Namibia' (page 367) on the one hand rights to benefit from wildlife are enshrined in the Nature Conservation Ordinance of 1975 but on the other hand the very same Ordinance disallows the registration of private nature reserves.

As noted previously, land and water use rights can be an important driver behind implementing, or not taking up, a technology. An example that shows where such rights can enable implementation is 'Social Tenure Domain Model (STDM), Kenya' (page 141), where innovative mapping tools are used to assess different tenure systems.

An example where lack of rights hinders implementation is: 'Mugie Livestock to Markets, Kenya' (see Box 4.2). In this case, laws encourage sub-division of rangelands into small units that are unviable in terms of maintaining essential ecosystem services or economic use. The 'Chyulu Hills Community REDD+, Kenya'[3] highlights the problem of management of different parts of the landscape by various authorities following different laws: this leads to confusions and conflicts that hinders the implementation of SRM.

Land use rights documented are mainly communally organised (35%) followed by individual/ rights (31%) (Figure 4.7). Water use rights are mainly communally organised (31%) with open access unorganised use rights a little less (21%). According to Figure 3.12, most of the individual (and leased) land use rights are found in 'small-scale settled pastures', as well as 'agropastoralist' systems.

Due to an increase of multiple claims over rangelands, compounded by increasingly limited resources, land and water use rights play a key role in enabling or hindering implementation of SRM. There are basically two categories of rights: formal/ legal rights and informal/ customary rights. In some situations these two rights are in conflict. Efforts to harmonise the two – e.g. by formalising customary rights – can remove obstacles to successful spreading of SRM: see for example the technology 'Dedha grazing system, Kenya' (page 149). Another example of formalising customary rules is the effort to ensure wide dissemination of community legislation governing the management of transhumance practices, and thus enabling conflict-free and sustainable access to resources for livestock keeping, as

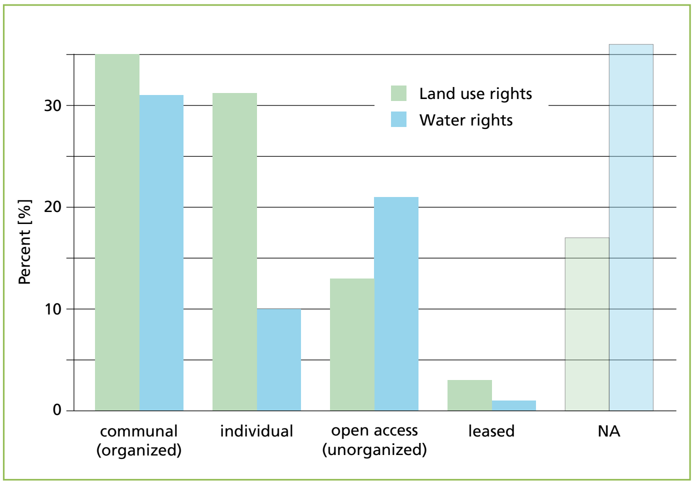


Figure 4.7: Land and water use rights where the technologies are applied in percent of total number of technologies. Several answers possible per documented technology. NA = data not available.

described in the approach 'Transboundary transhumance, Niger and Benin' (page 297). Furthermore, due to the highly variable and unpredictable availability of rangeland resources, inbuilt adaptive flexibility plays a key role: for example special arrangements for different seasons and for emergency situations (typically, extreme droughts).

The context of many pastoral societies in SSA is changing and so is the role of women in these societies (Flintan 2011b). In many instances, changes to pastoral communities, for example those based on greater commercialisation, further marginalise agropastoral female livestock keepers (Esenu and Ossiya 2010). However, the role and resource rights of women are being increasingly accommodated in new laws and codes with the aim of removing gender bias as an obstacle to change.

- Under the new Kenya Land Act, gender equity is a given right and protects women's access to matrimonial property and land. Within the same law, women can also inherit land from their parents (previously, only male children were entitled to inherit property) and contributions to accrual of property including non-monetary contributions is now taken into account during divorce. Under the Community Land Act, 2016 also in Kenya (where many rangelands fall under communal management), gender discrimination is not permitted. Through marriage, men and women gain automatic membership to the community, and thus to community resources, which only ceases in case of divorce[4].
- The Ethiopian National Action Plan for Gender Equality 2006-2010 (MoWA 2006) identified severe gender inequalities especially in pastoral and agropastoral societies. The plan called for specific measures to increase gender-balanced representation within the political and public sphere with special attention to women in pastoral regions.
- The African Union's policy document on pastoralism is the "Policy Framework for Pastoralism in Africa". Strategy 1.5 specifies that the role and rights of women in pastoral communities is to be strengthened (African Union 2010).

The absence of clarity with respect to land and water rights, government policies on sedentarisation, and the trend towards land privatisation, all encourage settled systems that lend themselves to crop production and more intensive forms of livestock keeping within integrated systems, in place of traditional mobile pastoralism (Woodhouse 2003, Sonneveld et al. 2010, Awgachew et al. 2015). Land titling is favoured by many current global development cooperation efforts, leading to fencing and fragmentation (Lovschal et al. 2017).

Common types of fragmentation – all of which transform habitats – include residential and urban development, establishment of ranches, commercial/ large-scale agriculture, conservancies, small-scale agriculture and perhaps unexpectedly, encroachment by invasive plant species (Flintan 2011a), for example *Prosopis spp* in Kenya, Ethiopia, Somalia and Sudan[5] (see Box 4.10 Woody Weeds). Agriculture compartmentalises rangelands by introducing fences and water channels and by utilising dry season grazing lands as farms (Kariuki et al. 2018). Land fragmentation is a direct threat to both wildlife conservation and pastoral mobility (AU-IBAR 2015).

Pastoralists sometimes encourage land subdivision when they want to protect their land from agriculturalists and conservationists, or when there is uncertainty over the leadership and effectiveness of communal land tenure. The outcome of land privatisation is a decline in exclusively pastoral systems, increased sedentarisation and livelihood diversification (Kariuki et al. 2018).

In the Sahel, settled families have increasingly privatised resources, putting more pressure on herders, while in East Africa there is growing subdivision of rangelands – 'landscape fragmentation' – that has led to declines in wildlife and livestock numbers (Mwangi 2009, AU-IBAR 2015). The impact of these trends has been to increase conflicts, impoverish herders and has led to further degradation of the environment (AU-IBAR 2015).

Take-home messages
A series of policies and pastoral laws have been approved and in general they support SRM. Implementation should focus on adherence to the laws and the proper interpretation and implementation in practice.
Efforts to clarify and formalise customary rights and harmonise them with formal legal rights are rewarding in terms of SRM
The issue of mobility against sedentarisation must be continuously addressed and questioned.
Multiple and especially transboundary claims over rangelands need to be addressed and solved to avoid pastoral use becoming increasingly marginalised
Land grabs must be addressed and reduced in the rangelands.
Tenure, land and water rights are a key challenge to SRM: clarity on tenure and rights and finding practices that work well is the starting point.
Care must be given where different tenure and rights – communal, individual or open access – apply to separate parts of the rangelands.
Due to increasing claims over rangelands, compounded by decreasing resources, land and water use rights play a key role in enabling SRM.
A critical issue regards droughts and the need for emergency grazing grounds or access to fodder supply and /or fair markets to sell animals.
The role and rights of women are increasingly being accommodated in new laws and codes. Nevertheless, gender bias needs further attention.

[3] https://qcat.wocat.net/en/summary/3426/

[4] http://kenyalaw.org/kl/fileadmin/pdfdownloads/Acts/CommunityLandAct_27of2016.pdf

[5] http://satg.org/wp-content/uploads/2017/11/Prosopis_Updated_Final2.pdf

4.1.6 Population, migration, conflicts and livelihoods

Population increase and migration

The growing population, and current levels of malnutrition, in most African states will require a massive and continuous increase in agricultural production over the coming decades (see Figure 2.6). There is an expected population growth of 3% per year for pastoralists and 2.5% for agropastoralists, assuming the same ownership patterns, and based on a "business-as-usual" scenario characterised by current policies (de Haan and Cervingi 2016). Touré et al. (2012) recorded an increase in the overall rural population of the West African drylands of 2.4% per year between 2005 and 2010. Almost all countries in Sub-Saharan Africa need to increase agricultural production. Land shortages are one inevitable consequence, where farming communities "spill-over" into rangeland areas in search of cropland (Liniger et al. 2011). Thus crop production is encroaching into rangelands together with rapid urbanisation, which often occurs on the best alluvial land, alongside perennial water sources. If rangelands remain marginalised, with marginal services, and marginal opportunities – the younger generation will simply move away, leaving women and older people behind. Therefore, even if population density does not increase as predicted, the composition of people in terms of age and gender will continue to alter throughout the entire Sub-Saharan rangeland crescent. This is a strong driver of change with respect to land use and its management.

It is often assumed that migration from rural to urban areas and the resulting concentration of populations in cities will ease the pressure on natural habitats. In many remote parts of SSA's rangelands, out-migration and subsequent concentration of people in urban areas has indeed reduced populations, thus leading to reduced rates of resource use: but closer to rural centres (with better infrastructure) and urban areas, the population of rangelands is still growing. Furthermore, land speculation by wealthy urban residents – encouraged by lack of land-use planning and control – has also driven the loss and fragmentation of rangelands close to towns and cities in Ethiopia, Kenya, and Uganda. In West Africa, the increased demand for food in cities has incentivised some groups to convert forests to agricultural fields to meet this demand. These examples underline the fact that any relief from pressure on habitats from rural-urban migration may be overtaken by the increased demand for food and other natural resources from rapidly growing African cities (Güneralp et al. 2018).

Figure 4.8 demonstrates that internal climate migration is likely to increase in Sub-Saharan Africa under three climatic scenarios – due to lower water availability and crop productivity, alongside rising sea level and storm surges. Two factors may be driving this. First, Sub-Saharan Africa is particularly vulnerable to climate impacts, especially in already fragile drylands and along exposed coastlines. Second, the region's agriculture sector, which employs a significant portion of the labour force, depends on rainfall for almost all its crop and livestock production (Rigaud et al. 2018).

In East Africa, where aridification is predicted to remain stable, or to decrease, due to increasing rainfall (see Figure 2.2b, Figure 2.5 and Table 2.1), pastoral and rangeland areas, as well as semi-natural and wildland areas may see climate in-migration owing to improved water availability. This will potentially lead to spatially concentrated climate migration hotspots. The south-eastern highlands of Ethiopia may also be an in-migration hotspot. Increasing population in these already densely populated and mostly semi-arid to arid

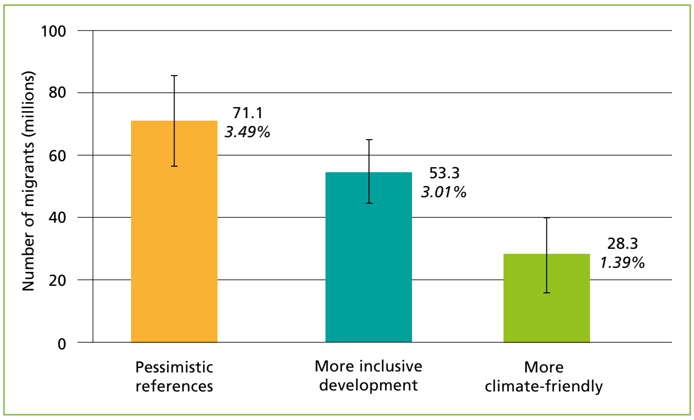


Figure 4.8: Projected total numbers and shares of internal climate migrants in Sub-Saharan Africa under three scenarios by 2050: "pessimistic reference scenario" (high greenhouse gas emissions combined with unequal development pathways); "more inclusive development" (similarly high emissions, but with improved development pathways); and "more climate-friendly" (lower global emissions combined with unequal development) (Rigaud et al. 2018).

areas will thus require substantial adaptation interventions in rangeland management to ensure sustainability (Rigaud et al. 2018). For the remaining part of Sub-Saharan Africa aridification is predicted to increase re-enforcing pressures on outmigration.

Labour and workload

In more than 50% of the approaches the higher workload and lack of manpower are reported as hindering SRM, while 45% actually cited a reduction of the workload and associated need for manpower under the new technology/ies as being an enabling or stimulating factor (see Figure 4.2a). Often cited reasons for labour constraints are out-migration and HIV-AIDS.

Sub-Saharan Africa is home to only 12% of the global population, yet accounts for 71% of the global burden of HIV infection[6]. East and Southern Africa is the region hardest hit by HIV. Countries mostly affected are South Africa (25%), Nigeria (13%), Mozambique (6%), Uganda (6%), Tanzania (6%), Zambia (4%), Zimbabwe (6%), Kenya (6%), Malawi (4%) and Ethiopia (3%)[7].

Security and conflicts

Data analysis shows that in almost 45% of the documented technologies conflict, was an issue (Figure 4.9). Furthermore, in almost 55% of the documented approaches, conflict mitigation was cited as an issue. Many conflicts within the rangelands are actually between groups of pastoralists competing for the same resources of grazing and water: and this situation is getting increasingly serious. Other conflicts – perhaps better publicised – are between pastoralists and farmers. Although conflict mitigation was not often the primary motivation behind SRM (though around 35% of the approaches it was: see Figure 4.30), it was influenced – showing that often conflict, in its diverse forms, may be a root cause and an underlying driver of improved SRM. Since conflicts are often about human relationships, approaches to improved SRM, rather than technologies themselves, would be most appropriate to tackle these problems. In the 'Community based rangeland management, Kenya' (page 287) involvement of customary institutions has contributed to mitigation and resolution of conflicts. 'Farmer-managed natural regeneration (FMNR), Kenya'[8] brings local stakeholders together for a dialogue and solving conflicts e.g. between livestock keepers and farmers.

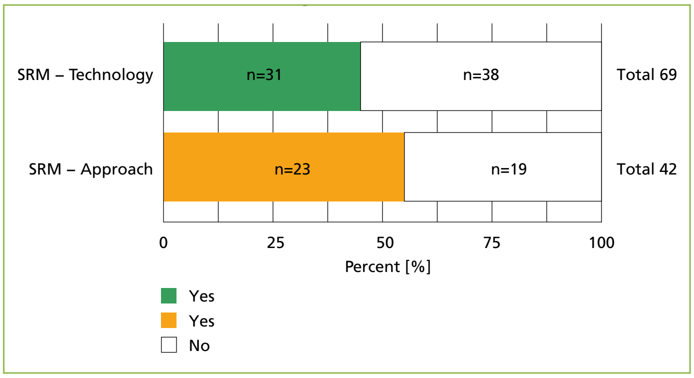


Figure 4.9: Conflict mitigation as a driver directly or indirectly addressed in the technologies and approaches. Number of cases indicated in bars.

Traditional natural resource access rules are rapidly changing. These were often based on a symbiotic relationship between crop farmers, who benefit from manure and the availability of draught animals as well as meat and milk, and pastoralists, who profit from crop residues, stubble grazing, and barter of their products for grain. However, in many areas, crop farmers are increasingly investing in livestock, while simultaneously pastoralists are taking up cropping as herd sizes fall below the minimum to sustain their households. The symbiotic relationship between crop farmers and pastoralists is, therefore, eroding. Furthermore, both groups are losing land to expanding agribusiness and real estate development. As a result, increasing competition for access to water and dry season grazing is marked by occasional outbursts of violence (de Haan et al. 2016)

Livelihoods, poverty and market orientation
Livelihoods in the rangelands, as has been noted, are diverse. Furthermore, there is a distinct disparity in wealth, between the few with substantial herds and the many with a small number of livestock.

In order to better understand drivers originating from the livelihoods of the people, a number of characteristics about the households and their market orientation have been analysed, based on the rangeland practices documented (Figure 4.10).

Scale of land use:
- Around half of the documented cases cover small-scale land use, about one fifth cover medium – and one fifth cover large-scale land use. However, this may not be representative of the different rangeland use systems in the SSA rangelands, where large-scale and medium-scale account for the largest area.
- Thus there is a bias towards reporting on small-scale practices, as already pointed out in Chapter 3.1.3.

Relative level of wealth of land users:
- Almost 50% of the land users that have applied SRM technologies are poor or very poor. Consequently they need support, or they have to implement low cost practices.
- Only 6% are considered rich or very rich: they can invest and reap benefits themselves. Livelihood systems are diversified. About one third of the cases declared an average level of wealth. The main economic opportunities are livestock, trade, and emerging activities and services such as oasis agriculture and tourism.

Market orientation:
- Over all technologies, the highest percentage (42%) is characterised by mixed (subsistence/ commercial) market orientation, followed by subsistence (32%) then commercial (16%).

Individual or group implementation:
- About the same number of SRM practices are implemented by individuals (42%) as by groups (38%). The rangeland use systems that integrate crop production depend more on individual land users than systems based solely on livestock production.
- Furthermore, 'collaboration/ coordination of actors' was cited as being one of the top hindering factors (Figure 4.2a). This is to be expected, as effective rangeland interventions mean communal and multi-stakeholder involvement and large-scale coverage. Responding to this requirement, there is a new movement emerging which organises and legitimises groups and associations. These include pasture user groups, group ranches, cooperatives and user associations (Box 4.5). The goal is to overcome constraints to investment and detrimental changes in rangeland management.

Gender – role of women:
- Most of the technologies are applied jointly by men and women (60%) compared to men alone (22%). Women, perhaps unsurprisingly, rarely apply SRM technologies independently.
- However, with changing dynamics, especially men leaving for urban areas in search of employment, women are increasingly finding themselves in positions of day-to-day decision-making, but seldom make major decisions such as sale of land. This outmigration of men is, however, leading to a 'feminisation' of agriculture and rangeland management (though seemingly less so), but with little associated decision-making power. This scenario, therefore, has implications on both labour and management.

Age of land users:
- In 35% of the technologies 'middle-aged' land users carry out the main role in livestock rearing/ range management activities, followed by 'youth' (18%) and 'elderly' (5%).
- However, the results show a picture contrary to what might be predicted. The expectation would be more and more outmigration and diversification of income by 'middle-aged' and the 'youth', leaving behind 'elderly' land users to carry on with the lead role in livestock rearing. However, the documented results show that this has not happened – at least not yet, or at least in the areas analysed.

[6] https://www.avert.org/professionals/hiv-around-world/sub-saharan-africa/overview/

[7] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4893541/

[7] https://qcat.wocat.net/en/summary/1834/

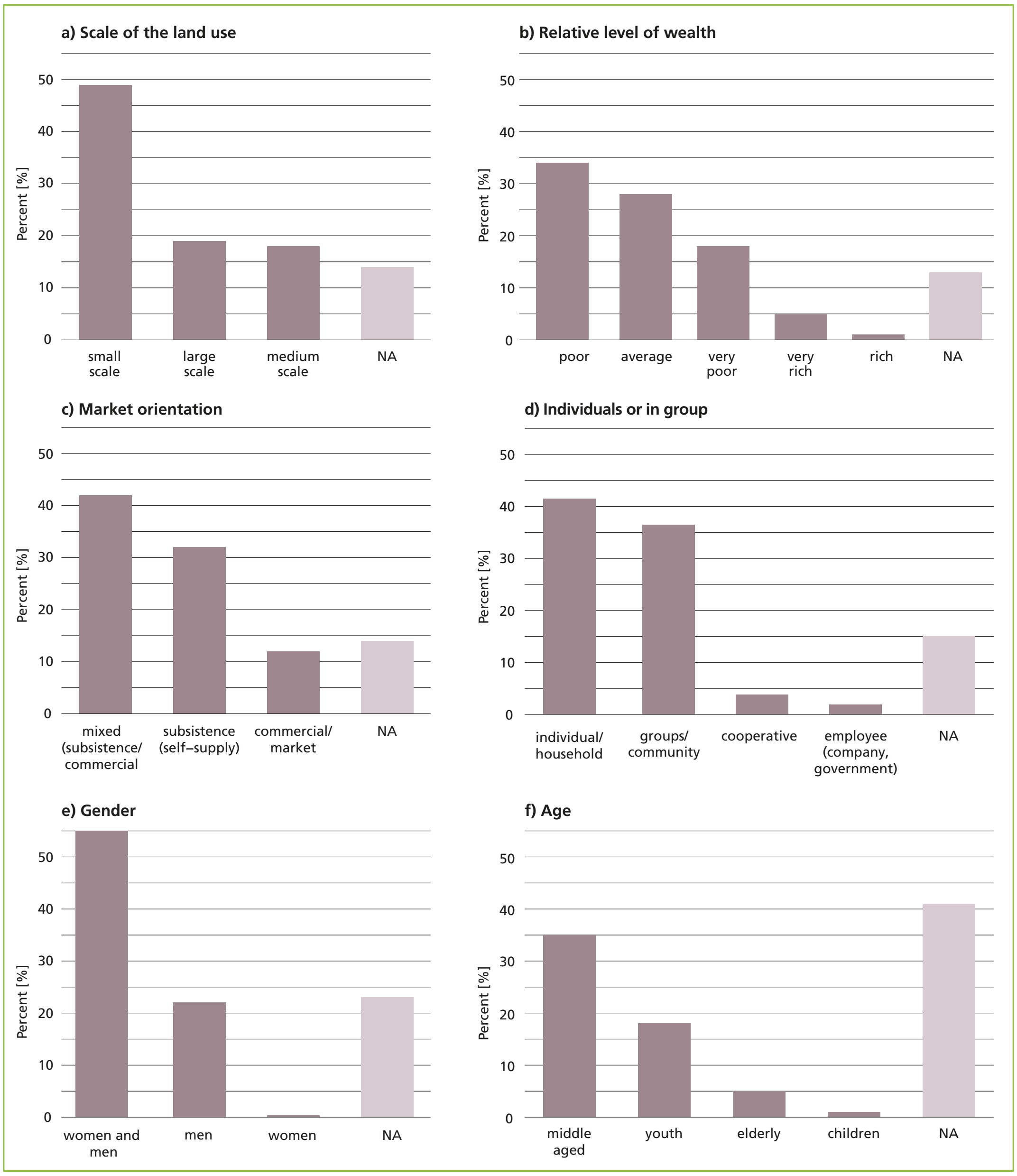


Figure 4.10: Characteristics of land users applying the technology in percent of total number of technologies. Several answers possible per documented technology. NA = data not available.

Take-home messages
Population growth and migration are still major drivers of change in land use and rangeland management.
Outmigration, especially of young males, tends to lead to feminisation in several rangeland use systems. Practices more focused on gender and reduced labour input have higher rates of successful implementation.
There is increasing migration of people predicted due to aridification especially in Western and Southern Africa.
Security and conflict resolution is reported to be a key issue in half of the cases and thus represents a top priority.
There is a bias on reporting (and supporting) of small-scale practices which cover a small proportion of the rangeland. Large-scale mobile systems are less supported as they may be too complex and demanding for projects.
Implementators should consider that more than half of the rangeland users implementing SRM are considered poor to very poor: they need support to implement SRM, or they have to implement low cost practices.
Successful practices are implemented by both individuals (especially where crop production is integrated) and groups.
There is a new movement towards organising and legitimising pasture user groups and associations, group ranches, and cooperatives.

4.1.7 Knowledge and capacity

Access to SLM knowledge and technical support was mentioned in more than 50% of the approaches as hindering implementation of technologies and in slightly less than 45% as enabling (see Figure 4.2a). Knowledge was often seen as insufficient and limiting.

- Valuable traditional knowledge is continuously being lost, but it could be argued that it is no longer applicable to the same extent as before, since many of the challenges to rangelands are new. But it is widely agreed that loss of traditional knowledge, and poor integration with new ideas and concepts, constrains adaptation to changing conditions in the rangelands (Jandreau and Berkes 2016).
- Knowledge about recent experiences, innovation and research are not sufficiently shared.
- Land degradation processes in rangelands are still (even after decades of concern) not well understood, and shortcomings in knowledge have contributed to poorly informed interventions – even leading in some cases to increased degradation. Knowledge gaps result from a limited understanding of rangeland ecology (Davies et al. 2015).

Box 4.5: Emergence and advocacy of pastoral associations

In West Africa at regional level, the **Billital Maroobe Network** (*"Reseau Billital Maroobe"*) for livestock keepers and pastoralists works to defend the interests of its members. The network is convinced that pastoralism, based on spatial and seasonal mobility, represents an essential form of production through its economic, social, cultural and ecological contribution to arid and semi-arid areas.
http://www.maroobe.com/index.php

The **East and Southern Pastoralism Network** aims to empower pastoralists in Eastern and Southern Africa to sustainably improve productivity and livelihoods, while making their voices heard through effective communication, advocacy and legitimate demand for services and resources from policy makers. http://pastoralistsesa.org/.

At community level in **East Africa** there is the **Pastoralist Forum** Ethiopia whose mission is to bring positive changes in the livelihoods of pastoralists through their own and members' capacity building, promoting commercialisation and entrepreneurship, research and technology transfer, networking and partnership, good governance and climate change adaptation
http://www.pfe-ethiopia.org/about.html.

Dodoth Agro-Pastoralist Development Organisation (DADO) in the triangular board areas of north-eastern Uganda, north-western Kenya and south-eastern South Sudan is a community based organisation (CBO), which provides livestock extension services and other related efforts to bring peace and reconciliation among the ethnic groups in north Karamoja.
http://www.dadoug.org/

The **Mainyoito Pastoralists Integrated Development Organisation** (MPIDO) of Kenya is an organisation working with the Maasai indigenous peoples with a mission to promote, facilitate, and create an enabling environment for securing human rights, including natural resources rights, for sustainable livelihoods among the pastoralist Maasai Society.
http://www.indigenousclimate.org/index.php?option=com_content&view=article&id=61&Itemid=79; https://mpido.org/.

The **Pastoralist Development Network** of **Kenya**'s mission is to lobby for the inclusion of the pastoralist agenda in mainstream development, with the vision of a prosperous pastoralist society.
http://www.pdnkenya.org/


(Reseau Billital Maroobe)


East and Southern Pastoralism Network (Rayofungi).

Training and capacity building to improve SRM knowledge and skills at different levels and extension services are suffering from decreasing financial support in many countries within SSA. Furthermore, constraints include shortage of trained personnel, and inadequate advisory and extension services.

Take-home messages

Improving knowledge is key in successful SRM. Poor understanding of land degradation and its consequences needs special attention.

Training and capacity building at all levels to support planning and implementation of SRM emerge as a major need.

A wide variety of drivers seem to be important for rangelands. The magnitude, combinations and change of these drivers make rangeland management especially challenging.

Rangelands throughout Sub-Saharan Africa are currently subject to three major new, additional or aggravating pressures: (1) increasing demands and claims on rangelands (driven by land demand for agriculture and nature conservation), (2) habitat fragmentation (changes in land use and land use rights) and (3) climate change (altered rainfall and seasonality patterns).

Policy is very important but not always well thought-through and not always implemented even when on the books. However, new and more enlightened policies are emerging on the one hand (rights to land and passage; transboundary agreements etc.) and on the other hand customary law is beginning to be accepted as legitimate. Conflicts and security play an important role in policy formulation, especially at national level.

4.2. SRM practices implemented

The following presents an analysis of the SRM practices – technology and approach – in the context of responding to the drivers discussed above (see Figure 4.1). While not meant to provide an exhaustive and comprehensive description of all options available, this section seeks to showcase most promising practices for upscaling. These are presented by groups.

4.2.1 Sustainable rangeland management technology groups

In the following, the five SRM technology groups (TGs) (see Chapter 3.2.1) will be further characterised based on the analysis of the cases available for SSA. The SRM TGs are:

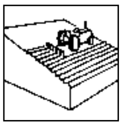
Enabling mobility and access to grazing – TG1 (5 cases)
Controlled grazing and seasonal plan grazing – TG2 (11 cases)
Range improvement – TG3 (38 cases)
Supplementary feeding – TG4 (6 cases)
Infrastructure improvement – TG5 (9 cases)

Origin/ introduction of the technology: In the technology groups 'range improvement', 'supplementary feeding' and 'infrastructure improvement' the technologies were predominantly introduced by projects (Figure 4.11a). In 'enabled mobility' and 'controlled grazing', where 'pastoral' and 'bounded' systems are involved (see Figure 3.14), i.e. covering larger areas, the technologies implemented are also based on traditional practices or are innovations by land users. Improvements in infrastructure are also often applied large-scale, but because they frequently involve high establishment costs and need maintenance, funding through projects or subsidies is often necessary. 'Research' was mentioned as being integrated into around one third of the cases documented under 'supplementary feeding' and one fifth of the cases of 'range improvement' and 'enabled mobility'.

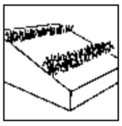
Stage of intervention: In 'enabled mobility', prevention and reduction are the focus of addressing land degradation. In controlled grazing and infrastructure, improvement inventions are done almost evenly at all stages (Figure 4.11b). 'Range improvement' and 'supplementary feeding' (e.g. cut and carry) are primarily implemented to reduce land degradation or restore land – but obviously both lead also directly to improved production as a result. These two groups directly manage the range, in contrast to 'controlled grazing' where the range is managed through the grazing of livestock and/or wildlife.

SRM measures: WOCAT disaggregates technologies into specific measures in order to help understand how these technologies function and what type of intervention is needed (Box 4.6). Measures implemented together are complementary, combine different functions, enhance each other's effectiveness and create synergies. The type of measure is an indication of what inputs, efforts and investments are involved.

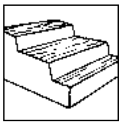
Box 4.6: Categories of SLM measures by WOCAT

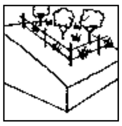
agronomic measures
- are associated with annual crops
- are repeated routinely each season or in a rotational sequence
- are of short duration and not permanent

vegetative measures
- involve the use of perennial grasses, shrubs or trees
- are of long duration

structural measures
- often lead to a change in slope profile
- are of long duration or permanent

management measures
- involve a fundamental change in land use
- involve no agronomic and structural measures.

Combinations of several measures are common and may comprise any two or more of the above measures

Technologies pertaining to the groups entitled 'enabling mobility' and 'controlled grazing' are established mainly through management measures (Figure 4.11c). Both groups are large-scale, and the measure is effected basically through management of grazing by livestock and wildlife. In 'Ecological monitoring, Mauritania' (page 135, monitoring guides implementation of corrective measures through specific management regimes (for instance prohibition of grazing). The management of concentrated livestock, either by daily combining livestock from all households into a single herd to be driven to different designated portions of the communal grazing area as in 'Combined herding, Namibia' (page 173), or on half of the available area for a full year as in 'Split ranch grazing, Botswana' (page 165), promotes optimal range recovery. Some paddocks are grazed the whole year to prevent grassland maturation and the consequent grazing pressure maintains the grassland in an immature, high-quality state, while resting the other half allows optimal recovery from the previous full year's grazing. In 'Il Ngwesi Holistic Management, Kenya' (page 157), grazing in villages is planned for the rains, then "bunching" and moving of all animals in herds is practiced during the dry season. Denuded land is recovered by a "boma" (corral) technology: i.e. strategic corralling of animals overnight, and reseeding (a vegetative measure).

'Range improvement' and 'supplementary feeding' are based mainly on vegetative measures, but are often combined with specific management, structural and agronomic measures. For example, firebreaks to stop the progression of fire into large areas of grazing land, and bush thinning to stimulate the re-growth of grasses, are of paramount importance for protecting and securing grazing – as described in 'Firebreaks, Niger' (page 195), and 'Bush thinning and biomass processing, Namibia' (page 229), respectively. In 'Grass reseeding, Kenya' (page 215), the vegetative measure is combined with a structural measure in the form of furrows capturing rainwater where it falls, to increase availability of water for emerging seedlings.

'Infrastructure improvement' clearly consists, by definition, mainly of structural measures. An example is 'Forage Christine, Burkina Faso' (page 263), where a main well with submersible pump is combined with a secondary well, which is equipped with a hand-operated pump are installed for watering livestock in the dry season. However, to a lesser extent (than the previous two technology groups) it can be combined with management as well as vegetative measures. In the 'Vallerani system, Burkina Faso' (page 183), a special tractor-pulled plough constructs micro-catchments for the sowing of indigenous species.

The natural environment of the SRM technologies is characterized with respect to:

Climate: Most of the SRM technologies documented are found in the semi-arid regions of SSA: the next most common locations are those that border these regions: drier (arid) zones, and wetter (sub-humid) regions (Figure 4.12c). 'Enabled mobility' is clearly the group that is most relevant

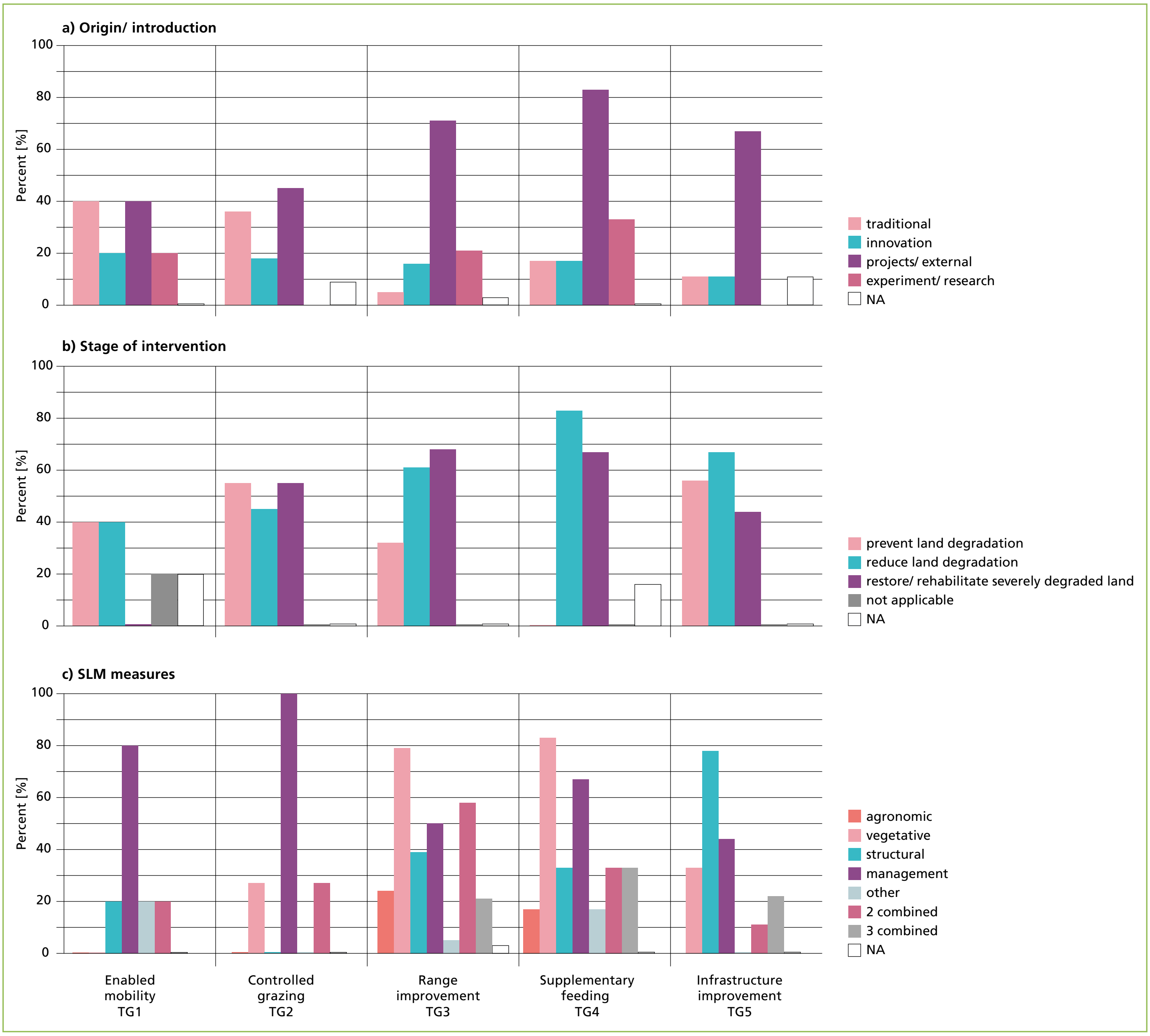


Figure 4.11: (a) origin/ introduction of the technology, (b) stage of intervention of the technology and (c) SLM measures applied in the technology by SRM technology groups. Several answers possible per documented technology. NA = data not available.

to the driest areas (semi-arid and arid) of the rangeland; here four out of the five practices documented experience annual rainfall below 500 mm (Figure 4.12b). Only one case, located in the mountainous zone of Kenya, has rainfall above 1000 mm. With respect to 'controlled grazing', more than 70% of the cases have rainfall below 500 mm. 'Range improvement' is evidently seldom applied in the driest areas: the majority of such interventions are implemented in semi-arid and sub-humid areas. 'Infrastructure improvement' was recorded mostly in the semi-arid drylands, where water supply was a common intervention. 'Supplementary feeding' logically predominates in the sub-humid and humid areas with an annual rainfall of 750 to 1500 mm: in these areas fodder crops can be most readily grown.

Slope: All the technology groups show, by far, the highest number of examples on flat to gentle slopes, except the supplementary feeding practices which spread into the rolling to hilly areas, typical of the more humid regions where they are concentrated (Figure 4.12d). However, mountainous areas provide most valuable water and fodder resources especially during droughts (e.g. 'Il Ngwesi Holistic Management, Kenya', page 157).

Soil organic matter in rangelands has already been identified as low to medium (see Figure 3.11). This applies to all technology groups (Figure 12e). Only in controlled grazing are the cases mostly under soil with medium levels of organic matter. The few cases with high soil organic matter content are within the supplementary feeding and infrastructure groups – again typical of the higher rainfall areas with better soil fertility.

Species diversity was reported highest in controlled grazing and lowest where 'range improvement' and 'supplementary feeding' was applied – in areas with more intense land use and less biodiversity (Figure 12f). In the other SRM technology groups, species diversity was generally medium.

Surface water availability under all SRM technology groups mostly reported to be medium to poor: this is to be expected from the rangelands (Figure 12g).

Groundwater availability in the 'enabled mobility' and 'controlled grazing' groups, is a constraint as the level of the groundwater table is deep (> 50 m) (Figure 12h) and this prevails in the 'pastoral' rangeland use system and in the

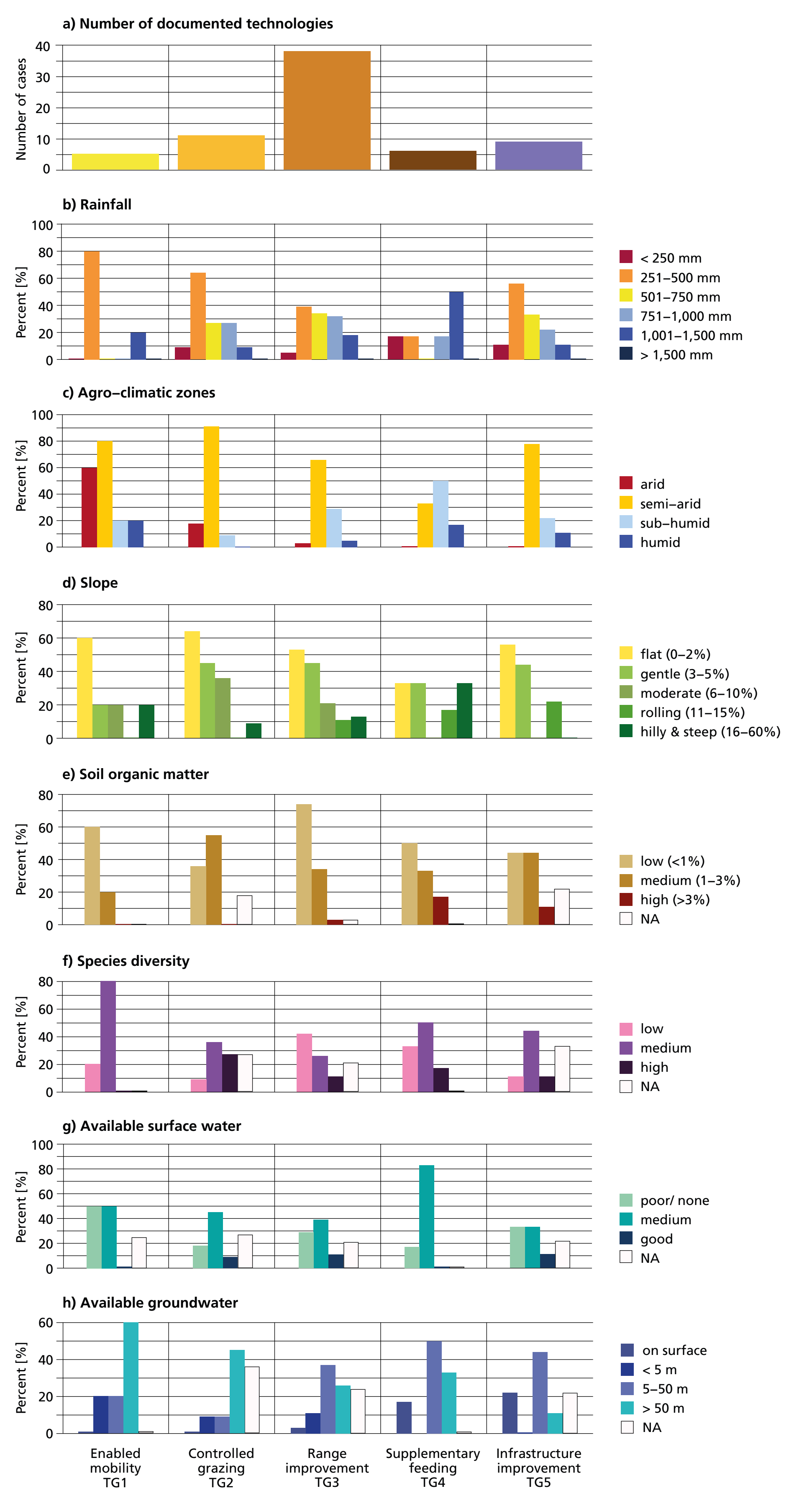


Figure 4.12: Natural environment in percent of each SRM technology group. Several answers possible per documented technology. NA = data not available. Figure (a) shows number of cases in each SRM technology group.

[9] https://qcat.wocat.net/en/summary/4029/

Table 4.2: Establishment costs (estab.) and maintenance costs (maint.) in USD per year of the different inputs in relation to the technology groups. TG1-TG4 show costs per ha and TG5 per technology implemented at single site (e.g. a dam, a water point, a slaughterhouse).

Groups		enabling mobility TG1		controlled grazing TG2		range improvement TG3		supplement feeding TG4		infrastructure impr. TG5	
		estab.	maint.	estab.	maint.	estab.	maint.	estab.	maint.	estab.	maint.
Labour		3	0	43	61	548	106	133	93	268	176
Equipment		5	0	26	20	104	11	39	0	277	69
Planting material		0	0	0	0	252	85	125	3	5	52
Fertilizers, biocides		0	0	0	0	14	14	15	0	0	0
Construction material		0	0	30	13	148	19	13	0	256	17
Others		8	0	0	1	260	2	49	0	0	18
Total	avg	17	0	99	94	1325	237	373	96	805	332
	std'dev	23	0	207	149	2800	744	281	189	1252	240
	median	17	0	0	19	250	37	391	3	112	242
	min	0	0	0	0	0	0	3	0	53	150
	max	33	0	600	430	9899	3837	652	432	2250	604

'bounded' systems. Groundwater table are closer to the surface in 'supplementary feeding' and 'infrastructure improvement' in the wetter areas of the rangelands.

The human environment of the of SRM technologies is characterized by:

Land use rights are most frequently communal (Figure 4.13b): this is true of 100% of the cases assigned to 'enabled mobility' under 'pastoral' and 'agropastoral' rangeland use systems (see Figure 3.14). Communal organisation was also the highest in the 'infrastructure improvement' group, where interventions are often expensive and hence less feasible under individual land use or where the land is leased. Individual land use rights are most frequent in 'supplementary feeding' and 'controlled grazing', which are often small-scale activities.

Water use rights in the cases documented are mainly open access and communal: typical of classical rangelands (Figure 4.13c). Individual and leased water use rights are most prevalent in the controlled grazing SRM technology group, which in turn is often applied under 'bounded' rangeland use systems (see Figure 3.14). Ranches are either private or are managed by a group of persons with individual land and water use rights: for example, group ranches in Kenya.

Scale of land use varies considerably across the different technology groups, except for 'enabled mobility' where large-scale rangeland management is (naturally) predominant (Figure 4.13d). Small-scale land use systems are, however, the most common in all other groups, and are particularly prevalent in 'range improvement' and 'supplementary feeding': again this is to be expected, as these are undertaken where land use is relatively intensive and integrated with crop production. 'Controlled grazing' and 'infrastructure improvement' are, to a large extent, scale-independent.

Market orientation: The commercial sector dominates 'controlled grazing' (Figure 4.13e). This group is mostly applied in 'bounded' rangeland management systems – and commercial ranches are clustered here. For example, the "Mara Beef" company uses their own private land – Naretoi farm – as well as partnering with the Enonkishu Conservancy, to cross high quality beef breeds with local herds, and sell the beef onto high-end supermarkets and restaurants through their own abattoir ('Mara Beef, Kenya', page 345). The Livestock to Market Program (LTM), a partnership between Northern Rangeland Trust (NRT), NRT affiliated conservancies, and two private conservancies was also designed to build resilient livelihoods for local pastoralists through providing a local, equitable, reliable and fair market for a large number of cattle ('NRT livestock to markets, Kenya', page 351). In the technology 'Supplementary fodder for dairy cattle, Uganda' (page 253) milk production is exclusively for the market. All other technology groups are mainly mixed, or subsistence.

Off-farm income is generally less than 10% of the total (Figure 4.13f). The implication is that rangeland users depend very closely on their livestock, on supplementary crop production, and in some areas on non-livestock range products (NLRP), which are also considered on-farm income (see Chapter 3.1.3). An exception is the 'controlled grazing' technology group where off-farm income of between 10 to 50% is common, resulting mainly from wildlife, and thus tourism, being part of the system. In 'Borana ranch grazing, Kenya'[9], livestock production is combined with conservation and tourism, which generates 10-50% of off-farm income.

Costs of inputs needed for establishment and maintenance:

'Range improvement' and 'infrastructure improvement' are the most demanding groups in term of establishment costs, as they require high labour input, costly equipment, and construction material to implement the technologies as well as to maintain them (Box 4.7, Table 4.2). Labour is the main requirement for maintenance. 'Range improvement' needs initial investment in plant materials, for example for reseeding of grass and its 'maintenance'. 'Supplementary feeding' shows a medium to high level of need for labour and plant material. Fertilizers, and probably less so biocides, may also contribute to costs in the 'range improvement' and 'supplementary feeding' groups. Regarding 'enabled mobility and 'controlled grazing', these groups are 'undemanding' to implement and maintain, as they don't require much labour or input costs.

However, it has to be noted that the results discussed above do not constitute a full set of data. Only the cases that have given their costs per hectare are comparable. Cases that could not give costs per area but reported costs per well (e.g. 'Securing pastoral mobility, Chad', page 127 or per km of

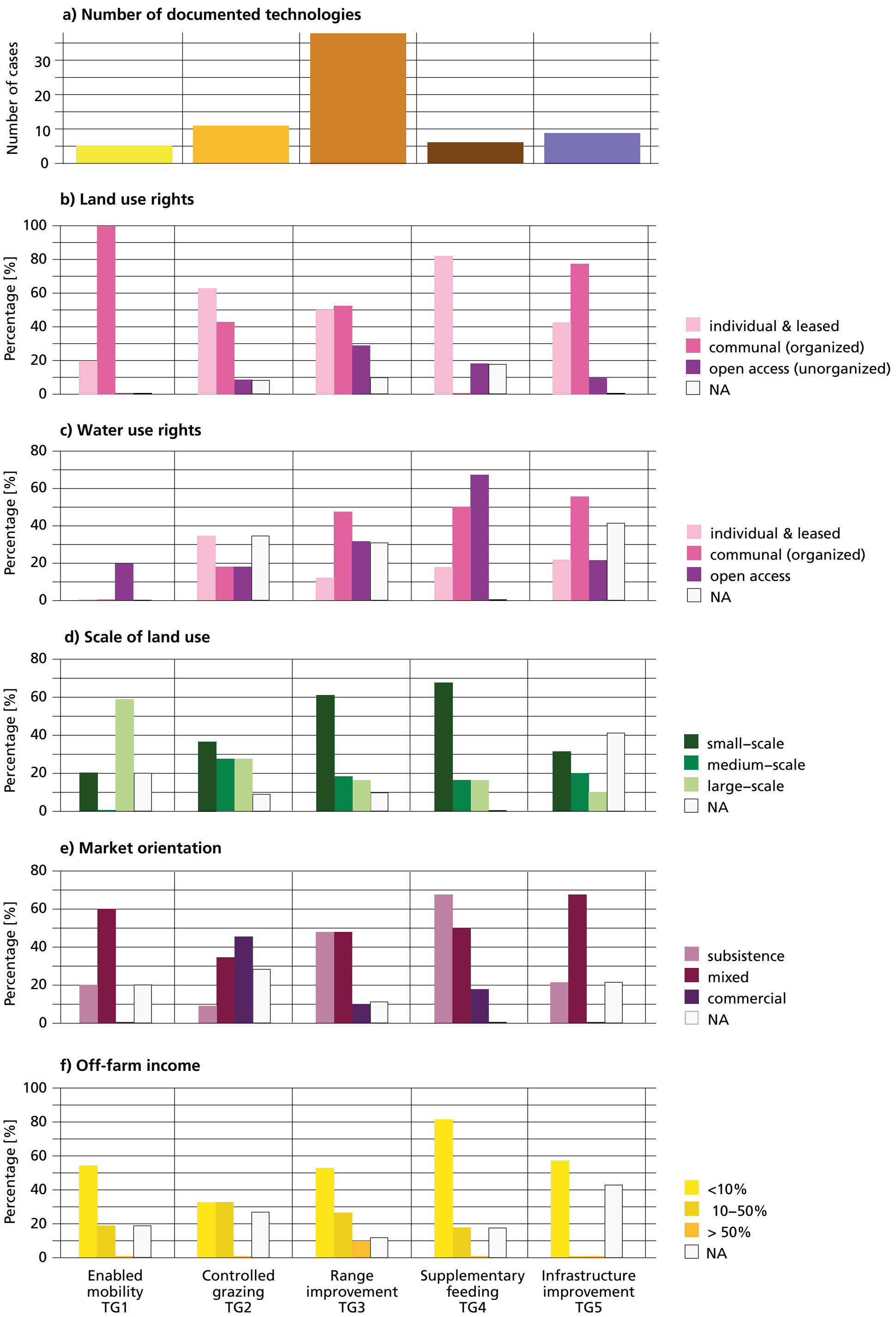


Figure 4.13: Human environment in percent of each SRM technology group. Several answers possible per documented technology. NA = data not available. Figure (a) shows number of cases in each SRM technology group.

Box 4.7 Definition of costs by WOCAT

***Establishment costs** are defined as those specific one-off, initial costs which are incurred during the setting up of the SRM technology. These investments are made over a period of time that can last anything from a few weeks to three years. These costs typically include labour, purchase or hire of machinery and equipment, seedlings.*

***Maintenance costs** are those that relate to maintaining a functioning system. They are regularly incurred and are accounted for on an annual basis. In general these are made up of labour, equipment and agricultural inputs.*

firebreak (e.g. 'Manual opening of firewalls, Mauritania'[10]), etc. are not comparable. In addition, technologies that indicated costs, which are prohibitively expensive were excluded from the analysis as they are not realistic candidates for widespread upscaling. The latter are three: 'Combating invader plants, South Africa'[11] with total establishment costs of USD 23,420 per ha, 'Reshaping gullies, South Africa'[12] with total establishment costs USD 88,430 per ha and 'Anti-erosion measures, Burkina Faso'[13] with total establishment costs USD 1,182,515 per ha.

Take-home messages

'Range improvement' and 'supplementary feeding' directly manage the range, in contrast to controlled grazing where the range is managed through the grazing of livestock and/or wildlife.

'Range improvement' is generally implemented in semi-arid and sub-humid areas, while 'supplementary feeding' predominates in the sub-humid and humid areas where fodder crops can be most readily grown.

Even though most of the rangelands and their use is in the flat lowlands, mountains and hills provide valuable resources during droughts.

Costs are hard to compare: in many technologies inputs are not fully reported and some calculate by area – but others by unit of infrastructure (wells; firebreaks etc.). Some technologies are prohibitively expensive.

Land use rights are most frequently communal: all of those cases assigned to 'enabled mobility'. However, individual land use rights are much the most frequent in small-scale systems.

Water use rights in the cases documented are mainly open access and communal: typical of classical rangelands.

Scale of land use varies considerably except for 'enabled mobility' where large-scale rangeland management is predominant.

The commercial sector dominates 'controlled grazing' typical of commercial ranches. All other technology groups are mainly mixed, or subsistence.

Off-farm income is generally less than 10% of the total except where wildlife, and thus tourism, are part of the system.

4.2.2 Sustainable rangeland management approach groups

The four SRM approach groups (AGs) (see Chapter 3.2) will be further characterised based on the analysis of the cases available for SSA. The SRM AGs are:

Community based NRM
(Natural Resource Management) – AG1 (9 cases)
Land & water use planning
(medium to large-scale) – AG2 (26 cases)
Marketing & alternative income – AG3 (5 cases)
Wildlife & nature tourism – AG4 (2 cases)

Origin of the approach: The documented approaches, just as the technologies, were mainly introduced or promoted by projects and to a lesser extent through 'innovation' and 'tradition'. In the 'land & water use planning' group, a few traditional approaches were documented, such as traditional governance and pastoral user groups ('Traditional pastoral management forums, Angola' (page 327), 'Empowering Dedha institutions, Kenya'[14] and 'Collective management, Mauritania'[15]). This illustrates a bias towards project approaches being recorded, as they have the resources, the motivation and the information about what is happening; this is very different compared with traditional and innovative practices, where it is difficult to find contributors with in-depth knowledge about how they function.

One of the keys to successful implementation is to recognise the origin of SLM approaches. Many projects build on already existing SRM technologies and approaches and adapt and develop them further: this is increasingly the case, and in stark contrast to 50 years ago. Because most of the reported cases are derived from projects implies that there is still substantial knowledge and experience about traditional, localised and innovative practices that has not yet been tapped. This information is still missing. Despite a specific effort to find more traditional and innovative cases, it was only possible to reach a small sample within the limited resources and time for the compilation of these guidelines. Even project implemented experiences are rarely available in an easily accessible or comparable format. It would be ideal, if it were possible, to track back the origins and evolution of SRM practices to shed light on their applicability and how they have adapted, or not, to changing conditions.

Stakeholder involvement: Land users and SLM specialists in all four SRM approach groups are reported as the main stakeholders involved (Figure 4.14). NGOs and government agencies are also involved except in the 'marketing & alternative' income group, where the private sector is dominant. International organisations are also well represented in all four groups. Since rangeland management is complex and challenging – combining different livelihoods, and requiring various skills – land users and livestock keepers can often benefit from outside expertise and support. Multi-stakeholder involvement and dealing with their diverse aims and objectives is key to successful implementation of SRM.

Under 'community based NRM', decisions on the selection of the technology were taken mainly by land users supported by SLM specialists, or alone as an independent initiative. In the 'land & water use planning' and the 'marketing & alternative income' groups, it was most common that all relevant actors took part in the decision making process.

Land user and community involvement in different phases: In more than 55% of the cases, land users and local communities have been interactively involved in all phases of the approach (Box 4.8), most particularly in the planning phase (in almost three quarters of the cases; Figure 4.15). External support is sometimes needed in the implementation phase as a subsidy or an incentive to trigger initial action. Land users are almost always part of the implementation phase, either interactively (64%), or through self-mobilisation (17%). In the monitoring phase, land users were interactively involved or self-mobilised in two-thirds of the cases, though they were passive or not involved at all in a quarter. This stage is key in conferring a feeling of responsibility, and land users should always

Box 4.8: Definition involvement of local communities by WOCAT

Self-mobilization: *means that local people participate by implementing their own initiatives independently of external institutions. They may interact with external institutions to obtain resources and technical advice, but they retain control over how resources are used.*

Interactive: *means that local people and the project team jointly analyse the situation, jointly develop action plans and form institutions, and jointly decide on the use of resources.*

External support: *means that local people participate in return for food, cash, or other material support.*

Passive: *means that local people participate by being informed what will happen or has already happened. They may also participate by being consulted or by answering questions, but they do not decide.*

[10] https://qcat.wocat.net/en/summary/2090/
[11] https://qcat.wocat.net/en/summary/1374/
[12] https://qcat.wocat.net/en/summary/3917/
[13] https://qcat.wocat.net/en/summary/614/
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[15] https://qcat.wocat.net/en/summary/3720/

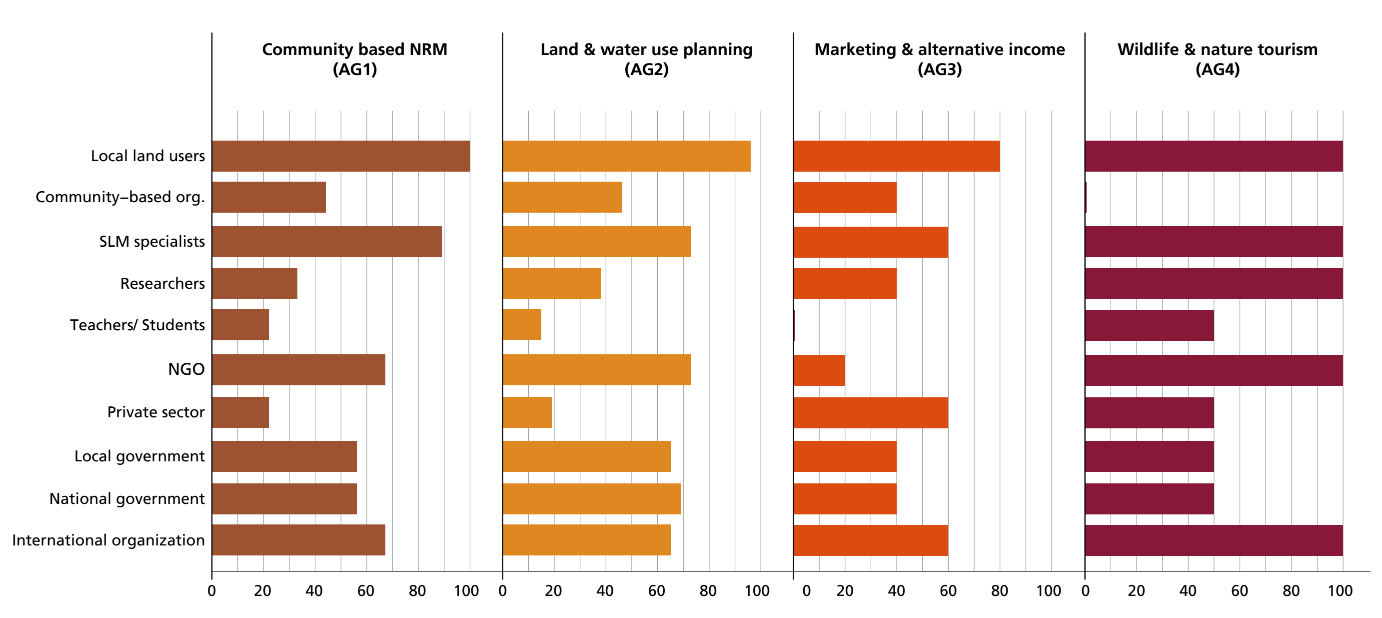


Figure 4.14: Stakeholder involvement in the implementation of the approach by SRM approach group – in percent of total number of approaches within each group. Several answers possible.

be involved. It hardly needs to be re-emphasised that high levels of involvement and active roles of land users in all stages of implementation is fundamental to the success of upscaling SRM. This is essential to create a better sense of ownership – and to ensure continuation of activities after external support has been withdrawn. All efforts should support their involvement while simultaneously building their capacities to initiate further SRM initiatives that are appropriate, and adapted to changing conditions.

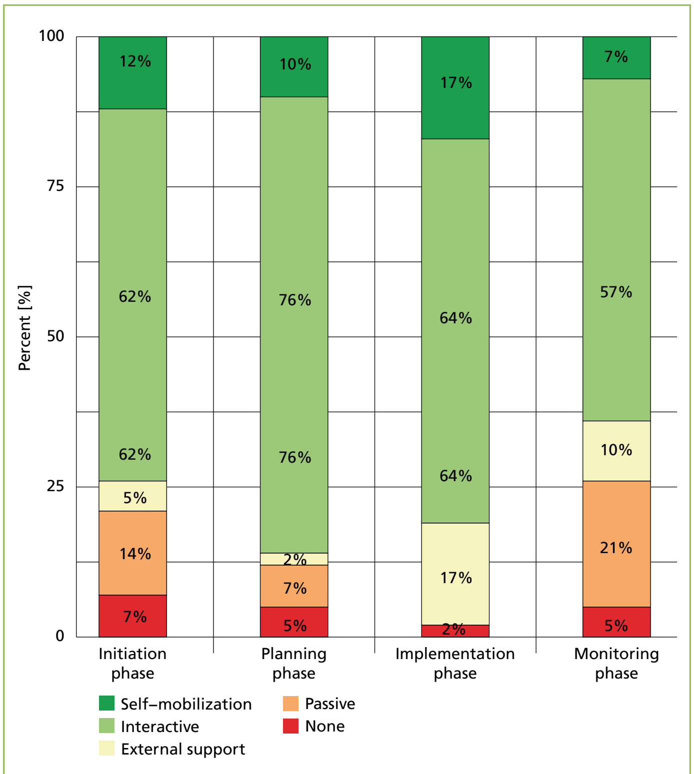


Figure 4.15: Involvement of land users and local communities in the different phases of the approach. Percentages indicate the proportion of involvement within each phase.

Technical and financial support: The support needed and most demanded in the documented approaches was for capacity building, and for monitoring and evaluation (Figure 4.16). In 'Integrated management of savannah, Tanzania'[16], knowledge acquisition and skill development was achieved through extension advisory services, demonstration plots, and on-the-job and action based training. In 'Pastoralist field schools, Ethiopia' (page 279) hands-on experimental and participatory learning improve livelihoods and resilience of pastoral communities.

Given the fact that knowledge has been stated as being one of the top constraints to successful implementation of SRM, the value and importance of capacity building and training cannot be overstressed. Advisory services were provided only under 'community based NRM', but it is heartening to note that research was an integral part of the approach in all four groups. Financial and material support were received by land users for implementing the technology in every group, but to a varying extent: half of the cases under the 'land & water use planning' group, 60% under 'marketing & alternative income group', 78% under 'community based NRM', but all cases under 'wildlife & nature tourism'. Since most of the technologies are project-based, this nature of support is to be expected. In all four groups, organisational development is missing and the indication is that this issue was not an objective of the projects. This is a paradoxical finding as institutional set-up was stated to be an important hindering factor.

Cost and investments: Annual budgets for SRM diverge widely (Figure 4.17), indicating the very wide range and scale of approaches; these include, for example, traditional, innovative and project-supported approaches and corresponding technologies and different scales from local to transboundary to joint village approaches.

Under 'community based NRM' a wide spectrum of annual costs are involved, with 35% lying in the USD 10,000 – 100,000 range and almost 20% between USD 100,000 and 1,000,000. 'Land and & water use planning', although large-scale and expected to be more costly, indicated lower budgets than in 'Community based NRM', ranging between USD 2,000 and 100,000. 'Marketing & alternative income' and 'wildlife

Table 4.3: Examples from the four approach groups with different annual budget size.

Annual Budget	USD 10,000-100,000	USD 100,000-1,000,000
Community based NRM (AG1)	'Social Tenure Domain Model (STDM), Kenya' (page 141)	'Combating erosion and climate change adaptation, Burkina Faso' (https://qcat.wocat.net/en/summary/1882/)
Land & water us planning (AG2)	'Joint village, Tanzania' (page 319)	'Stabilisation through conservation approach, Kenya' (https://qcat.wocat.net/en/summary/4025/)
Marketing & alternative income (AG3)	'Mugie Livestock to Markets, Kenya' (https://qcat.wocat.net/en/summary/3762/) (page 351)	'Kenya Livestock Insurance Program (KLIP), Kenya' (page 337)
Wildlife & and nature tourism (AG4)	'Holistic rangeland management and tourism, Kenya' (page 359)	'Restoration of game migration routes, Namibia' (page 367)

nature tourism' are on the more expensive side. Some examples of documented approaches are shown in Table 4.3.

Accurate compilation of costs for the implementation of SRM is a major challenge. It is quite common that some costs are forgotten such as those for building institutional and human capacity – 'software' for rangeland management.

Costs for implementation, especially for the establishment of SRM, is a key constraint. Thus the first choice options should be those which require low levels of investment, building on (as far as possible) what is already on-the-ground. Community based approaches generally have this advantage.

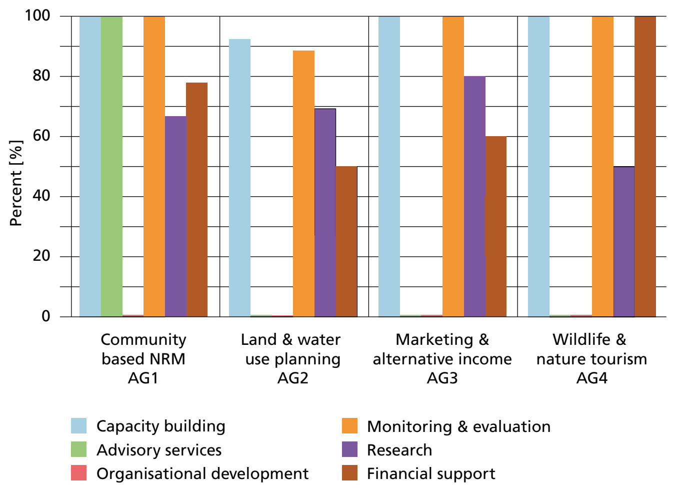


Figure 4.16: Technical and financial support provided by the approach in percent of total number of approaches within each approach group. Several answers possible.

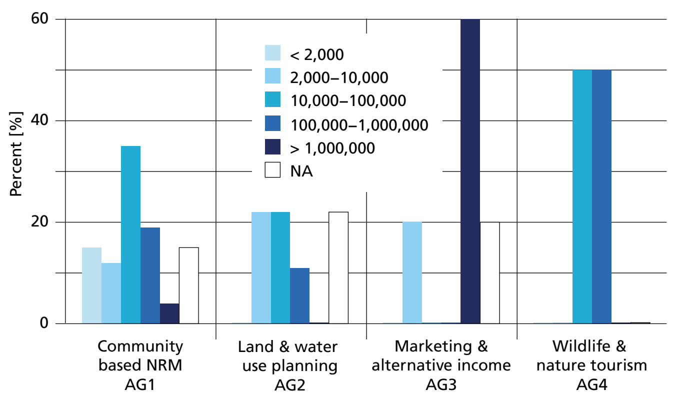


Figure 4.17: Annual budget in USD of the SRM component of the approach in percent of total number of approaches within each approach group. NA = data not available.

However, clearly, as with the technologies, costs should be related to the benefits of the investments. If, compared with the costs, the benefits are much higher than current practices then further investments can be justified. Obviously, the level of investment in the interventions depends on the available financial resources of land users and projects. Cost-benefits are discussed further in Chapter 4.4.

Subsidies are costs not borne by land users, and can be an important incentive and motivating factor. Over a third of the documented approaches did not receive any subsidies, with the exception of the 'wildlife & nature tourism' group (Figure 4.18). Of the 'marketing & alternative income' group, not one of the six cases subsidised labour – in contrast to the other approach groups (> 30% of the cases). However, one fifth of the cases received subsidies for equipment, agricultural inputs – such as seeds – and infrastructure.

Take-home messages

In most cases, land users and local communities are interactively involved in all phases of the approach; most particularly in the planning phase. This proves to be a prerequisite for successful implementation of SRM.

Since rangeland management is complex and challenging, land users and livestock keepers can often benefit from outside expertise and support. This is an opportunity for valuable project interventions.

Another key to successful implementation is to recognise the origin of SLM approaches. Increasingly many projects build on already existing SRM approaches and technologies, adapt and develop them further.

Multi-stakeholder involvement is key to successful implementation of SRM.

Capacity building and support for monitoring and evaluation are top priority in all AGs.

Organisational development is missing as an objective of the projects. This is a paradoxical finding as institutional set-up was stated to be an important hindering factor.

A wide spectrum of different technologies and approaches have been identified. Dividing technologies and approaches into groups helps to focus on specific types of problems and targeting solutions. It furthermore helps to streamline actor involvement, SRM measures and investments.

[16] https://qcat.wocat.net/en/summary/1315/

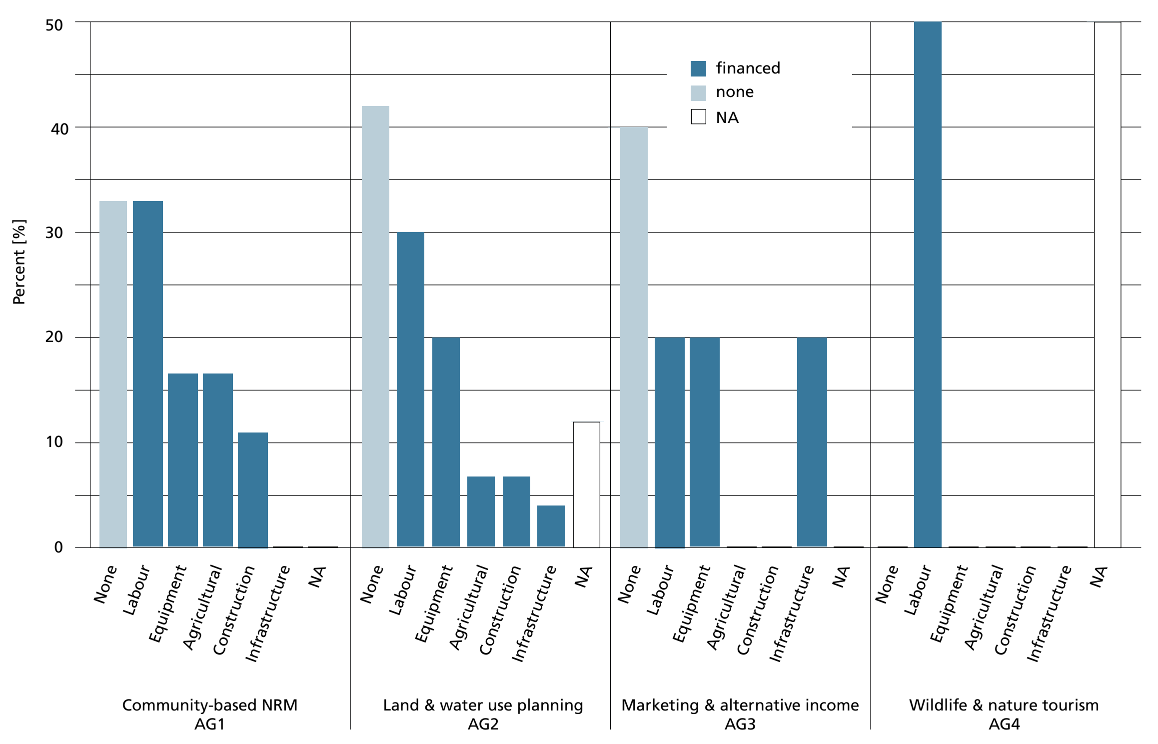


Figure 4.18: Subsidies to specific inputs and labour of the approach in percent of total number of approaches within each approach group. NA = data not available.

4.3 Impacts of SRM on health of land resources

Each land management practice, and change in practice, has an impact on the rangeland's resources: on the soil, the water, the vegetation and the animals it carries. In the following, various impacts of SRM technologies on the "health" (or "state") of the land are analysed and discussed. Dependent on the technology, these impacts may be negative – continuing and accelerating land degradation if the practices are not adapted or suited to the particular site where applied – or alternatively impacts may be positive, reducing degradation, restoring land, or preventing land degradation where the land is still healthy if the practices fulfil the criteria of SRM. Indicators of the health of the land's resources on-site are presented in Table 4.4 and are further elaborated in this chapter. Impacts of land management also affect health of land off-site (see Chapter 4.4).

4.3.1 SRM addressing land degradation

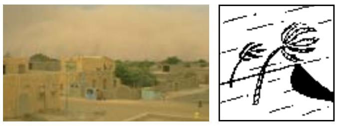
The main purpose/ objective of applying SRM technologies is to reduce, prevent and/or restore land degradation (see Figure 4.3). The practices documented show that the urgency of addressing land degradation in the rangelands is recognised, and it is being specifically targeted.

Biological degradation of the vegetation cover is a major problem cited in all groups, followed by **soil erosion by water** (Figure 4.19; Box 4.9). The exception is the 'enabled mobility' group where water degradation is perceived to be as important as biological degradation (the two major degradation factors limiting livestock production). 'Infrastructure improvement' technologies also address water degradation through, for example, weirs that span the entire width of a valley to spread floodwater over the adjacent land area ('Water spreading weirs, Chad'[17]). **Soil erosion by wind** appears to be more of an issue in the 'controlled grazing' group, as does soil fertility in the 'range improvement' group.

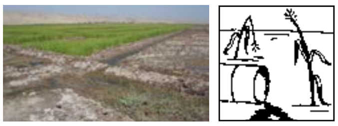
Water degradation (decrease in water quantity and/or quality) is found throughout the SRM technology groups, but perhaps because it is generally accepted as inherent and inevitable in the drylands it does not appear to be the main focus of the technologies. However, given that soil erosion by water (and accompanied loss of runoff) is such a

Box 4.9: Types of land degradation as defined by WOCAT

Soil erosion by water
(e.g. gully erosion, mass movements/ landslides, loss of topsoil/ surface erosion)



Soil erosion by wind
(e.g. loss of topsoil, deflation and deposition)



Chemical soil deterioration
(e.g. fertility decline and reduced soil organic matter, soil pollution, salinization)

Physical soil deterioration
(e.g. compaction, sealing, waterlogging)

Biological degradation
(e.g. reduction of vegetation cover, loss of habitats, increase of pests/ diseases)

Water degradation
(e.g. change in quantity of surface water, decline of surface water quality)

Table 4.4: Key indicators of rangeland health related to degradation and impacts of rangeland management technologies (WOCAT Technology Questionnaire 2018).

Aspect of land resources	Land degradation type	On-site impact indicators (In bold issues that are addressed)
Vegetation	• Biological degradation: reduction of vegetation cover and quantity biomass decline • Biological degradation: detrimental effects of fires	• **Soil cover** (retained/ improved) • **Vegetation cover** (retained/ improved) • **Biomass, above ground C** (retained/ improved) • **Invasive alien species** (reduced)
Soil	• Soil erosion by water and wind • Physical deterioration: compaction, sealing and crusting • Chemical deterioration: fertility decline • Biological degradation: loss of soil life	• **Soil loss/ erosion** (reduced) • **Nutrient cycling** (improved) • **Soil organic matter/ below ground C** (improved) • **Soil crusting and sealing** (reduced) • Soil compaction (reduced) • **Soil moisture** (improved)
Water	• Water degradation: aridification • Water degradation: change in quantity of surface water • Water degradation: change in groundwater/ aquifer level	• **Water quantity** (conserved) • Water quality (improved) • **Surface runoff** (regulated) • **Surface evaporation** (reduced) • Ground water table/ aquifer (recharged)
Biodiversity	• Biological degradation: loss of habitats, quality and species composition	• Plant diversity (increased) • Animal diversity (increased) • **Habitat diversity** (increased)
Animal health (pest and diseases)	• Biological degradation: increase of pests and diseases	• **Pests/ diseases** (reduced)

serious problem, then logically water degradation should also be cited – as the two go hand-in-hand. **Chemical (fertility) and physical (compaction) deterioration** are also issues that are addressed via the SRM technology groups – given varying, but in general low, importance.

Closer inspection of the different degradation types addressed by technologies in Figure 4.20 reveals the following:

For **vegetation**, a reduction of cover is the major problem under all technology groups. This represents a loss of biomass – most importantly perennial grass cover – and thus reduced forage availability. Furthermore, there is degradation in the quality of the biomass and species diversity decline indicated in all groups. This compounds the problem. Not only is there less biomass but it is of poorer quality: the implication is a loss of forage/ fodder resources for livestock and wildlife. It is also associated with invasion by forbs, shrubs and trees – frequently unpalatable and of little economic or biodiversity value – both native and alien (Box 4.10).

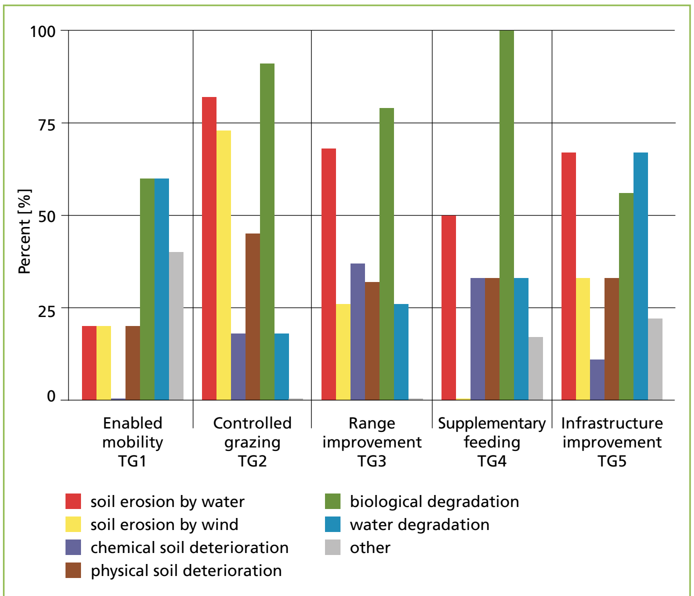


Figure 4.19: Major forms of land degradation in Sub-Saharan Africa addressed in the different SRM technology groups (in percent of the number of technologies within each technology group). Several answers possible.

Reduced cover leads to additional negative impacts: compaction, sealing and crusting, resulting in increased runoff, and erosion by water and wind. Thus, addressing vegetation degradation must be seen as the key priority. Vegetation – comprising the grass and herbaceous layer beneath the bushes and trees (where present) – is the basic resource of the rangelands.

Degradation due to fire appears to be only seen as an issue in the 'controlled grazing' 'infrastructure improvement' groups (mentioned in around 30% of the cases). Do fires impede or improve pastures? Probably either, depending on the frequency and the heat of the fire, and the context in which it is used (Box 4.11; see Chapter 2.1.9).

Soil loss due to erosion by water is, in all groups, the most commonly perceived degradation type that technologies are designed to address. Considering that most of the rangelands are in the drylands, it seems paradoxical that the most serious problem is runoff causing serious erosion, but lack of vegetation cover at the beginning of the rainy season explains this phenomenon. Soil erosion by wind is also seen an issue, but less than erosion by water in all technology groups except under 'enabling mobility', where it is absent. Soil fertility decline is an issue that is addressed to a certain extent in all technology groups, but particularly in the 'range improvement' group. Soil compaction is more prominent in the 'infrastructure improvement' group, where it is mentioned in more than 40% of the cases. Micro-organisms within the soil itself constitute a factor that has not been documented or analysed here, but this aspect of below-ground biodiversity is of immense importance to maintenance of soil health.

[17] https://qcat.wocat.net/en/summary/1537/

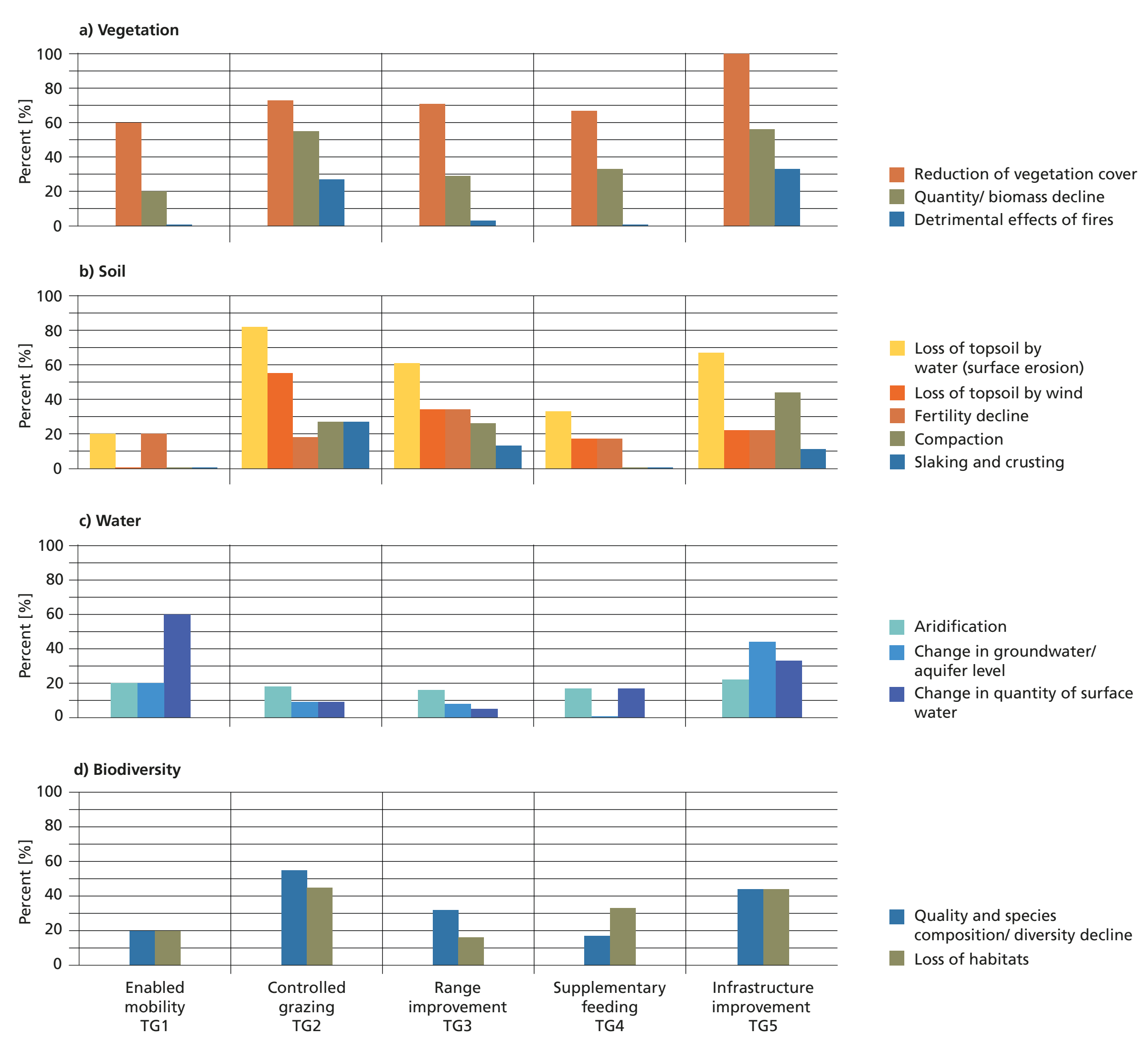


Figure 4.20: Land resources and related land degradation types reported from the areas where SRM technologies are implemented (in percent of the number of technologies within each technology group).

All soil degradation types threaten the productivity of vegetation. However, any soil degradation also affects water availability: first by reducing rainwater storage in the soil, as a result of crusting and sealing, which reduces infiltration and increases runoff; secondly by reducing the soil's water storage capacity. This leads to a vicious cycle of degradation, where vegetation degradation increases soil degradation, which leads to further vegetation degradation – and so on in a descending spiral (Box 4.12). A fundamental challenge for SRM is to break out of this cycle.

Water: Aridification may be accelerated by climate change, but the more urgent issue is aridification caused by people through poor land management. The vicious cycle depicted in Box 4.12 shows how the soil is deprived of precious rainwater: increased runoff and greater evaporation of water from the barren soil surface lead to more arid conditions. A very considerable, but unperceived, loss of water is direct evaporation from the surface or the top soil, amounting to 60-80% of the rainfall in areas with sparse grass cover (Liniger et al 2011). This is a shockingly large loss of precious rainwater in water-scarce rangelands. However, aridification due to reduced soil water availability/ moisture is only reported from around 20% of all technology groups. In the 'enabled mobility' groups the focus is more on surface water availability, and is mentioned in 60% of the cases. The 'infrastructure improvement' group's emphasis is on changes in groundwater level and surface water availability. Aridification in rangelands, despite its severity, is the least perceived face of degradation: it is a hidden threat, a stealthy process with multiple detrimental impacts.

Surface water degradation is also a consequence of the vicious cycle of degradation; more runoff leading to floods, and causing erosion. Heavy sediment loads in rivers pollute the water, and siltation reduces the capacity of dams and lakes. Droughts are exacerbated when there is less water in the soil – and in dams also. It is a sad irony that areas already suffering from water scarcity lose so much in runoff and floods. This process can be exacerbated by inappropriate location, alignment and design of infrastructure such as water points, fences, roads, bridges and culverts[18].

Biodiversity: All SRM technology groups address loss of biodiversity. 'Range improvement' practices pay more attention to quantity, species composition and diversity decline than to habitat diversity. Around half of 'controlled grazing' and 'infrastructure' cases mention that both aspects of biodiversity are being addressed (Box 4.13).

[18] https://www.youtube.com/watch?v=6C4V_Cib8ts

Box 4.10: Invasive alien species as drivers of rangeland degradation: the example of prosopis

Many alien trees and shrubs have been deliberately introduced in SSA by development projects for timber, firewood, fodder, or other purposes. However some have 'escaped', invaded productive land and threaten native species and ecosystem function. Across East Africa and the Horn, prosopis species native to Central and South America are now a severe threat to grassland ecosystems. The consequences for ecosystems are serious, since prosopis at a cover of over 60% completely displaces perennial herbaceous vegetation, as it is a heavy water user and competitor with the grasses. In Afar Region, Ethiopia, prosopis was first planted in the early 1980s; now the evergreen *Prosopis juliflora* has invaded more than one million ha (Figure 1), while grassland cover has dropped by 25%. The most rapid change is on the Awash River's floodplains – priority areas for dry season grazing. Combined with the expansion of cropping, the invasion has led to an almost complete loss of grasslands in the upper parts of the floodplains (Figure 2).

At low densities, prosopis may provide some useful services, including urgently needed firewood and charcoal. While the leaves of prosopis are hardly eaten, the pods are palatable to a range of domestic livestock and can be included in mixed diets. However, as livestock go in search of ever-decreasing grazing land they carry the seed of prosopis and spread it in their dung. Also, the aggressive invasiveness of prosopis and its tendency to form impenetrable thickets changes the ecosystem and its services, including an almost total loss of fodder productivity for livestock and wildlife, a decline in biodiversity – including medicinal plants – and a depletion of soil water and groundwater. Modelling has revealed that almost all floodplains in Afar region are suitable for prosopis. Hence, further spread is highly likely and unless remedial measures are taken, it will displace the remaining grasslands. This in turn increases the likelihood of ethnic conflicts as pastoralists compete for diminishing forage.

Restoring prosopis-invaded areas poses a serious and urgent challenge. As *Prosopis juliflora*, the most invasive species in East Africa and the Horn, is largely fire-resistant, management by fire is no option. Some projects claim that prosopis could be a potential income source through carbon credits. A better alternative may be cutting prosopis, killing the rootstocks, planting and assisting regeneration of native grasses, shrubs and trees, and combining this with allocation of secure land use rights – as pioneered in Baringo County, Kenya. Here, there has been a huge local increase in fodder, while soil organic carbon has been restored to higher levels than on prosopis-invaded land (Fig 3). Another possible strategy is to introduce natural enemies, specific to prosopis, native to Latin America, into East Africa for biological control. This approach is being successfully applied in Australia, where the wisdom of introducing another alien species is seriously questioned.

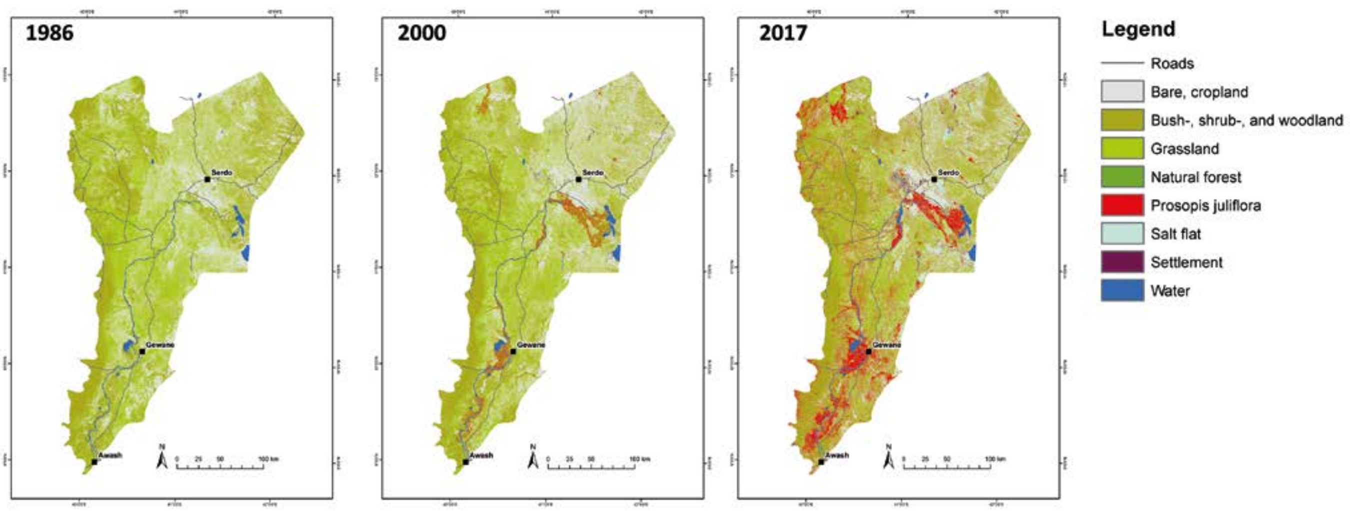


Figure 1: Invasion of prosopis (indicated in red) in Afar region within 30 years.

Figure 2: Invasion of the alien *Prosopis juliflora* in East Africa. Left: Grassland in Baringo, Kenya, with continuous cover (foreground) being replaced by invading proposis (background). Right: In the floodplains of the Awash river, Afar region, Ethiopia, prosopis forms impenetrable thickets with no grass cover remaining (P. Rima, U. Schaffner).

Figure 3: Grassland restored in Baringo County, Kenya, after hand cutting of prosopis, reseeding with native species including Rhodes grass (*Choris guyana*) and *Setaria* sp, and allocation of user rights (W. Critchley).

Source: Urs Schaffner and René Eschen, CABI Switzerland; Sandra Eckert, CDE, Switzerland; Hailu Shiferaw, Water and Land Resource Centre, Ethiopia; Purity Rima, University of Nairobi, Kenya. The information is based on research conducted in the frame of the 'Woody Weeds' project (woodyweeds.org); Shiferaw et al. 2019a,b.

Box 4.11: Fire management

Management of fire is crucial to its utility as a tool for increasing rangeland productivity. Poor management of fire, or over-occurrence – perhaps as a result of climate change – can lead to the decline of vegetation types that are fire-sensitive. This alters the composition of plant communities more radically, reducing rangeland biodiversity (Polley et al. 2017). Strategic management of fire, however, can help ensure sustained rangeland productivity. Controlled burning can also assist in reducing fuel loads and thus the risks of large-scale unplanned fires, which may cause loss of pasture across vast landscapes. Furthermore, rangeland management by fire can help manage invasive plant species; on the other hand fire can promote certain invasive species that are resistant to burning. Grazing in planned locations can be a tool to manage fire, by effectively creating firebreaks in the landscape through reducing biomass. However, overgrazing, where too much vegetative biomass is lost overall, can lead to the end of traditional fire management techniques in rangelands.

Landscapes that have been shaped by controlled fires show a greater functional heterogeneity than those in which fires occur less often (Fuhlendorf et.al. 2017). Little is known about the specific effects of rangeland fire management on livestock production, despite pastoralists using burning since time immemorial. It is known however that livestock gain proportionally more weight from equal quantities of vegetation on burned sites. This is due to the increased digestibility and higher concentrations of nutrients in regrowth. The protein content and digestibility of grass is higher from regularly burned sites. Unsurprisingly, herbivores prefer grazing on recently burned sites (Sensenig et al. 2010, Limb et al. 2016).

Prescribed burning in South Africa at the end of the dry season (left) triggers a green flush of grass growth after the first rains (right) (Hanspeter Liniger).

Box 4.13: Definition of species and habitat diversity by WOCAT

Species diversity: *a measure of diversity within an ecological community that incorporates both species richness (the number of species in a community) and the evenness of species' abundance; species include all fauna and flora above ground and in the soil (modified from eoearth.org).*

Habitat diversity: *refers to the variety or range of habitats in a given region, landscape, or ecosystem (modified from oecd.org).*

Take-home messages

The practices documented show that the urgency of addressing land degradation in the rangelands is recognised, and is being specifically targeted.

A reduction of the vegetation cover is the major problem under all technology groups, most importantly perennial grass cover. Not only is there less biomass but it is of poorer quality.

Management of fire is crucial to its utility as a tool for increasing rangeland productivity. Poor management of fire can lead to the decline of vegetation types that are fire-sensitive.

A vicious cycle of degradation can occure where vegetation degradation increases soil degradation, which leads to further vegetation degradation – and so on in a descending spiral.

Aridification in rangelands, despite its severity, is the least perceived face of degradation: it is a hidden threat, a stealthy process with multiple detrimental impacts.

4.3.2 Health of the land

According to the technical reference on "interpreting indicators of rangeland health" (Pellant et al. 2005) rangeland health is defined as "the degree to which the integrity of the soil, vegetation, water, and air, as well as the ecological processes of the rangeland ecosystem are balanced and sustained." Different land management practices have varying impacts on the state or "health" of the land resources, which can be assessed through several indicators. An assessment was carried out by land users and SRM specialists – based mainly on observations – but supported with measurement where possible. Figure 4.21 shows the impact of the implementation of the SRM technologies on the state of the land using the indicators of vegetation, soil, water and biodiversity.

Vegetation

The application of most rangeland management practices from all five SRM technology groups improve soil cover by almost 60% (Figure 4.21) but most prominently in 'range improvement' and 'controlled grazing'. Furthermore, almost half of all technologies have improved the above-ground biomass, thus increasing the carbon stock. However, in the 'supplementary feeding group' 18% of the cases reported a negative impact. For 'supplementary feeding' grass is cut and carried to the animals, thus removing the biomass from the fields. Soil cover (in contrast to 'vegetation cover') includes any material that covers the soil: dead or alive. Vegetation cover is by living plants. Under the technologies cited, green vegetation cover is improved – but not as much as total soil cover, indicating that decomposing vegetation and dead material have also increased.

Box 4.12: Land degradation and land improvement spiral

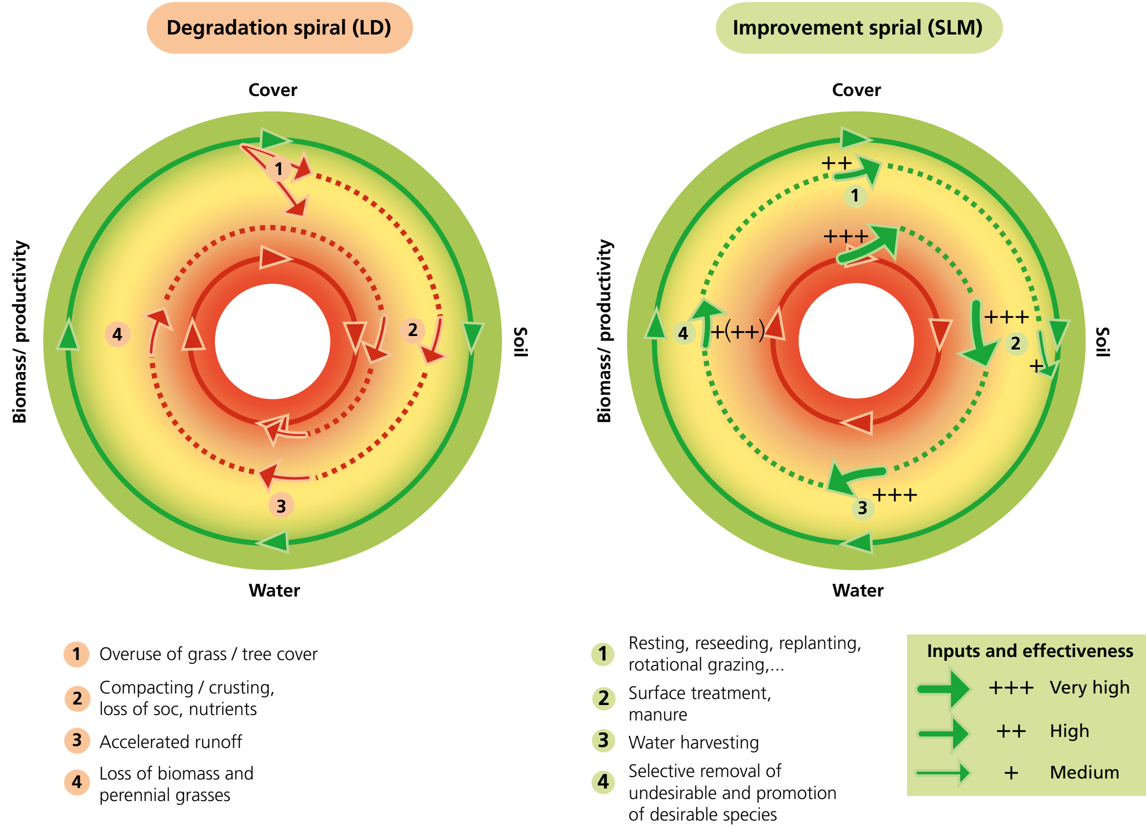


Figure 1: Downward spiral of degradation or improvement spiral of SRM. Outer green circle represents the sustainability circle, the inner red the degradation circle. Red dashed the downward degradation spiral, and green dashed the upward spiral towards sustainability (Hanspeter Liniger).

Maintaining healthy and productive rangelands needs a continuous effort to maintain a high cover of vegetation, good soil properties, high water use efficiency and biomass productivity. The aim is to establish a sustainability cycle. If vegetation cover is reduced, soil properties, water availability and biomass productivity begin to decline, and this triggers a downward spiral with further degradation of cover, soil, water and biomass. At any stage of the downward spiral, interventions can be made to stop the trend and redirect it into an upward spiral. The earlier the intervention and investment in SRM the less input needed and the easier it is to use the capacity of nature to restore itself: so crucial in the rangelands. Most effective interventions relate to vegetation cover improvement – especially grass – and this can be assisted by water harvesting measures and manure application (see Box 4.14).

Figure 2: Soil profile dug after a rainfall of 20 mm where there was a good cover of grass adjacent to bare ground. Under the grass cover, water infiltrated to a depth of about 25 cm and the soil is healthy. Where the soil was bare, the surface was sealed, the topsoil was hard and sterile, and no water infiltrated. This vividly illustrates the spiral towards degradation and the impact of SRM less than one meter apart (Hanspeter Liniger).

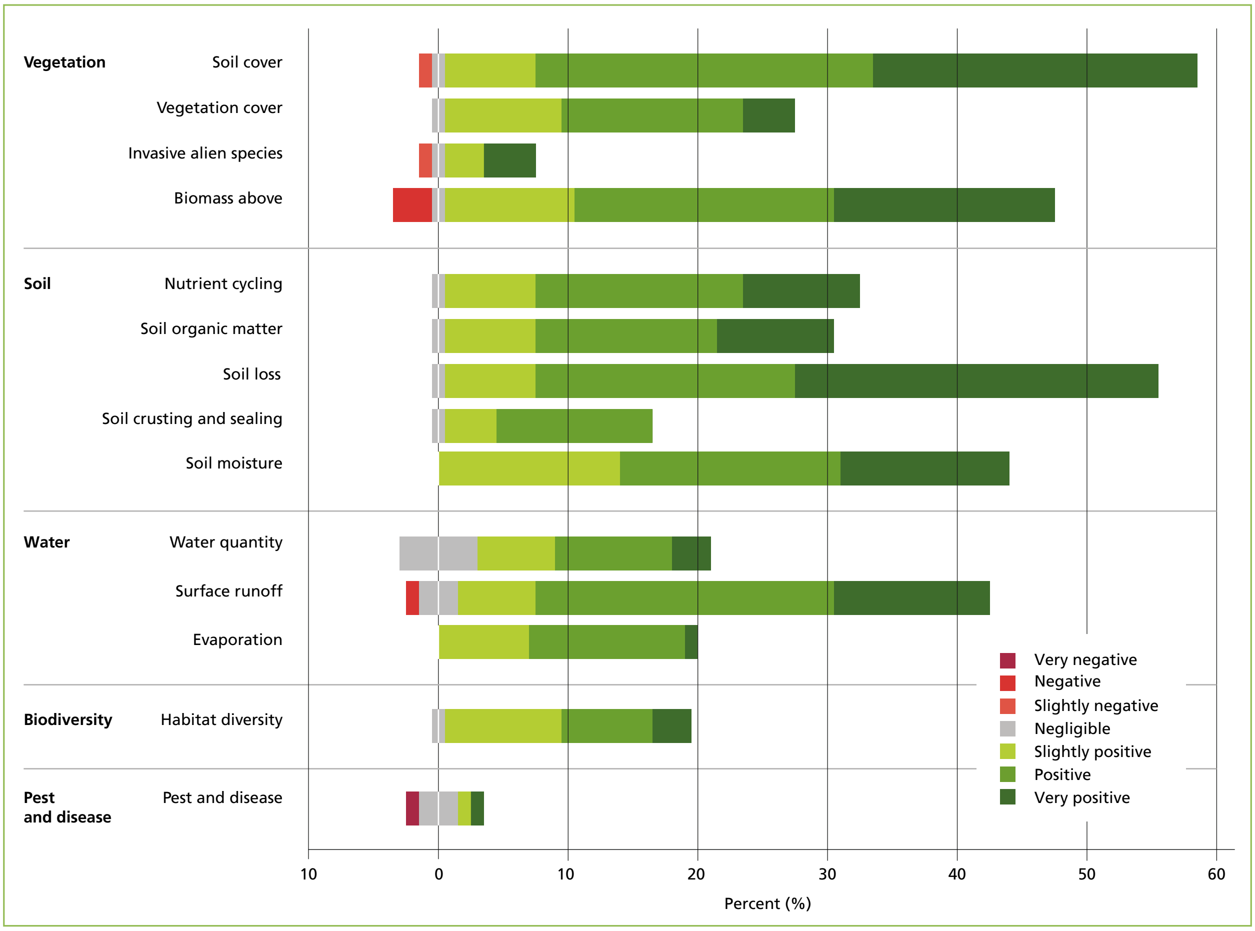


Figure 4.21: On-site impacts that the technologies have on the health of the vegetation, soil, water, biodiversity, pests and diseases in percent of total number of technologies. Impacts can be positive or negative (to varying degrees) compared with untreated areas.

Structural changes in plant cover, notably the loss or gain of shrubs and trees, also affect grass and herbaceous cover and productivity. On the one hand, browsing, tree and bush cover destruction by elephants, gathering of fuelwood and charcoal making, as well as clearing and burning for agriculture, can reduce the tree and bush cover. On the other hand, bush encroachment and tree cover increase due to reduced competition from grasses and less frequent and less intense fires (e.g. Rogues et al. 2001) and lead to degradation, for example in Southern Africa – due to invasion of thicket-forming acacias (see Box 4.10).

Practices for removal of invasive species can improve soil moisture availability and help to conserve the water table and in-stream flows. Invasive species such as the non-indigenous tree prosopis (*Prosopis* spp. or 'mesquite') reduce access to productive resources of pasture and water, by forming impenetrable thickets, suppressing indigenous vegetation, and by lowering water tables. Their economic impact is often profound. SRM practices to reduce invasive species and increase perennial grasses are 'Rangeland restoration, Kenya' (page 221) and 'Combating invader plants, South Africa'[19]. Other examples of loss of quality due to bush encroachment include 'Bush control, Namibia'[20] and 'Bush thinning and biomass processing, Namibia' (page 229).

Among Sub-Saharan African ecosystems, savannah vegetation has been identified as one of the most vulnerable to the effects of climate change. Over the last century, the encroachment of woody plants has already affected savannahs. Observed expansions in tree cover in South Africa have been attributed to increased atmospheric carbon dioxide concentrations and/or nitrogen deposition (Wigley et al. 2010). In the western Sahel, however, a 20% decline in tree density, and a significant decline in species richness across the Sahel was observed over the second half of the twentieth century, and mainly explained by changes in temperature and rainfall variability (Gonzalez et al. 2012). However, increased rainfall, a revision of laws governing ownership of trees, and a surge in land users' protection of emerging seedlings and trees has led to a reversal of this trend in many parts of the region (Critchley 2010). Sustainable rangeland management practices that address this problem include 'Assisted natural regeneration, Niger' (page 205).

However, the major concern is the loss of perennial grass cover – its replacement by forbs and weeds – and the exposure of barren, locally hard-crusted soil surfaces, changes in the micro-climate and increases in the aridity of rangeland through greater loss of rainfall in runoff (see Box 4.18). All of this hinders revegetation, and the rehabilitation of rangeland becomes difficult or even impossible, with a marked reduction in overall productivity and loss of many valuable plant species. SRM practices to address this include various water harvesting technologies (see Box 4.16) that capture runoff and use it for better vegetative growth (e.g. 'Vallerani system, Burkina Faso', page 183) – and protection of the natural water harvesting system such as *"brousse tigrée"*.

High levels of cover by perennial grasses play a key role in protecting the soil surface against raindrop impact; it holds soils and reduces runoff. Crucially these species, by definition, provide at least some cover at the end of the dry season. Overgrazing and poor management of livestock has the potential to greatly reduce perennial grass cover

Box 4.14: Community grazing management for perennial grass recovery in Namibia

Regeneration of rangeland productivity in communal grazing areas through grazing plans and merging herds was begun in 2006 at Erora, Namibia. Approximately 1200 cattle from 12 households were combined. Livestock owners noticed higher densities of annual grasses after the first season, then a dramatic improvement in soil cover after three years with emergence of grass seedlings where none had grown for decades. Then after another three years, perennial grasses returned with increased biodiversity in many parts.

https://qcat.wocat.net/en/summary/3423

(Kapi Uhangatenua)

(e.g. Pratt and Gwynne 1977, Briske et al. 2008), thereby greatly accelerating rates of soil erosion and rangeland degradation (Milton et al. 1994, Liniger and Thomas 1998, Fynn and O'Connor 2000). Apart from the problems of loss of soils, loss of deep-rooted perennial grasses decrease productivity of the rangelands (Box 4.14; O'Connor et al. 2001). Thus, for most of the practices, a major aim is to create better conditions for perennial grasses to spread – either by seed, rhizomes or stolons.

Soil

A decrease in soil loss (in 55% of the cases), reduced surface water runoff (in 42%), and increase soil moisture content (in 44%) have been the reported positive impacts of the rangeland management practices documented (Figure 4.21). The impact is moderate or substantial, especially in the 'range improvement' and 'infrastructure improvement' groups. There are associated increases in soil cover, improvements in range health and species compostion, improved water infiltration and better recharge of soil water. Several technologies illustrate the attempt to do so: 'Rangeland restoration, Kenya' (page 221), 'Reshaping gullies, South Africa' (page 235), 'Grass reseeding, Kenya' (page 215) and 'Assisted natural regeneration, Niger' (page 205). Additionally, structures to harvest water mainly for livestock, but also from people and small-scale crop production have the effect of capturing runoff, thus reducing water loss and soil erosion considerably, and with that comes improved soil moisture and fertility. Better soil organic matter and nutrient cycling, in other words improved soil fertility, is also reported in 30% of the cases. Box 4.15 shows an example of top soil organic matter enrichment due to corralling.

Water

Nearly half of the technologies implemented had a slight to very positive impact on regulating surface water runoff (Figure 4.21). This was (to a greater or lesser extent) observed in all technology groups except for 'enabling mobility'. Examples of positive impact on water runoff in the group 'controlled grazing' is 'Assisted natural regeneration, Burkina Faso'[21]; in 'range improvement' is 'Gully erosion management, Ethiopia'[22]; in 'supplementary feeding' is 'Intensive Livestock Management, Uganda'[23] and in 'infrastructure improvement' is 'Permeable rock dams, Burkina Faso'[24]. Most observations of water harvested come from the 'infrastructure improvement' group. In two cases within the 'range improvement' group, a negative impact on surface runoff was reported, for example in 'Firebreaks, Niger' (page 195) where surface runoff increased to at least 20% after the clearing of a firebreak. Technologies that enhance groundwater recharge include 'Sub-surface dams (SSD), Kenya' (page 271) and 'Infiltration ditches and ponding banks, Namibia'[25].

Rangeland management is recognised as being able to affect water supply both in terms of quantity and quality. Ensuring water availability for domestic and livestock supplies is essential for productivity and human well-being in the rangelands. In dry areas, this requires installation and operation of infrastructure, which is often expensive. SRM technologies can increase on-site water availability at a relatively low financial and ecological cost by harvesting runoff, reducing evaporation and improving the management of livestock watering points. An efficient and strategically located network/ distribution of water points is a key element of sustainable pastoralism: it helps to assure a balanced distribution of herds, and thus avoids overuse of vegetation around a limited number of wells (e.g. 'Improved well distribution, Niger'[26] and 'Indigenous livestock watering, Tanzania'[27].

Water quantity: Making productive use of potentially damaging runoff through in situ water conservation and water harvesting methodologies (Box 4.16), conserving soil and water, and promoting practices to improve cover within the different SRM technology groups are key issues.

Appropriate improvements in water infrastructure however can play a key role in the rangeland use systems (see Chapter 3.1). One particular sub-set are water harvesting structures that harness and hold or spread runoff, for example and especially permeable rock dams and water spreading weirs (Box 4.17), or reshaped gullies. However, land and water rights must be in place to assure the effectiveness of water harvesting systems. For example, in Ethiopian spate systems water rights are different from the rights that govern the sharing and allocation of perennial flows (van Steenbergen et al. 2011). They are more dynamic and respond to a situation that differs from year-to-year, as well as seasonally.

Pasture management affects the proportion of rainfall that is lost as runoff, as it creates the ecological conditions for improved water infiltration – thereby maintaining water tables and surface river water flows (Descheemaeker 2009, Blignaut et al. 2010, Taye et al. 2018). Healthy rangelands, where runoff, water availability and vegetation are well-

[19] https://qcat.wocat.net/en/summary/1374/
[20] https://qcat.wocat.net/en/summary/3396/
[21] https://qcat.wocat.net/en/summary/1359/
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[24] https://qcat.wocat.net/en/summary/1618/
[25] https://qcat.wocat.net/en/summary/3414/
[26] https://qcat.wocat.net/en/summary/2178/
[27] https://qcat.wocat.net/en/summary/3880/

Box 4.15: Grassland rehabilitation and topsoil organic matter enrichment: the impact of strategic 'mobile' corralling

Movable night corrals (bomas or kraals) are located on bare patches of soil to recover the degraded land through dung accumulation and breaking of the soil by hooves. Traditionally, these are formed by thorn-fence corrals used for months or years, but there are also metal-fence mobile corrals which can be moved after few weeks or even a few days (Porensky and Veblen 2015).

Results from an experiment in the semi-arid Laikipia rangelands of Kenya show not only improved spread of grass but also that former corral sites have significantly higher amounts of soil organic carbon (SOC), as well as macronutrients in topsoil compared to close-by reference sites (Herger 2018). Improvements are more pronounced after a number of years: thus former corrals turn into 'ecological hotspots' with improved grass cover – and stay that way for long periods of time, dependent on management (Figure 1).

On the investigated sites, each night corral was moved on average, after one to two weeks during the dry season and one week during the wet season. In one corral of 1000 m2, 400 cows were corralled at night. Former bare patches with this corral treatment recovered well after a few years (Figure 2).

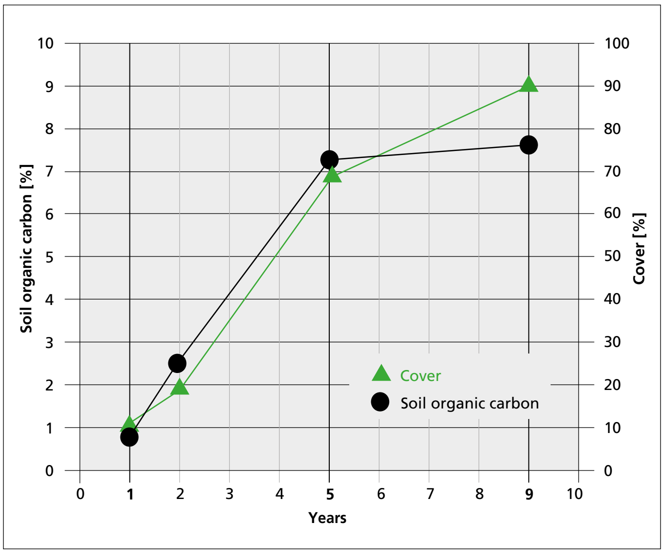


Figure 1: Topsoil organic carbon of a reference site and former coral sites 1, 5 and 9 years after treatment with movable night corralling (Hanspeter Liniger based on Herger 2018).

Figure 2: Sites of former night corrals moved over degraded and bare areas to improve cover and grass production. Left foreground: one year after removal of the corrals; left background: two years after with some increased greenness; right: nine years later, areas of the corrals still have a marked increase in grass cover (Hanspeter Liniger).

In Uganda, an enterprising community has been restoring denuded land in this way for a number of years through its own initiative (Muwaya et al, 2016). Night corrals are fenced with cut thorn bush and used for several months before being moved. The aim is to achieve a depth of 5 cm animal manure over the whole area. The naturally occurring stargrass, *Cynodon* spp, spreads through its vigorous stolons, which colonise the enriched area, forming a dense sward (Figure 3). Pasture dry matter was recorded to have increased to 4,500 kg/ha (from virtually none) and soil organic matter increased from 1.3% to 3.1%.

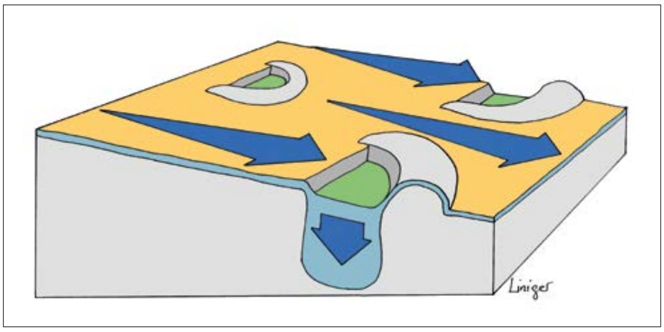
In this technology, land restores through localised nutrient enrichment, altering soil texture, grass recovery, and attraction of livestock and wildlife (Veblen 2012, Porensky and Veblen 2015). This positive effect has been proven to be long lasting for this reason (Augustine and Milchunas 2009). This means that the concentrated supply of dung is continued through this preferential grazing and resting also long after the corral has been removed. Thus former corrals sites can still be detected today as tree and shrub free vegetation patches with rich grasses – often surrounded by bare ground.

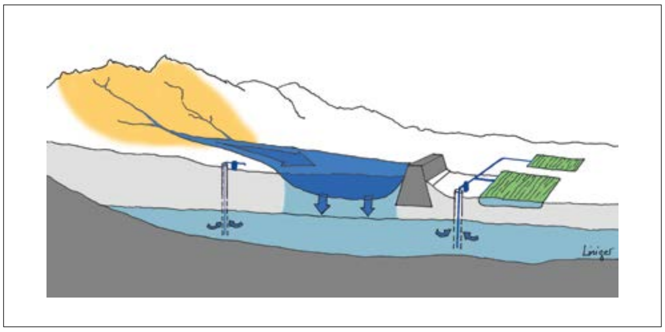
Figure 3: *Cynodon* spp is fast-growing and forms dense turf. It is native to Eastern Africa's drylands and is very palatable. While drought tolerant, it can withstand temporary flooding, has good tolerance of salinity and alkaline soils. Importantly it is stoloniferous and therefore can spread rapidly (William Critchley).

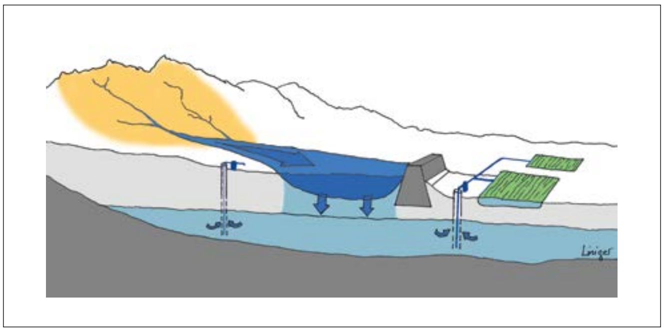
Box 4.16: Moisture conservation and water harvesting (WH) in rangelands

In-situ moisture conservation keeps rainfall in place by improved rainwater infiltration and reduced evaporation (soil and vegetation cover) and improved soil water holding capacity (soil organic matter content and structure);

Water harvesting captures precipitation falling in one area and transfers it to another, e.g. micro- and macro-catchments; basic components are a catchment or collection area, the runoff conveyance system, a storage component and an application area.







"Tiger bush" (*brousse tigrée*) is a naturally occurring WH system occurring in low slopes of arid and semi-arid regions such as Sahelian West Africa. It consists of alternating bands of trees or shrubs, separated by bare ground or low herb cover, that run roughly parallel to contour lines of equal elevation. On the bare soil, 80 – 90% of the rains is translated into runoff. Trees and grasses capture the runoff and utilise it after infiltration.

(Mekdaschi Studer and Liniger 2013).

Box 4.17: Water-spreading weirs for the development of degraded dry river valleys; Chad

In the dry valleys of Chad where water flows in the rivers for only a few days a year, weirs serve to distribute the incoming runoff over the valley floor and allow as much water as possible to infiltrate the soil. The aquifer is thus replenished and is then available for agricultural use.

In Niger, a weir enabled expansion of a production area from 2.85 ha before to 5.29 ha after (effects in Chad were similar). In Chad millet yield increased from 160 kg/ha before construction of a weir to 655 kg/ha afterwards. Users of water-spreading weirs had 112% higher incomes compared to farmers outside the impact zone from sales of vegetables and surplus grain.

In some communities, groundwater has risen to a depth of 6m below the surface. The increase in groundwater level has led to a significant increase in the number of cattle that can be watered – from 6,000 before to 16,000 cattle afterwards

https://qcat.wocat.net/en/summary/1537/; (Nill et al. 2011)

https://qcat.wocat.net/en/summary/1623/

Aerial view of a water-spreading weir, Chad (Heinz Bender).

Water-spreading weir, Mali (Klaus Wohlmann).

managed, continue to maintain the water cycle and maximise productivity with relatively little additional investment by rangeland users. But where vegetation cover over large areas has been lost, this can make runoff more difficult to handle and causes alterations in the hydrology of the system. In short, sustainable rangeland management can play a positive role in the dryland water cycle. This is difficult to quantify, but where rangelands are being degraded or converted to other uses, and the on-site capacity to hold runoff is lost, the negative effects on hydrology both on and off-site become more apparent as downstream water supplies are affected.

Box 4.18: Comparing neighbouring private and group ranches in Kenya: impact on the land

From a series of studies carried out on two neighbouring ranches, one a private ranch and the other a group (community) ranch, with similar environmental conditions – but very different management practices and grazing pressures – productivity and environmental impacts were assessed and compared (Figure 1).

Characteristics of the two neighbouring ranches:

	Private ranch	Community ranch
Wildlife	Antelopes, zebras, elephants, giraffes, predators and others	Antelopes, elephants and others about 15 times less than in private ranches
Livestock	Cattle, sheep, camels	Sheep, goats, cattle, donkeys, camels
Stocking rate	Livestock alone: 5.2 ha/ TLU* Livestock and wildlife: 3.7 ha/TLU* Rotational grazing of livestock	0.6 ha/ TLU* Continuous grazing during dry season; rotational grazing during wet season
Production focus	Commercial: milk, meat, wool	Subsistence: milk, blood, meat, honey

* TLU: Tropical Livestock Unit. Source: Compilation from Herger 2018.

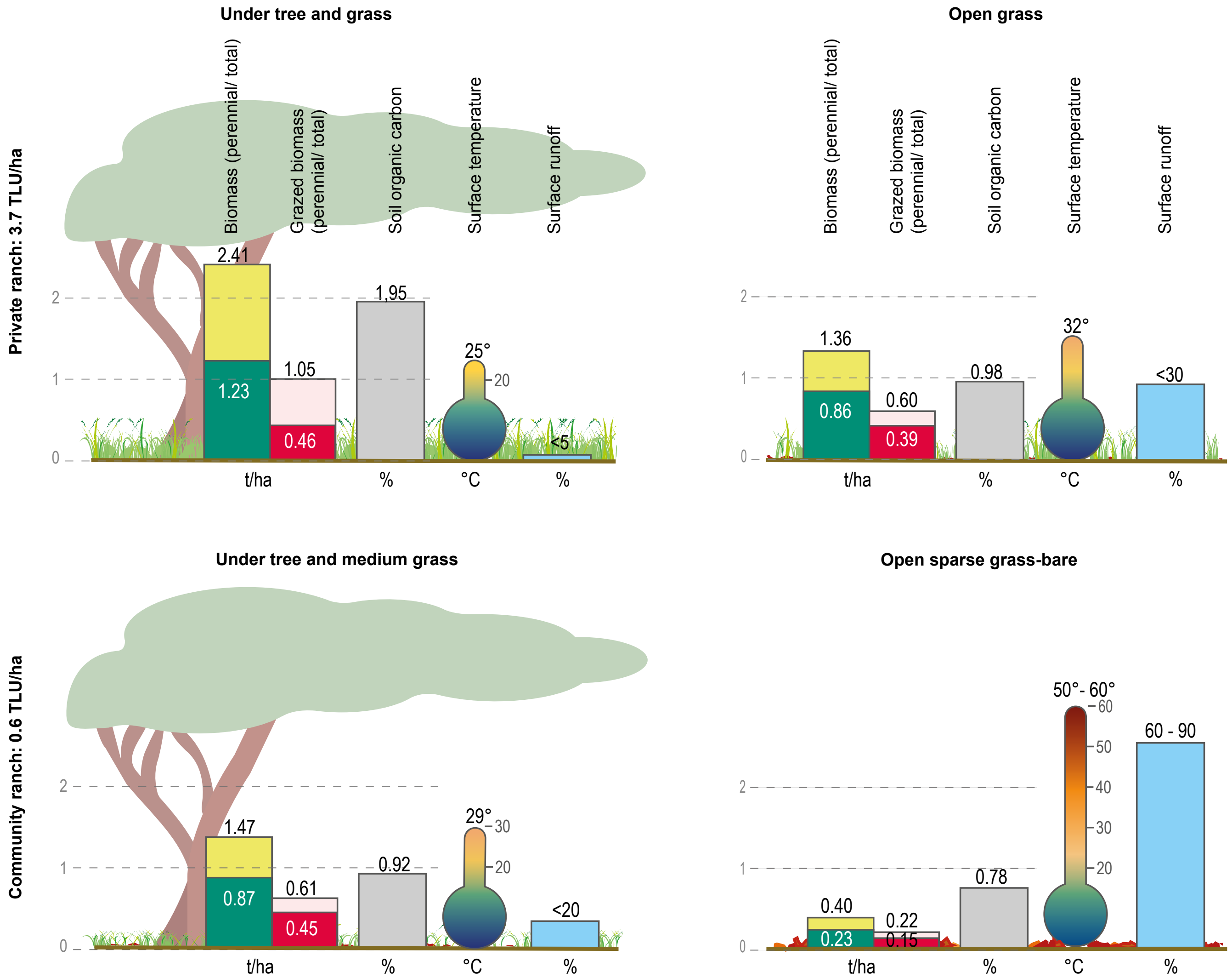


Figure 1: Biomass total and grazed, soil organic carbon, surface temperature, (infiltration) and runoff from a private and the neighbouring community ranch (Hanspeter Liniger based on Kironchi et al. 1993, Okello 1996, Liniger and Thomas 1998, Herger 2018).

Water quality: Vegetative cover, root systems and soil properties are recognised as playing essential roles in not only regulating water flow but also in improving water quality. In around 10% of the practices a positive impact on water quality was reported. Vegetation, microfauna and microflora in healthy soils reduce pollutants from overland flow and in groundwater through various means. These include trapping water and sediments, adhering to contaminants, reducing water speed and enhancing infiltration, biochemical transformation of nutrients, absorbing water and nutrients from the root zone, stabilising eroding banks, and diluting contaminated water (Elmqvist et al. 2010). Questions regarding water quality take second place to the more pressing issue of water shortage and availability. However, the value of potable water – and danger of deterioration of water quality especially when humans and livestock share the same sources, should not be underestimated. An example reporting benefits to water

Box 4.18 continued: Comparing neighbouring private and group ranches in Kenya: impact on the land

The grazing pressure in the community group ranch is six times higher yet the biomass available is less than half than in the private ranch. While it could be argued that the group ranch is over ten times as efficient – in terms of maintaining livestock numbers – livestock growth rate was not measured. Furthermore, the livestock from the group ranch are not entirely restricted to stay within their own demarcated areas, especially during dry seasons and droughts (grazing on neighbouring private ranches, on farms of agro-pastoralists or in forest reserves).

There is a marked difference both under trees and in the open grassland areas where the private ranch has around double the biomass – and twice the amount that is grazed. Soil organic carbon (SOC) of the topsoil under trees in the private reaches 2% compared with about 1% in the community ranch. Under open grass cover SOC in the private ranch is 1% compared with 0.78 % in the group ranch – where perennial grasses have almost disappeared.

Measuring surface temperature in the early afternoon reveals very wide differences. Under trees 25–29 degrees are recorded depending on herbaceous cover. On patches of good perennial grassland the temperature is around 30 degrees, while where the red soil is exposed, it heats up to 50–60 degrees. There are major implications for water loss by evaporation and runoff and also for soil biodiversity: the earth becomes dried out and, eventually, sterile (see Box: 4.22).

Runoff rates also change dramatically depending on the cover and the management: bare land in the group ranches can lose 60% – 90% of daily rainfall. Combined with direct evaporation from the surface this means greatly reduced vegetation growth. Yet, keeping land covered with perennial grasses not only maintains cooler conditions but also captures rainfall and even runon water from neighbouring bare soil patches: a "virtuous cycle".

Figure 2: Comparison of different management sites and cover differences from adjacent sites on the same day in the dry season. Left: good perennial grass cover (under trees and in the open areas). Middle: topsoil under tree with good perennial grass cover: SOC 1.97%, loose well structures soil with high root density. Right: open land with no perennial grass cover: SOC 0.78%, soil surface crusting and hard and sterile top soil (Hanspeter Liniger).

This example illustrates how different land management can have a fundamental impact on the soil, microclimate and vegetation – and how vegetation itself can contribute to improved growing conditions. Apart from a reduced biomass production, there is also an increase of undesirable plant species (e.g. opuntia) in the community ranch. Striking is that these differences occur next to each other within a few meters distance.

Figure 3 illustrates the effect of cover on runoff and soil loss for soil derived from metamorphic gneisses. The straight line in (a) encloses the maximum percentage of runoff that occurred. With a herbaceous cover of less than 5%, over 90% of the rain can be lost through runoff; at a cover of 40%, runoff is reduced to practically zero. For soil loss, the figure shows that with a cover of more than 20 %, topsoil loss is reduced to almost zero. However, on long slopes, gully erosion can occur if enough surface runoff is accumulated and able to cut into the topsoil.

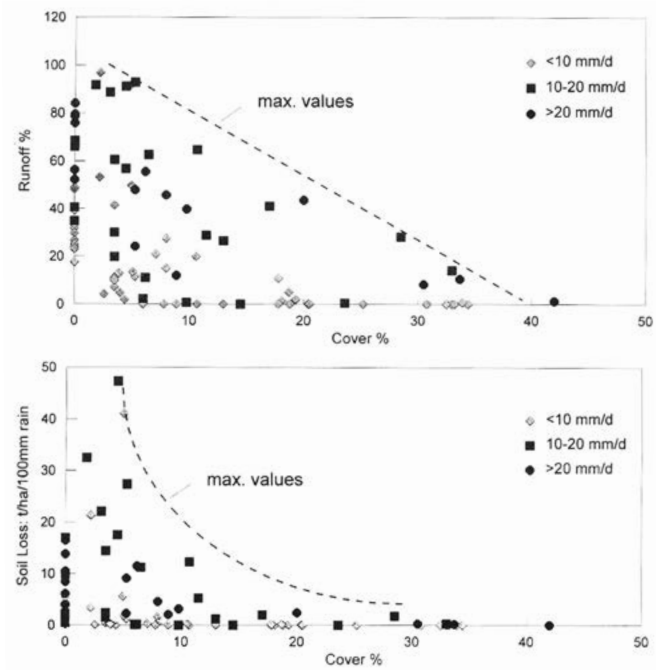


Figure 3: Effect of land-use/cover on runoff and soil loss from 2 by 10 m plots in the ranches (Liniger and Thomas 1998).

quality is 'Indigenous livestock watering, Tanzania'[28], not allowing animals to enter into the water ponds but drink from troughs instead. The impact of good land management on water quality – and thus water-borne diseases and livelihoods – has not been sufficiently established, but the connection is clear.

Biodiversity

Over all the documented practices almost 20% indicated a positive impact on habitat diversity, with as many as 45% under 'controlled grazing' practices (Figure 4.21). The fact that habitat diversity is recognised in so many cases indicates an element that would be worthwhile further exploring. In particular the role of alien – and some native – invasive species leading to the loss of grass cover and increasing land degradation still needs keen attention (see Box 4.10).

The role of fire on its own, or in combination with bush encroachment, has been reported to affect biodiversity (see Box 4.11). 'Enabled mobility' is a group where there are almost no remarks about how it affects the state of the land – though it would be expected that grazing pressure would diminish. But evidently the impacts are not perceived – possibly because the scale is too large to allow recognition of changes in degradation status.

Box 4.18 shows and example of of contrasting differences in land management and the impact on the health of the land.

Take-home messages
Bush encroachment and tree cover increase due to reduced competition from grasses.
Among Sub-Saharan African ecosystems, savannah vegetation has been identified as one of the most vulnerable to the effects of climate change.
A high level of cover by perennial grasses plays a key role in protecting the soil surface against raindrop impact; it holds soils and reduces runoff.
A major aim is to create better conditions for perennial grasses to spread – either by seed, rhizomes or stolons.
Rangeland management is recognised as being able to affect water supply both in terms of quantity and quality
Making productive use of potentially damaging runoff through in situ water conservation and water harvesting methodologies conserving soil and water, and promoting practices to improve cover are key issues.
Sustainable rangeland management can play a positive role in the dryland water cycle (quantity and quality)

4.4 Impacts of SRM on ecosystem services and human well-being

This section describes the nature and value of SRM impacts on ecosystem services, in water-stressed and drought-prone rangelands across Sub-Saharan Africa. It highlights the benefits of SRM from cases documented by WOCAT in different parts of SSA. Each technology and approach generates an array of social-cultural, economic and ecological impacts which must be taken into account for planning and decision-making for further implementation. The influence of SRM on ecosystem services can include both on-site and off-site impacts. On-site impacts are directly important to the rangeland users, but off-site impacts also affect other groups in society. Table 4.5, Figures 4.22 and 4.23 show and analyse the impact of the technologies and approaches on the services for production, nature and people.

4.4.1 Services for production

Providing forage and fodder: The technologies applied had a positive impact on fodder/ forage production (in around 75% of the cases), on livestock production (60%) and on fodder/ forage quality (50%) (Figure 4.22). Fodder/ forage production improved considerably in 80-100% of the cases pertaining to 'controlled grazing', 'range improvement' and 'supplementary feeding' (data from WOCAT DB). Under 'infrastructure improvement', fodder production was improved in only 40% of the cases: it is not the primary objective in those situations.

However, improved fodder/ forage production was adjudged to be of overall priority for rangeland management, ranked even above livestock production. This is promising for those implementing SRM, when despite the widespread degraded conditions of the vegetation, other rangeland users often stated that livestock (particularly cattle) were valued more than the land. Where efforts are made towards SRM, the value and importance of improving forage and fodder production – as the foundation of animal production – should be seen as the number one priority.

Providing water for livestock and people: Water availability for livestock improved in 20% of the cases, and mainly in those cases where it was specifically targeted (Figure 4.22). These included a number of technologies under 'enabled mobility', 'infrastructure improvement' and 'controlled grazing'.

Boreholes, water pans (excavated earthen reservoirs) and small dams are common features of many Sub-Saharan African rangelands. But a relatively new development is that vast areas of rangeland, previously utilised only seasonally by domestic livestock, are now accessible year-round as a result of the expansion of borehole technologies (Le Houerou 1989, WRMA 2016a, WRMA 2016b). Climate change and associated water scarcity are contributing to a situation where many rangelands are becoming increasingly dependent on boreholes for a greater part of the year. During dry seasons and droughts, large numbers of people and livestock gather around boreholes, available water pans, permanent rivers and wetlands – and also seasonal rivers where, though apparently dry, water is stored in the sand beds and can be tapped (e.g. 'Sand dams, Kenya'[29]). During these periods, wetlands and floodplains come into use. However, permanent or prolonged availability of water increases pressure on the land as animals can graze in the vicinity for longer. Likewise, poorly sited watering points may increase degradation by encouraging grazing where land would have been better rested.

A range of technologies and innovations are available for constructing and improving water pans and small dams. However, these have a limited lifetime if they are not well protected against sedimentation. Good practice includes attention to siting, design of inlets/ silt traps, fencing and barriers to prevent animals from entering the water, and dredging for the removal of sediment – though this latter practice is expensive and a last resort. Dams and pans are very sensitive to management of their catchment area. If the land and its vegetation cover is degraded then the dams and pans will be rapidly degraded in turn. Investment in the catchment area to improve cover, biomass production simultaneously improves long-term water availability. Where water pans and dams can be constructed and managed effectively, these generally supply water at a lower cost than boreholes (Box 4.19). In Burkina Faso 'Permeable rock dams'[30] – which allow water to flow through, while sediment is trapped – serve to restore seriously degraded forest/ rangeland. They are effective in

Table 4.5: Ecosystem services for production (provisioning), for nature (regulating and supporting) and for people (socio-cultural). In bold are issues that are specifically addressed in this chapter (WOCAT Technology Questionnaire 2018).

Ecosystem Services	Impacts on-site and off-site of technologies on:	Impacts of approaches on:
Service for production	• **fodder/ forage production** • **fodder/ forage quality** • **animal/ livestock production** • non-wood forest production • **water availability for livestock** • water quality for livestock	
Service for nature	On-site • **micro-climate** • **drought** • **fire risk** • **emissions of CO2 and other GHGs** • **water availability** Off-site • **water availability (groundwater/ springs)** • **reliable and stable stream flow** • **downstream flooding (and erosion)** • **downstream siltation** • **wind transported sediment** • buffering/ filtering capacity (by soil, vegetation, wetlands) • groundwater/ river pollution • impact of GHGs	
Service for people	• **damage on public/ private infrastructure and property** (off-site) • **food security/ self-sufficiency** • health situation • **land use/ water rights** • **institutional: land & water use systems and social structures** • **SLM/ LD knowledge,** (environmental consciousness; education) • **conflict mitigation** • **situation of social and economically disadvantaged groups/ gender** • cultural opportunities (spiritual, religious, aesthetic) • **recreational opportunities** • **benefits and costs**	• **food security and nutrition** • **land use rights** • access to water and sanitation • **build/ strengthen institutions, collaboration between stakeholders** • **knowledge and capacities of land users to implement SLM** • knowledge and capacities of other stakeholders • **mitigate conflicts** • **empower socially and economically disadvantaged groups** • **gender equality and empower women and girls** • **resilience to CC**

raising the water table in wells and in protecting the bottomlands from sand filling and gully erosion.

Changing the types of watering points that are available in rangeland (e.g. from naturally occurring seasonal water pans to boreholes) can give greater control to local rangeland managers. This is because at boreholes they can choose to turn water supplies on and off at different times of the year, whereas pans remain open for anyone to use – free of charge – until they dry up. In Namibia, herders rely on over 50,000 boreholes that tap deep underground aquifers for their water: solar energy has been used for pumping for over 30 years, and between 2001 and 2006, 669 new solar-powered wells were installed (McGahey et al. 2014). It is not only in Southern Africa, but throughout the rangelands of Sub-Saharan Africa, that more and more boreholes are being dug and groundwater tapped (Box 4.20). The recharge of these groundwater aquifers is in most cases not assured, and sinking groundwater levels are commonly reported. The longer-term consequences of this increasing number of boreholes is a growing worry: increased use of groundwater in drylands without knowledge of the recharge rate and the source of water, means that it is unsure for how long these supplies will remain viable and how soon the aquifers, upon which they depend, will be depleted. Yet, as demands on water increase and surface water has become scarcer, more and more groundwater is being tapped especially during drought periods.

There is need for operators to manage the water points, and for institutional structures to organise them (Box 4.21). These may involve customary institutions that have evolved in the rangelands according to local traditions (e.g. as described in Tari and Pattison 2014) or, where such structures do not exist, governments may seek to create water user associations. These institutions also require funds to pay for staff time and operational costs. In some cases, these are included in the fees that are paid by the water users.

Water productivity: Beef production 'water footprint' studies have shown that industrial livestock systems have a far higher freshwater footprint than livestock raised in extensive grazing systems – meaning they are much less efficient in water use, basically because they use so much grain (itself a 'thirsty' crop) which then has to be converted into meat. Industrial livestock also produce 'grey water', that is dirty wastewater that has to be disposed of; however this is not an issue for rangelands (McGahey et al. 2014). Significantly, Kenya has made the case for evaluating rangeland productivity on the basis of economic productivity per unit of water, rather than per unit of land (Government of Kenya 2017). Analyses of productivity per unit of water tend to demonstrate that extensive rangeland management systems can be highly efficient, compared to other more water-intensive production systems. In many dry and drought-prone areas, productivity per unit of water is more critical than productivity per unit of land – which is less limiting.

[28] https://qcat.wocat.net/en/summary/3880/
[29] https://qcat.wocat.net/en/summary/3588/
[30] https://qcat.wocat.net/en/summary/1618/

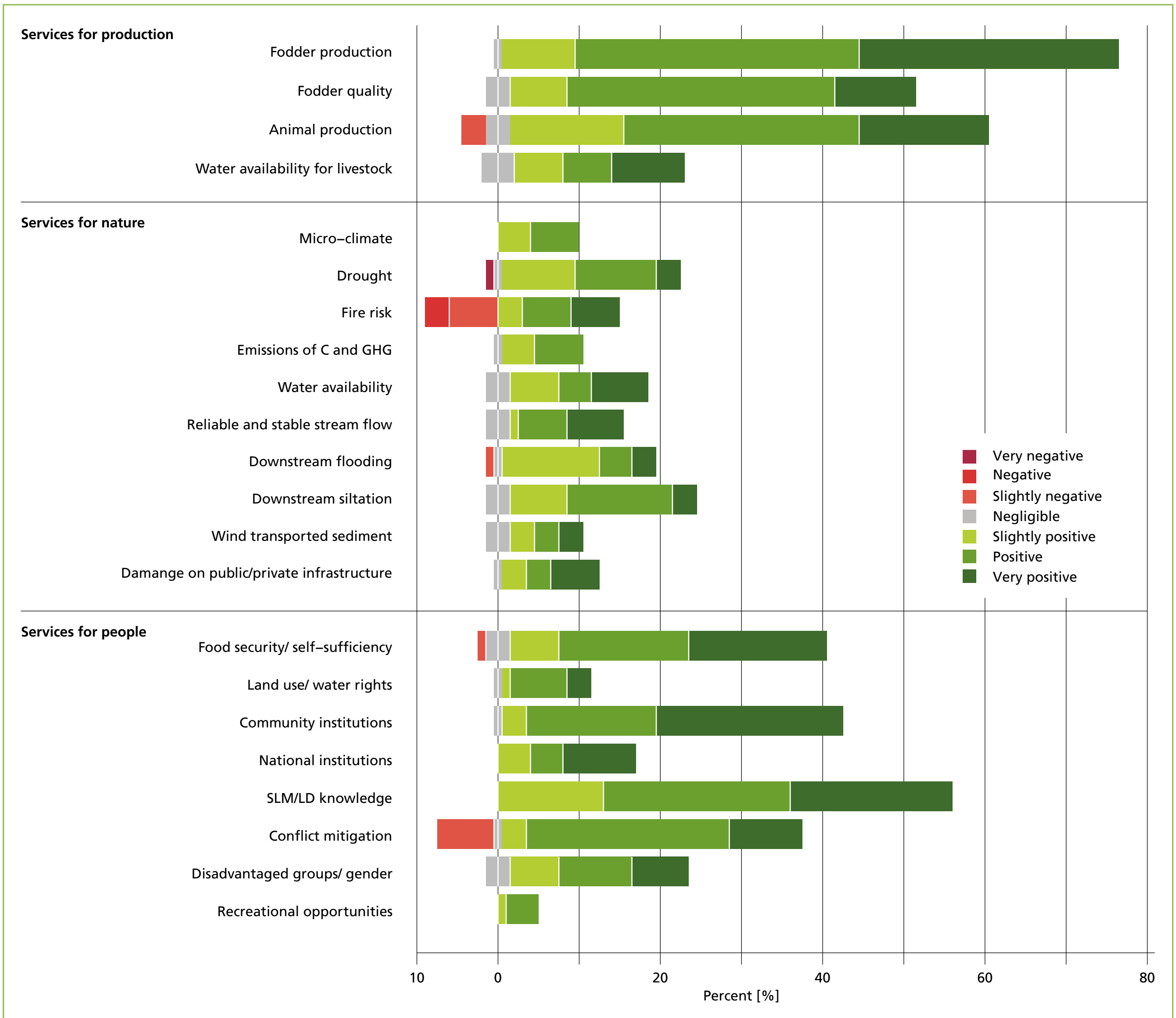


Figure 4.22: On- and off-site impacts of SRM technologies on ecosystem services for production, for ecology and nature and for people (percent of total technologies). Impacts of SRM can be positive or negative.

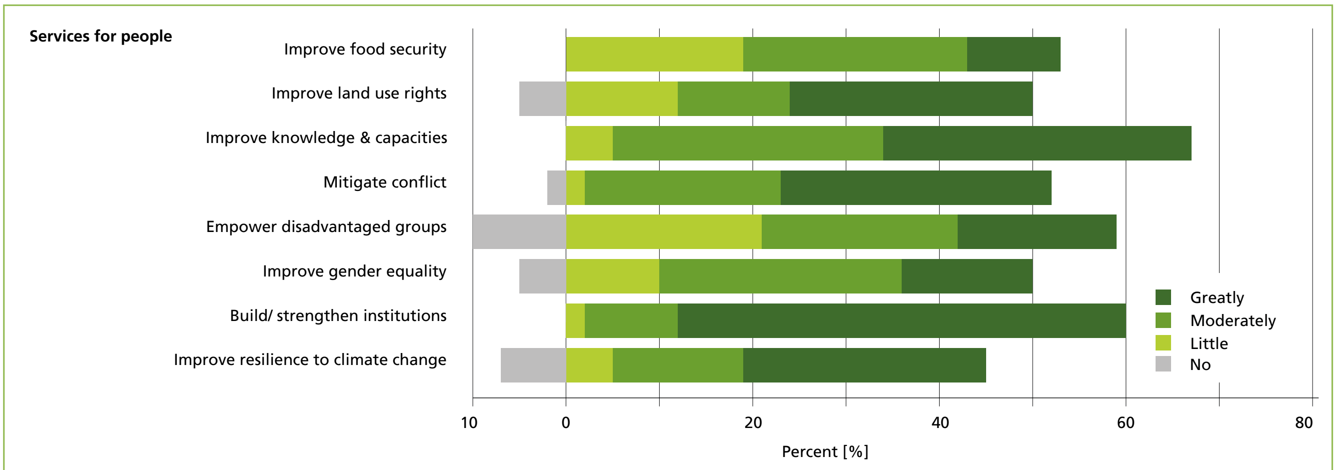


Figure 4.23: Impacts of SRM approaches on services for people in percent of total number of approaches.

4.4.2 Service for nature

The impact on services for ecological benefits were little evident from the cases analysed – probably because not all technologies were intended to address the same service, and furthermore, ecological changes usually take time, and are also mainly off-site. The greatest impacts were recorded for downstream siltation, according to almost 25% of the cases, followed by drought (23%), downstream flooding (almost 20%), water availability, reliable and stable downstream flow and fire (about 15%). Some improvements in micro-climates were recorded in 10% of the technologies (Figure 4.22).

Box 4.19: Improving the management of Har Buyo pan in Garba Tula, Kenya

At Har Buyo water pan in Garba Tula, Kenya, in 2014 the Abaerega (natural resource manager), reported that he used one litre of diesel per day to pump water to a trough. To cover these costs, and any others arising, he collected levies from users as follows: US$ 0.11 (Ksh 10) per camel, US$ 0.03 (Ksh 3) per cow, US$ 0.1 (Ksh 1) per goat or sheep, no charges for people, donkeys or young livestock (Awuor, 2014). Generic water requirements for animals can be estimated, and used to derive the price paid per unit of volume, and the overall demands of livestock populations (see table below). However, these do not reflect the value of the water, and indeed barely cover the costs of the equipment and energy used to pump it.

Unit cost of water in Garba Tula based on generic requirements (WRMA 2013)

Type	WRMA (litres/capita/day)	Price per head (US$)	Price per head (Ksh)	Unit cost (US$/l)	Unit cost (Ksh/l)
Shoat	3.5	0.01	1	0.003	0.29
Cattle	23.25	0.03	3	0.001	0.13
Camel	33.5	0.11	10	0.003	0.30

http://pubs.iied.org/pdfs/10183IIED.pdf

Working group on domestic and institutional uses of water and energy, Garba Tula (Ibrahim Jarso).

Har Buyo pan (Ibrahim Jarso).

Box 4.20: Increased rate of groundwater abstraction, Kenya

'The Ministry of Water and Sanitation together with the private sector in Kenya are engaged in drilling of boreholes to improve access to water for households. A total of 2,419 boreholes are expected to be sunk country-wide in 2017/18 compared to 1,557 boreholes sunk in 2016/17 as a drought mitigation measure. Whereas the number of boreholes drilled by the public sector declined, those drilled by the private sector almost doubled in 2017/18.'

Excerpt from Economic Survey of Kenya at: https://www.knbs.or.ke/download/economic-survey-2018/

(drillingforlife.org)

Micro-climate: Importantly, observations and measurements reveal that reduced or improved vegetation and soil cover have a dramatic impact on the micro-climate, as demonstrated in Box 4.22. Soil surface temperature between adjacent sites show a difference of more than 30 °C: thus on a site with about 50% dry grass cover, compared to a site a few meters away with a bare soil surface, the temperature can rise from around 30 to over 60 °C. The extremely hot surface of a bare soil destroys soil life and is a factor in sterility and aridification. The impact and the importance of a favourable microclimate is often underestimated, and unperceived. Favourable micro-climates can lead to improved soil moisture and air humidity, balanced temperature extremes and radiation, and protection against wind damage.

Fire risk: Implementation of the SRM technologies also showed negative impacts – as with fire risk (in 9% of cases). More biomass and 'improved' rangeland can increase the risk of spontaneous fire under long dry periods and drought. Further analysis showed that a fire risk increase has been reported from 'range improvement' (e.g. 'Infiltration ditches and ponding banks, Namibia'[31]; 'Pitting to restore degraded catchment, South Africa'[32]) and 'supplementary feeding' (e.g. 'Area closure, Ethiopia'[33], affecting around 15-18% of the cases, due to greater biomass production.

[31] https://qcat.wocat.net/en/summary/3414/
[32] https://qcat.wocat.net/en/summary/3659/
[33] https://qcat.wocat.net/en/summary/1599/

Box 4.21: Improving the management of boreholes in Merti, Kenya

Ward Adaptation Planning Committees (WAPCs) have dug new boreholes and also improved the management of existing water points. They also added troughs to accommodate more livestock, together with separate taps for domestic water collection and toilets. This has eased congestion, saving time and averting conflicts. As a result, women can use water points more frequently. Women using Yamicha and Urura boreholes in the remote northwest can now fill ten jerrycans (20 litres capacity) each time they visit. If they do this daily, it will cover the minimum needs of 20 litres per person for a household of six, and still leave an additional 80 litres for washing and caring for smallstock.

The WAPCs have also improved water quality at both boreholes and water pans. Covering storage cisterns and fencing water pans, for example, has prevented contamination by birds and livestock. Livestock used to wander into unfenced water pans, making the water unfit for human use. Once the water became too dirty even for livestock, the women would abandon the water pans and either buy more water from kiosks or search for it elsewhere. By protecting its quality, humans and livestock have been able to make better use of more of the available water.

http://pubs.iied.org/pdfs/17345IIED.pdf

Participatory resource mapping under solar panels in Merti (Caroline King-Okumu).

Pastoralists loading donkeys with water for domestic use at Duma borehole (Jane Kiiru).

Water availability was improved in around 20% of all documented technologies (Figure 4.22), but mainly in the 'enabled mobility' (60%) and the 'infrastructure improvement' (56%) groups. Both of them involve better distribution of water points and/ or water harvesting and surface water management.

Coping with gradual climate change and climate-related extremes/ disasters: Figure 4.24 shows that more than 35% of the technologies were appraised to be able to cope well or very well with drought, almost 30% with increasing annual temperatures, and 25% with local rainstorms and windstorms. Further analysis showed that 'Enabled mobility' (60%), 'range improvement' (42%) and 'infrastructure improvement' (42%) coped best with drought. In these TGs 'Index based livestock insurance, Kenya'[34], 'Vallerani trenches, Niger'[35] and 'Indigenous livestock watering, Tanzania'[36] are examples showing different drought coping strategies, respectively. 'Range improvement' technologies were found to tolerate an increase in annual temperature the best, as they create favourable micro-climates through improved soil and vegetation cover.

The technologies applied improved the capacity to cope with droughts and water availability (on-site), and protected against downstream flooding and siltation (off-site) – probably as a result of better soil cover and less runoff. Through 'enabled mobility', the effects of drought were mitigated in 60% of the cases in a positive/ very positive way. This technology group has, by far, the best coping mechanism during droughts. This is followed by controlled grazing, where parts of the rangelands are rested to build up fodder and forage reserves for the dry seasons and droughts. High impacts of drought in one year are acknowledged to have significant effects on households' abilities to cope in subsequent years, but SRM practices act in multiple ways to cope with long dry periods and droughts. Investing in the land and its productive capacity are vital in strengthening people's resilience to drought and climatic shocks. Sustaining rangeland water and pasture resources and avoiding the depletion of household assets can help to reduce the needs for large-scale movements of people during droughts. This reduces the risk of situations where very large numbers of people and animals are crowded into areas with little water or food resources to support them. Traditional mechanisms that pastoralists have used to adapt to drought have in many cases have proved no longer effective in many cases. For example, in Ethiopia's pastoral Borana zone, the local institutions that support social safety networks have been weakened by time, compounded by years of cyclical drought. Their place has been filled by external aid and state support schemes – but these are not able to make up for this loss of adaptive capacity (Holden and Shiferaw 2004). Furthermore this has eroded local 'ownership' of the processes.

Off-site impacts of land management (downstream and downwind): In water-stressed basins, where water demands for domestic and other needs are increasing, there can be growing competition between livestock and human populations for finite supplies. In many parts of West and East Africa, seasonal floodplains used by pastoralists for grazing and water during dry seasons have been altered by upstream extractions of water for irrigation and hydropower – resulting from the lack of recognition of the seasonal rangeland production systems that would be impacted. Examples include the extensive rangeland systems of Northern Nigeria (Barbier 2011) the Inner Niger delta in Mali (Aich et al. 2016) and parts of Mauritania (Shine and Dunford 2016). A similar situation is potentially developing in Southern Africa also, for example in Namibia where water is extracted from the upstream Okavango river to irrigate maize, while the Okavango is the very river that nourishes the delta floodplains of the Okavango in Botswana (Box 4.23).

Water is both an input (cost) of rangeland production, but also an output or service provided to people and animals by naturally occurring wetlands in the extensive open access

Box 4.22: Shocking surface temperatures of degraded rangeland

Two examples demonstrate the enormous differences in the afternoon temperature of surfaces with vegetation cover, and those with bare and exposed soil.

Figure 1 shows a location in the highlands of Kenya at 1800 m a.s.l. with perennial grass and tree cover – where surface temperature at 2 pm on clear and sunny days is around 25°C (left). In sharp contrast, closely neighbouring it, is the bare soil of an overgrazed area where the surface temperature is more than double: around 56°C (right). Figure 2 show a similar comparison in the lowlands (800 m.a.s.l.). Here the temperatures rise from around 35°C on patches with about 50% grass and tree cover, to around 43°C on surfaces with 50% dry grass, and up to 63°C on bare soil patches: this latter temperature is as high as that of an exposed gneiss rock surface. This remarkable difference, due to removal of vegetation cover, is clearly detrimental to the health of the land, the livestock and wildlife, and the people (see Boxes 4.12 and 4.18). Considering the extended areas of degraded land with an increased fraction of bare soil, the contribution of land degradation towards global warming would be worthwhile investigating.

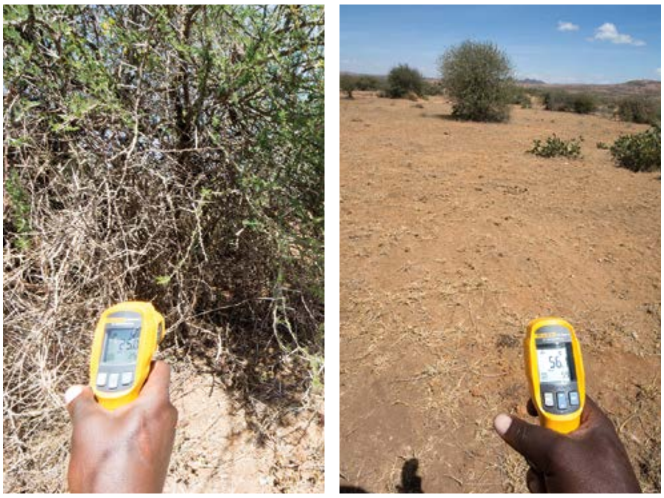


Figure 1: Early afternoon surface temperature under cover equal 25°C (left), and on almost bare soil equal 56°C (right) on Kenya's semi-arid Laikipia Plateau (Hanspeter Liniger).

Figure 2: Early afternoon soil surface temperature in the northern Kenya semi-arid lowlands. From left to right: (a) 50% dry bush/ grass cover = 33°C (b) 50% dry grass cover = 43°C (c) on bare soil = 63°C and (d) on bare gneiss rock = 63°C (Hanspeter Liniger).

rangeland management systems. Wetlands buffer water by absorbing flood flows and providing a permanent source of water – and forage – for pastoralists and their livestock, as well as wildlife, during dry seasons and periods of droughts. As with most natural resources in the rangelands many wetlands are subject to increasing pressure. On the one hand, water supply to the wetlands is changing due to increased water abstraction upstream – and the combination of increasing rainfall intensities and land use change is likely to lead to increased flood flows for wetlands to absorb. On the other hand, there is greater use of the water and vegetative biomass, and inadequate recovery time. There is plenty of anecdotal evidence from wetland users but little data regarding change, and impact on wetland resources and their services. Apart from being affected by climate change and greater variability of rainfall, wetlands also have to absorb changes in the upstream land use and its implications on flow and sediment delivery. Also the demand on the wetland resources attracts people, their livestock and the wildlife from far away making monitoring and management of wetlands a real challenge (Box 4.24, see Chapter 2.1.1). Changing the management of the rangeland system can affect the demand for water – for example for inputs to crop production – and also the ability of the system to provide clean water supplies at low cost.

In terms of off-site impacts, 25% of the cases coped positively with downstream siltation, almost 20% were able to deal with downstream flooding – which could lead to off-site damage of infrastructure – and 15% showed an improvement in terms of a reliable and stable stream flow regime (Figure 4.22). 'Enabling mobility' and 'controlled grazing' which are mainly managed through livestock and wildlife grazing, did not show any effect on downstream siltation or flooding, in contrast to the other three technology groups. This is surprising, as controlled grazing should improve cover, which would mean a reduction in runoff and soil loss. The reported cases have probably not monitored – or perhaps not even perceived – the impact downstream.

High priority questions requiring attention from rangeland managers – in association with researchers – concern the effects of their SRM practices, either individually or collectively, on watershed scale hydrology (George et al. 2011; Box 4.25). Managing rangeland watersheds to deliver improved quality and quantities of water to urban consumers has been identified as a critically important way in which SRM can affect ecosystem services that are of value to people (Goldstein et al. 2011, Gammie and Bievre 2015).

[34] https://qcat.wocat.net/en/summary/4012/
[35] https://qcat.wocat.net/en/summary/1614/
[36] https://qcat.wocat.net/en/summary/3880/

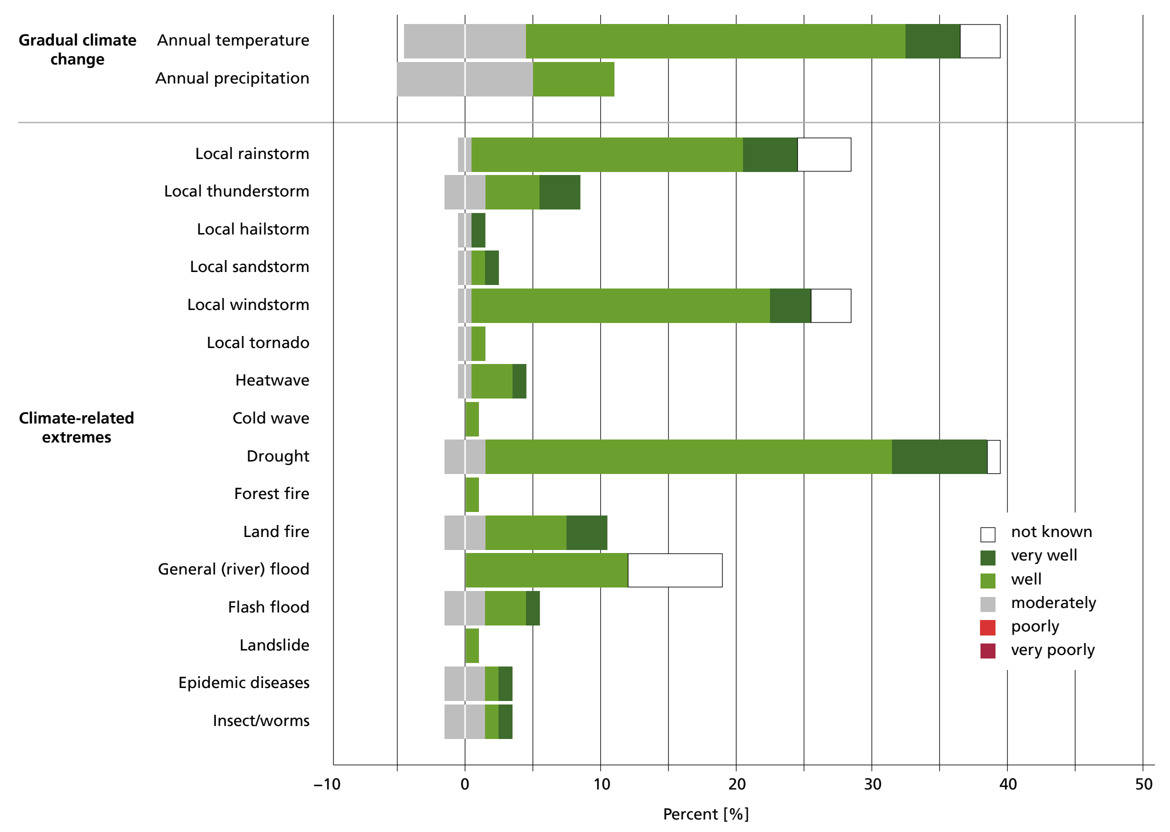


Figure 4.24 : Sensitivity (coping capacity) of the technology to gradual climate change and climate-related extremes/ disasters as perceived by range users in percent of total number of technologies.

Water storage in aquifers and base flows in surface waterways provide services that are useful to people, as a consequence of water remaining in the system. SRM practices can affect groundwater recharge and flows through sub-surface, as well as surface, water flows off-site.

Increased runoff and erosion on-site (upstream) and resultant altered water flows off-site (downstream) cause floods as well as shortages. Compound disasters of floods and droughts following each other have received considerable attention in many parts of Sub-Saharan Africa. SRM can offer, at least in part, a disaster risk reduction solution.

Avoiding downstream sedimentation and pollution of water bodies is another potential positive impact of SRM. Offsite sedimentation is a major concern that is associated with land degradation. In East Africa, significant problems due to sedimentation in the great lakes have been attributed to population pressure and inappropriate land management over many decades, including the pastoral rangelands (Tanaka et al. 2011). This leads to unwanted sediment movement and stream flow changes that mainly affects downstream human communities and natural ecosystems through increased loading of non-point pollutants. Increased sedimentation in the rivers and lakes has many impacts. For example, it alters aquatic habitats and communities, abets the proliferation of algal blooms and the invasive weed, water hyacinth – which in turn has further reduced the amount of dissolved oxygen and contributed to eutrophication.

Extreme climatic conditions and drought, combined with overuse of vegetation favour wind erosion, "sandification" and moving sand dunes. The consequences are loss of soil but a reduction in quality also, as wind erosion is selective: the finest and most nutrient-rich particles are removed preferentially. Thus in the topsoil that remains, organic matter levels and fertility are reduced. This can, in turn, increase runoff meaning a loss of precious water (in regions that are often water scarce) while simultaneously causing soil erosion. In arid and semi-arid areas, wind erosion results in the displacement of sand from the source and its accumulation and deposition elsewhere. This destination is often near an obstacle – for example buildings, fences, or wind breaks of trees.

In the Sahel, sand dune encroachment can lead to loss of agricultural and pastoral land, and threaten villages (Box 2.26). The dunes may form as a result of an increase in wind erosion, but are commonly triggered by formerly stabilised dunes that have become mobile again following the disappearance of vegetation. Dune stabilisation techniques can be: (i) mechanical fixation (fences, hedges, palisades etc.) that stabilises moving sandy masses or blocks, further movement, and/or (ii) biological fixation that comprises the creation of permanent vegetative cover on the dune. Palisades and vegetation furthermore provide shade that, in turn, lowers soil temperatures and maintains organic matter. With increasingly strong winds and accelerated degradation of the natural vegetation growing on sand dunes – a widespread phenomenon at present – it is very likely that the problems caused by shifting dunes will worsen in the future. Techniques to stabilise shifting sand dunes will therefore become more important.

4.4.3 Services for people

From the analysis displayed in Figure 4.22, it was found that technologies with the highest impacts on people were improving SLM/ LD knowledge (56%), improving community institutions (42%), followed by food security (40%), conflict mitigation (36%) and empowerment of disadvantaged groups/ gender equality (21%).

Box 4.23: Community-led tourism as an alternative livelihood in the Okavango Delta

The Okavango Kopano Mokoro Community Trust offers opportunities for community-led tourism in the famous Okavango Delta. The aim is to provide affordable game and nature trips with camping at night – to allow more people to enjoy the delta while providing jobs in the impoverished local villages. The trust was legally registered in 1997, and its board members are from the communities themselves. Community-based natural resource management is the overall objective. This includes sustainable utilisation of natural resources through direct participation in managing the environment, animals and plants abundant in the delta. In this way, the trust uses tourism to protect the rich natural resources while deriving a source of income to sustain local livelihoods.

Community guides know best how to access and explore the delta during the different seasons. Overnight camping, combined with day and night trips in local Mokoro dugout canoes has become a popular way to experience the tranquillity of the Okavango Delta – at an affordable price. A highlight is gliding silently through the serene landscape – offering a special perspective of the abundant wildlife, and enjoying the beauty and richness of nature in silence. The delta is home to a vast array of wildlife, including elephant, wildebeest, giraffe, zebra and antelope. The local guides know the special spots within the unique Okavango landscape and wildlife. They can rightly claim this is the best way to experience the true, wild, Africa.

The benefits don't accrue to a tourist agency but directly to the local community. Many tourists appreciate this concept– and it offers excellent value for money. Community-led tourism offers untapped potential for the use and conservation of rangelands, while simultaneously benefiting local people. It is surely worthy of further attention.

Source: http://www.okmct.org.bw/

Figures 1 and 2: Community member take tourists on day trips in dugout canoes to appreciate the silence and richness of the wildlife and the wetland ecosystem. Statement of a trust member: "I am a community member of the trust. Making a living of the trust has become our way of life. Living here has brought joy in my life as I am able to put my children to school" (Hanspeter Liniger).

Figures 3 and 4: The delta offers a vast range and wildlife to be appreciated by visitors in a silent and non-invasive way from birds like bee-eaters to the famous megafauna like the hippos (Hanspeter Liniger).

Responses in the approaches concerning 'services for people' presented a similar picture to the technologies. In almost 70% of the approaches, positive impacts on knowledge and capacity building were reported (Figure 4.23). This is followed by institutional strengthening (60%), empowerment of disadvantaged groups (59%), food security (53%), conflict mitigation (52%) and gender equality (50%).

The importance of **SRM knowledge** has already been highlighted as a critical constraint to implementation (see Chapter 4.1.7). The second highest impact is related to improving community institutions. It is striking that in some technology groups, the empowerment of community institutions was rated more highly than SLM/LD knowledge: these groups include 'enabled mobility' (of whom 100% cite improved community institutions), 'infrastructure improvement' (82%) and 'controlled grazing' (55%). This confirms the importance of strengthening local institutions in order

Box 4.24: Wetlands and Rivers: their key role in the rangelands of SSA

In Sub-Saharan Africa, 4.7% of the surface area is covered by wetlands: this figure rises to 6.0% when lakes, rivers and reservoirs are included (Rebelo et al. 2009). Rivers flowing through the rangelands or draining into wetlands are arteries of life for people, animals – but also for vegetation – especially when surrounded by drylands'. Examples include the River Niger, Senegal, rivers and streams flowing into Lake Chad, the Lorian Swamps in Northern Kenya which drain into Somalia, and the Okavango Delta in Botswana. River flows, and their flow regimes, change from season to season. However a trend towards extremes is being increasingly observed, with higher flows and more violent floods damaging and destabilising river beds and banks and, during the dry season, diminishing flows or water courses drying entirely. Upstream development, especially increasing irrigation, significantly affects river flows in some basins – yet the extent of the impact and the consequences for the rangelands are unclear and contested. Evidence is still lacking though research is underway in some basins, notably the Ewaso Ng'iro Basin in northern Kenya (Providoli et al. 2019) and the Okavango Basin in Southern Africa (Liniger et al. 2017).

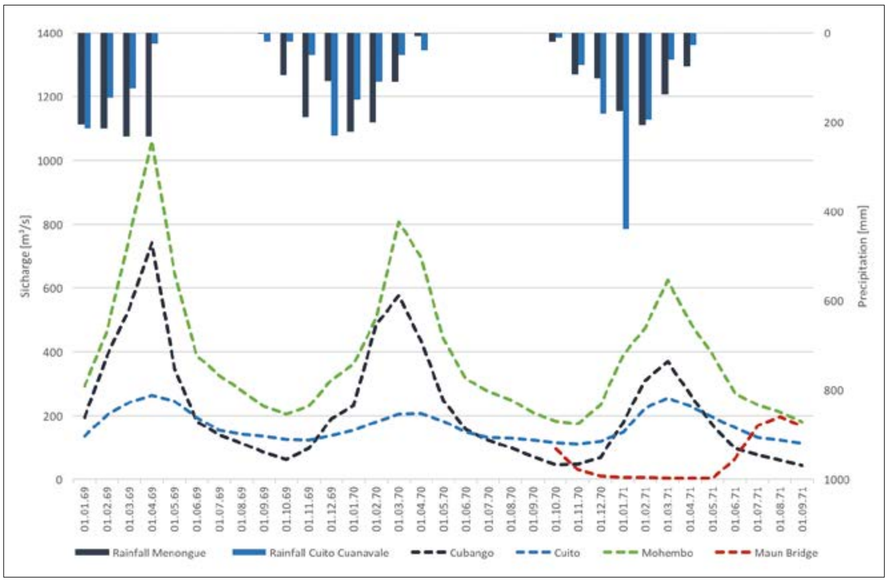


Figure 1: Discharge of the Okavango River at four water gauges from north to south, Cubango/ Cuito, Mohembo (Namibia) and Maun (Botswana), in relation to the precipitation measured at two stations in Angola (Menongue and Cuito Cuanavale). The discharge at the station in Maun is multiplied by 10 to illustrate the migration of the peak of the water flow towards the dry season during the flow of the river. There are very few long-term datasets reporting rivers flows into wetlands and the rangelands. The above represent historical data from the 1970s (Hendrik Göhmann in Liniger et al. 2017).

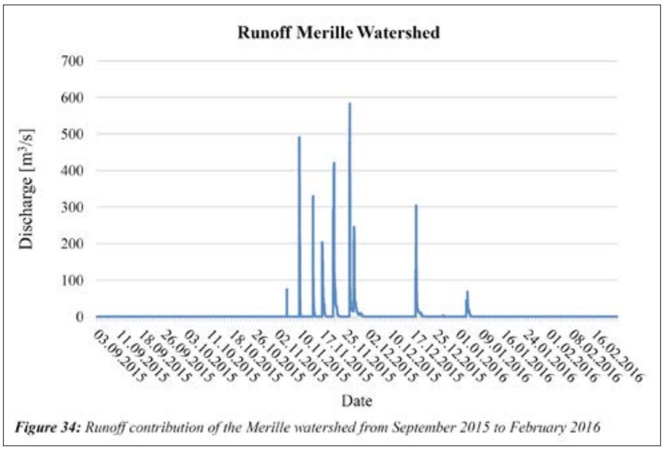


Figure 2: Typical flow behaviour of a seasonal river, Merille, in the northern rangelands of Kenya draining a watershed of 1400 km². There are extremely fast rising peaks followed by rapidly declining flows afterwards, and eventually periods of no surface flow (Joss 2018). People and animals depend on the same water (Hanspeter Liniger).

Figure 3: Widespread degradation in rangelands causes high levels of runoff and floods, destabilising riverbeds, uprooting trees and widening the watercourses. In protected areas along the rivers, severe erosion of the riverbeds and destruction of the riparian forests has led to degradation of biodiversity in these zones – upon which these protected areas closely depend. Samburu National Reserve, Kenya (Hanspeter Liniger).

Box 4.25 Examples of altered catchment hydrology due to rangeland management change

The Olifants basin in South Africa is an example where rangeland uses are located upstream. In this basin, a 31.6% decrease in rangeland with matching increases in agriculture lands (20.1%), urban areas (10.5%) and forest (0.7%) led to a 47% increase in surface runoff generation (Gyamfi et al. 2016). The implication is that water was not retained on the land, and higher surface runoff is usually correlated with higher peak flows and sediment losses also. Another example of an African basin where ecological effects have been observed following the loss of upstream rangelands is the Lake Bosomtwe basin in Ghana (Adjei et al. 2017).

In the Mara basin, which is shared between Kenya and Tanzania, Mati et al. (2008) found that land-use change between 1973 and 2000, including deforestation and conversion of rangelands to croplands, increased the peak flow of the Mara River by 7%. Mwangi et al. (2016) estimated that land-use change in the last 50 years contributed to about 97% of the observed increase in the mean streamflow of Nyangores River (a headwater tributary of the Mara River). Deforestation and intensification of agriculture are likely to cause an increase in surface runoff due to degradation of the watershed, which reduces its capacity to absorb rainwater (Mwangi et al. 2017).

In the Gilgel Tekeze catchment, Northern Ethiopia, major increments of cultivated land and settlements of 15.4% and 9.9%, respectively, at the expense of shrubland and grazing lands have caused an increase in annual surface runoff of 101 mm, and a decrease in groundwater recharge of 39 mm over the period 1976–2003 (Haregeweyn et al. 2015). These results signify an increasing threat of moisture unavailability, and suggest that appropriate land management measures under the framework of the integrated catchment management (ICM) approach are urgently needed.

Source: http://www.okmct.org.bw/

Olifants Basin, Southern Waters (www.drift-eflows.com).

Lake Bosomtwe basin in Ghana (http://ghana.arocha.org).

to achieve successful implementation of SRM, but also probably highlights the fact that many development agencies are increasingly working through local institutions in the search for long-term sustainability.

Food security is being improved in all technologies and approaches groups to almost the same extent (between 40% and 60%). Only in practices under 'supplementary feeding' is the impact on food security said to be much lower: but that could indicate that in this group, people are better-off and food security is not a major concern.

Some technologies and apporaches had a positive impact on **conflict mitigation** (36% and 20-55% repectively). However, 8% of the technologies described were associated with a negative impact. This was mainly within the 'controlled grazing' and the 'range improvement' groups. In both of them, improved grazing land conditions also attract neighbours to invade those "green spots", especially during droughts.

Land use rights improvement were mentioned in 50% of the approaches – which was lower than expected. Despite the urgency of the need to achieve better land tenure, having a significant impact on land use right issues is evidently both difficult and time-consuming.

Empowerment of disadvantaged groups and gender equality were greatly to moderately affected in more than half of the approaches documented: the impact was similar in all approaches groups except in 'marketing & alternative income', where, in all cases, positive impacts were recorded for disadvantaged groups such as ethnic minorities in remote areas. Improving gender equality is a real concern in SSA, and it is important to note that good land management has a positive impact. The role of women in decision-making, use, access, ownership and control of rangeland resources differs from that of men (Box 4.27). In practice, women are owners and managers of some natural resources, particularly those situated near homesteads. They may certain specific pastoral products – such as milk. These roles are often well recognised and nested in customary tenure systems, although some beliefs and taboos may not promote an active role of women in sustainable rangeland management: especially those that hinder decision-making by women. In 'FMNR approach, Kenya'[37] women are included in discussions and trainings and are empowered to take decisions although old traditions ("clean agriculture") hinder women from planting and working with trees and from participating in meetings.

Women clearly hold intrinsic knowledge about rangeland management in line with their use of the range. This knowledge, coupled with skills, management and access to resources, is key to addressing issues of land degradation and climate change. However, it needs to be re-emphasised that these issues impact on women and men differently. For example, the amount of time and effort needed by women to accomplish their traditional roles of (for example) fetching water for domestic use and taking care of sick or lactating livestock can increase very considerably with resource scarcity and degradation.

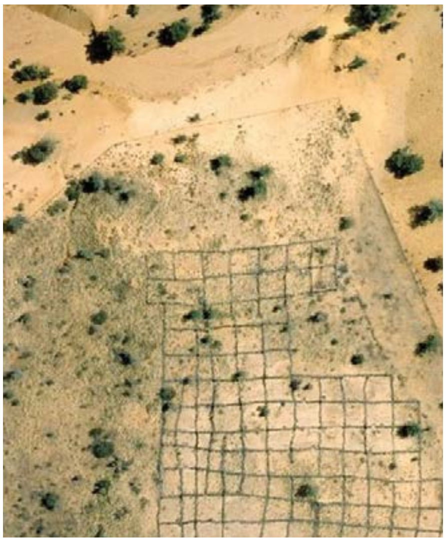
[37] https://qcat.wocat.net/en/summary/4014

Box 4.26: Sand dune stabilisation, Niger

The encroachment of sand dunes particularly affects oases, threatening 9% of the productive land in the oases of Niger. Additionally in the oases and lowlands of the agro-silvo-pastoral zone, sand dune formation and dust bowls threaten 60% of the infrastructure – water points, roads and settlements etc. Sand dunes are stabilised by setting up dead or living windbreaks arranged in a checkerboard pattern or in strips aligned against the prevailing wind direction. The windbreaks are formed by palisades (e.g. from millet stalks, branches of doum palm trees or other plant material) or by hedges (e.g. Euphorbia balsamifera) and trees (*Acacia senegal, Balanites aegyptiaca*).

From an economic point of view, the advantage/ impact of the technology is the increase in agro-silvo-pastoral income, livestock production, straw and pasture production, and fruit production (dates, mangoes, citrus, etc.). Ecologically, the advantages/ impacts are the increase in vegetation cover/ soil fertility, the reduction of wind and water erosion, and an increase in biodiversity. At the socio-cultural level, this technology reduces conflicts between land users and strengthens the institutional capacities of local communities.

Source: https://qcat.wocat.net/en/summary/3566/; https://qcat.wocat.net/en/summary/3857/; https://qcat.wocat.net/en/summary/1621/



left: Topsoil erosion and destruction of vegetative cover may destabilize sandy soils and cause large amounts of sand to become mobile affecting neighbouring areas, Niger (HP. Liniger); middle: Dune stabilisation using palisades, Koublé Doki, Niger (Guéro Maman); right: Bird's eye view of a stabilised sand dune (Andreas Buerkert).

Box 4.27: Dynamics of community land bill in Kenya on women

Significantly, the Community Land Act, 2016 in Kenya recognises the role of women and their access rights. The bill protects against gender-based discrimination, and states that all members of the community have equal rights of use, access to, enjoyment and benefit from the land (GoK 2016).

http://www.landcoalition.org/en/regions/africa/blog/gender-evaluation-criteria-key-moment-scaling

Use of the Gender Evaluation Criteria: a tool to assess land policies and laws against gender justice.

Land users' resilience to climate change was reported to be increased in 45% of the approaches (Figure 4.23), the most in 'land & water use planning' and the least in in 'community based NRM'. Main strategies are to establish insurances, to regulate dry season or emergency grazing and to establish fodder reserves and emergency markets.

Benefits and costs of rangeland management practices

Benefits and costs are crucial in justifying interventions and encouraging adoption of SRM. So far, the majority of available studies on the benefits and costs of SLM concern crop production systems. Far fewer assessments have been devoted to benefits and costs of rangeland management systems (Rota 2018). Frameworks for assessment of the value of dryland ecosystems, and the potential benefits of managing them sustainably have only recently begun to emerge (King-Okumu 2017). Due to the wide extent and diffuse nature of rangeland systems, the broad range of management practices, multiple benefits, variable outcomes and uncertainties (Sandford and Scoones 2006), the benefit/cost calculations are often considerably more complicated and problematic for agricultural economists than the economics of monocropping or agroforestry systems. Furthermore, input requirements and costs are also not as predictable as they are in cropping systems. Nevertheless, it has been argued that the potential returns on restoring rangelands can be higher than those for any other dryland ecosystem type – hence the importance of attempting analyses (IPBES 2018, De Groot et al. 2013).

To assess the benefit – cost ratios for the SRM technologies identified in this book, the perspective of land users and/ or other stakeholders of short-term and long-term of establishment and maintenance benefits and costs has been used as

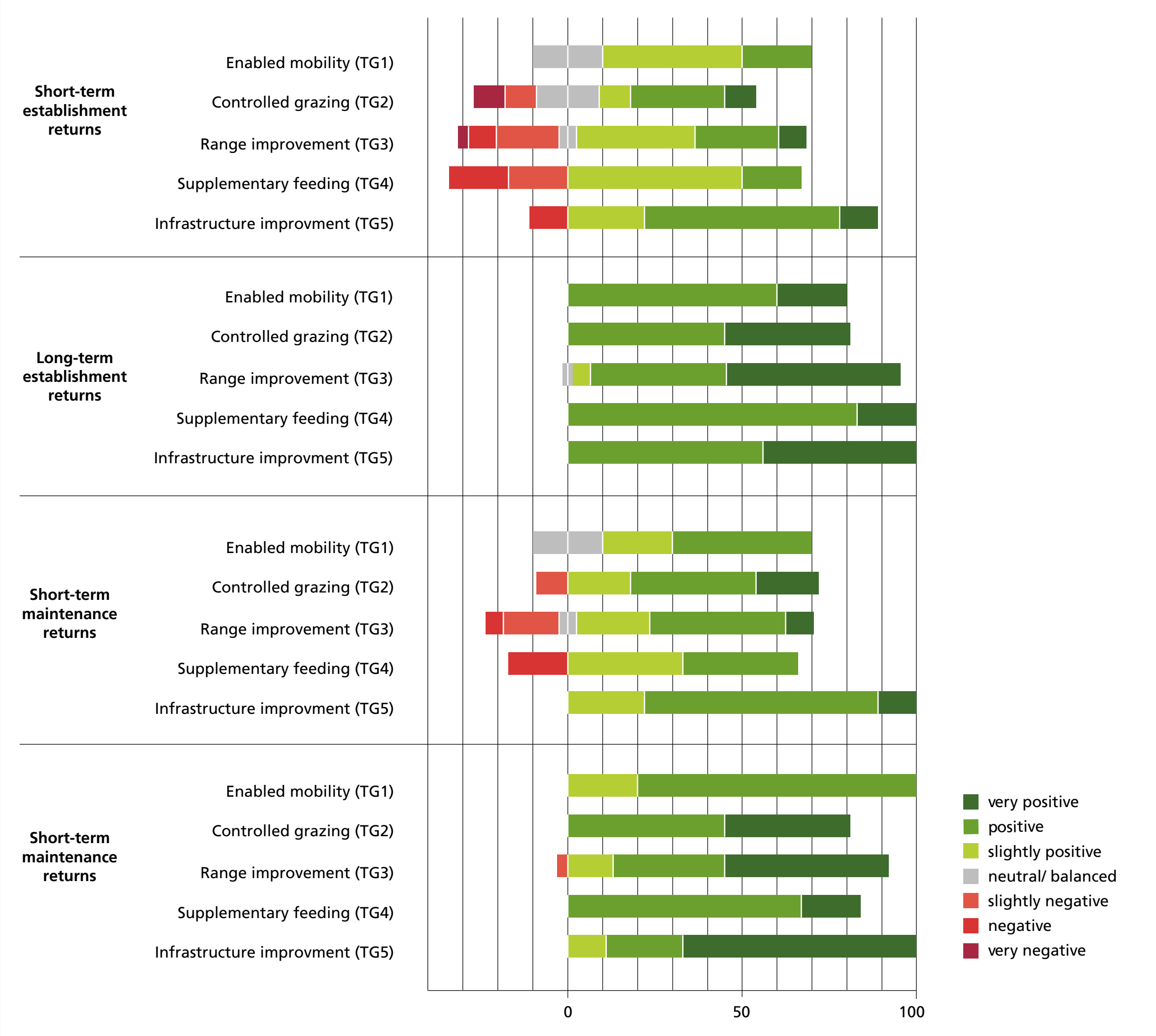


Figure 4.25: Perceived benefits of technologies (by SRM technology group) in the short and long-term and related to establishment and maintenance costs.

a proxy indicator. According to WOCAT, short-term covers 1 – 3 years, and long-term at least 10 years. Land users were asked their opinions of whether the ratios were positive or negative. Generally, from experience, such assessments place a quite low value on people's time and in-kind investments, and also do not take into consideration the cost of establishing necessary approaches, institutional frameworks, capacities, etc. that the technologies need to be embedded into.

Results show that, for the short-term, in all technology groups, more than half of the cases demonstrate positive returns (Figure 4.25). The highest were recorded under 'infrastructure improvement', 'enabled mobility' and 'range improvement'. Compared to the costs involved for establishment, the practices requiring high inputs also show rapid beneficial returns – such as 'infrastructure improvement'. Those needing less input (see Figure 4.14) also give high benefits such as the 'controlled grazing' and 'supplementary feeding' groups.

However, establishment costs often exceed short-term benefits, as reported in around 30% of the cases. The most negative benefit/ cost ratio in the first 1 to 3 years are recorded under 'controlled grazing', 'range improvement' and 'supplementary feeding'. 'Infrastructure improvement' showed less negative benefit-cost ratio than expected. In the 'enabled mobility' technology group, benefits already exceed costs in the first years. Here the perceived investment costs are relatively low compared to the other groups, as these are mostly related to a management change. Surprisingly, in around 10% of the 'controlled grazing' group, the returns are rated as being very negative. This could be explained by reduced grazing or even exclusion of grazing in the first few years. 'Rotational grazing, South Africa'[38] has very high establishment costs, which discourages land users from using the multi-paddock grazing system.

Long-term, the investment pays back in all technology groups. This is particularly so, and in a very positive way, for 'infrastructure improvement', 'and 'range improvement' both of which need time (10 years or more) to fully manifest their benefits.

In terms of maintenance returns (benefit-cost ratio), in the short-term as well as the long-term, there is a similar pattern to establishment returns. One exception is the 'enabling mobility group', where long-term maintenance benefits are perceived as less positive than long-term establishment benefits, probably due to a withdrawal of support after 3-5 years of project duration. Furthermore, in a few cases of 'range improvement', long-term maintenance returns are rated slightly negative, probably due to less financial support for inputs and repairs after projects pull out.

SRM should aim, ideally, to achieve both short-term (rapid) and long-term (sustained) paybacks. Practices (technologies and approaches), as documented by WOCAT, include a majority,

[38] https://qcat.wocat.net/en/summary/2211/

Table 4.6: Distribution of long- and short-term establishment benefits of SRM documented by WOCAT

Short term: 1 – 3 years; long term: 10 years

which report high returns anticipated over longer (10-year) timeframes (Table 4.6). Even in the short- term, slightly positive to very positive returns are common. Generally, the move towards more positive returns in the long-term is reflected. In relation to rangeland use systems, and also the technology groups, no distinct patterns emerge.

However, it is important to note that assessments of ecological restoration often deal in much longer timeframes than this, that is 25- or 30-year time horizons (e.g. IPBES 2018).

Valuing Ecosystem Services

Valuation of ecosystem services is important to enable economic assessment of the benefits of SRM, in order to weigh these against the costs of implementation (see Figure 4.25 on costs). Economic assessments involve subjective decisions about what matters most, which values should be counted, which should be left out, and what define the most critical timeframes for the investments to break-even. Benefits are perceived differently by different people as it is difficult to assess monetary/ non-monetary (e.g. price of meat and milk/ insurance and pride) or direct/ indirect (hay production/ protection against floods) values. Without a positive perception of benefits, however, neither rangeland users, nor donors are likely to invest in SRM.

Non-livestock rangeland products (NLRP) – including wildlife, medicinal plants, fuelwood, tourism and many other products and services – are often overlooked (see Chapter 2.1.3).

The economics of **risk reduction and improved resilience** in the rangelands is an emerging field in which particular attention is paid to the costs of losses due to drought and other disasters (Flint and Luloff 2005, Bond et al. 2017, Venton 2018). It also includes consideration of the value that managers place on avoiding, or insuring against, these risks and losses. Since the loss of livelihoods in marginal rangeland areas cause famines and conflicts, this can have disastrous consequences for national economies, security, and for society as a whole. Recognition of this point has important implications not only for the selection of optimal management strategies, but also for economic assessment of their benefits. Although most available assessments of benefits and costs of interventions to build resilience to drought in rangeland areas focus on the household level economies, some do also consider effects on the wider regional and national economies or even global environmental benefits, such as carbon sequestration (Vardakoulias and Nicholles 2014a and 2014b, Siedenburg 2016, Venton 2018). A recent assessment by FAO (2018) demonstrated that giving livestock owners fodder for their animals during drought saved lives and achieved a 3.5:1 return on investment costs to procure and distribute the fodder. But if rangeland users were better able to protect forage resources – or make hay – they could achieve the same outcome in terms of avoiding livestock losses. In such cases, their coping systems are also strengthened, and they would not be dependent on handouts.

Recently, rangeland managers have begun to consider the need to involve **off-site as well as on-site** stakeholders in shaping their assessments of SRM impacts (Tanaka et al. 2011, Brown and Macleod 2017). In cases where some benefits are of more value to off-site stakeholders than they are to on-site resource users, there can be rationale for the off-site beneficiaries to offer incentives to the rangeland users for maintaining or improving relevant practices – for

Box 4.28: Chyulu Hills Community REDD+ project, Kenya

The Chyulu Hills REDD+ project combines two government agencies, three local NGOs and four communities together under a unified banner, the Chyulu Hills Conservation Trust (CHCT). The project aims to protect its rangeland and forest landscapes by creating an alternative income opportunity, and improving both livestock and rangeland management, while preventing the emission of over 18 million tons of carbon dioxide over the project's 30-year lifetime.

A main goal of the project is to improve grazing and livestock management to prevent further degradation of the rangeland and forest resources.

https://qcat.wocat.net/en/summary/4264/

Tsavo National Park West (© Charlie Shoemaker).

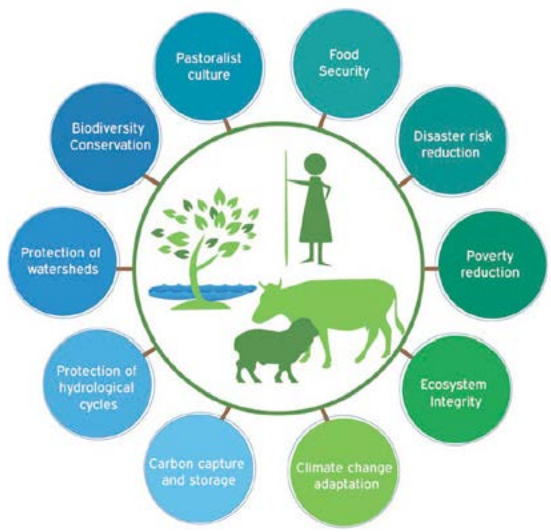


Figure 4.26: Valuing the benefits of sustainable rangeland management. Valuing the multiple benefits of sustainable rangeland management (McGahey et al. 2014).

example to reduce erosion and sedimentation of downstream water supplies or increase carbon sequestration (Blignaut et al. 2010). This is a form of payment for ecosystem services (PES).

The economics of **hydrological regulation** is difficult to assess in terms of use values for the stored water, or replacement costs for wells or water treatment instead of water availability in the surface waterbodies and near subsurface. This has been attempted in various studies carried out in rangeland areas in different parts of Sub-Saharan Africa (Acharya and Barbier 2002, Blignaut et al. 2010, Balana et al. 2012). Drinking water for people and livestock often has a range of different market prices that will escalate during shortages. The majority of available studies on the benefits and costs of SLM concern crop production systems. Far fewer assessments have been devoted to benefits and costs of rangeland management systems. Due to the multiple benefits and uncertainties that characterise the rangeland systems, these calculations are often considerably more complicated and problematic for agricultural economists than the economics of monocropping or agroforestry systems.

The economics of **carbon sequestration** is often discussed in relation to the economics of sustainable rangeland management and payment for ecosystem ser vices (Box 4.28). But these values still can only be realised in very few rangelands in SSA – where there is sufficient institutional support to make payments for carbon credits (Lipper et al. 2010).

On the other hand, the economics of **land claims and mining rights** (subterranean resource exploitation) can be more tangible to rangeland users – even under communal systems. Rangeland communities can receive payments from mineral exploration, and land developers of different kinds if they can establish their claim on their land and oblige investors to pay for the rights to access resources there.

There are more issues and benefits involved related to sustainable land management as illustrated in Figure 4.26. Each of them would need to be assessed and valued, and trade-offs and co-benefits between them to be assessed, in order to paint a comprehensive picture of the value of rangeland management.

Take-home messages

- The influence of SRM on ecosystem services can include both on-site and off-site impacts.
- Where efforts are made towards SRM, the value and importance of improving forage and fodder production – as the foundation of animal production – should be seen as the number one priority.
- Climate change and associated water scarcity are contributing to a situation where many rangelands are becoming increasingly dependent on boreholes for a greater part of the year.
- Dams, pans and lakes are very sensitive to management of their catchment area. If the land and its vegetation cover is degraded then the waterbodies will be rapidly degraded in turn.
- Changing the types of watering points that are available in rangeland (e.g. from naturally occurring seasonal water pans to boreholes) can give more control to local rangeland managers.
- As demands on water increase and surface water has become scarcer, more and more groundwater is being tapped especially during drought periods – the longer-term consequences of this is a growing worry.
- Beef production 'water footprint' studies have shown that industrial livestock systems have a far higher freshwater footprint than livestock raised in extensive grazing systems.
- More than 35% of the technologies were appraised as being able to cope well or very well with drought.
- Investing in the land and its productive capacity are vital in strengthening people's resilience to drought and climatic shocks.
- Managing rangeland watersheds to deliver improved quality and quantities of water to urban consumers has been identified as a critically important way in which SRM can affect ecosystem services that are of value to people.
- Compound disasters of floods and droughts following each other have received considerable attention in many parts of Sub-Saharan Africa. SRM can offer, at least in part, a disaster risk reduction solution.

Women clearly hold intrinsic knowledge about rangeland management in line with their use of the range.

So far, the majority of available studies on the benefits and costs of SLM concern crop production systems. Far fewer assessments have been devoted to benefits and costs of rangeland management systems.

Results show that, for the short-term, in all technology groups, more than half of the cases demonstrate positive returns.

Long-term, the investment pays back in all technology groups. In terms of maintenance returns, in the short-term as well as the long-term, there is a similar pattern to establishment returns.

In some cases, long-term maintenance returns are rated less positive than long-term establishment benefits, probably due to a withdrawal of support after 3-5 years of project duration.

If rangeland users were better able to protect forage resources – or make hay – they could avoid livestock losses.

Recently, rangeland managers have begun to consider the need to involve off-site as well as on-site stakeholders in shaping their assessments of SRM impacts.

4.5 Feedback of Ecosystem Services from SRM on Drivers

Ecosystem services (ESS) provided from rangeland management, and the changes due to investments in sustainable land management practices, influence and change the original drivers of the management of the rangeland. This feedback mechanism closes the cycle in the framework of sustainable rangeland management (see Figure 4.1). New drivers are formed, which in turn drive land users to make changes and further investments, or to maintain the services provided by the land use. Thus assessment of the impacts on ESS shows how drivers are changed, creating the enabling environment ideally towards improved conditions for further spread ('out-scaling') of SRM practices.

The main motivation of land users for implementing SRM has been reported to be increased production (Figure 4.27). Along the same lines, increased profitability is mentioned as being very important under a number of approaches. Reducing land degradation and environmental consciousness are also driving forces or at least strongly motivating factors. Enhanced SRM knowledge and skills, as well as conflict mitigation, are recurring themes throughout this chapter, indicating their importance as a driving force.

Activities from the 'community based NRM' group can all be fully sustained or continued once any external project support has been terminated or has pulled out (Figure 4.28). For around 70% of the 'land & water use planning' cases and 50% of those under 'wildlife & nature tourism' continuation of implementation of activities has also been reported. However, for around 80% of the cases of 'marketing & alternative income' and around 30% of 'land & water use planning', continuation is unlikely or even impossible without the support of a project or government agency.

With respect to take-up of the practices, 40% of the cases reported spontaneous adoption. Adoption of technologies pertaining to the 'enabled mobility' group are by far the highest (Figure 4.29). Forty percent of the cases reported that 10-50% of the land users have adopted the technologies, and 60% of all cases reported an adoption rate of more than half of the land users within the region. This is a very encouraging sign and shows that practices promoted under 'enabled mobility' are first, clearly needed, and second, attractive.

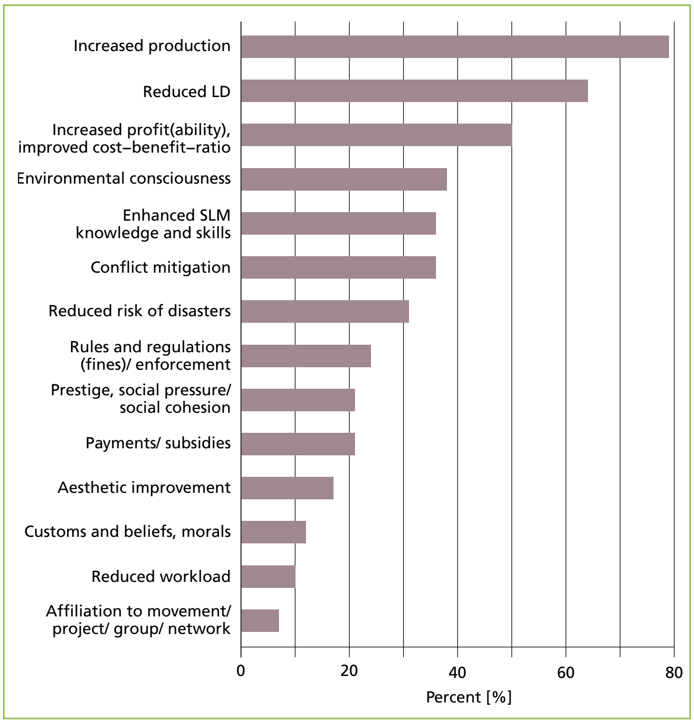


Figure 4.27: Main motivation of the land users/ stakeholders to implement SRM technologies. Note: in percent of the SRM technologies, multiple responses are possible.

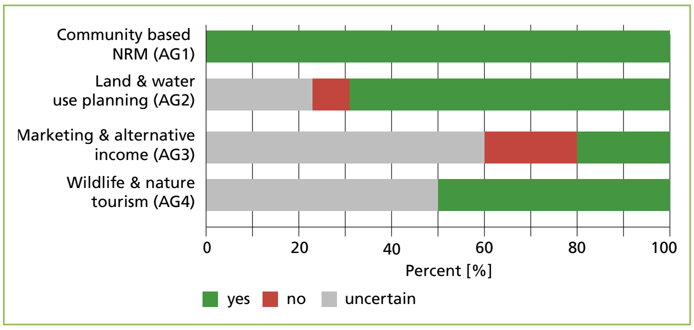


Figure 4.28: Sustainability of what has been implemented through the approach by land users.

The costs showed that they are affordable and already pay back in the short-term: so rangeland users can spontaneously adopt these practices. 'Controlled grazing' also has good adoption rates – in around 35% of the cases, with more than 50% adoption in some. Again, the reasons are that they are affordable and pay back quickly. In all the other technology groups, adoption is less, but it still exists. In these cases more inputs are required, especially 'improved infrastructure' and thus rely more on support from outside agencies. However, the high proportion of 'not available' data on adoption is an indication of insufficient monitoring of the spread and take-up of land management technologies.

Further analysis showed that only 25% of the cases reported adaptation of the technologies by land users to suit local context and changing conditions: about the same number indicated no adaptation and almost half did not, or simply could not, answer the question. Of those who adapted the practice, 13% indicated climate change, 3% market change but 84% could not specify the reason. The high number of 'no replies' to critical questions like adoption and adaption rises serious concerns about monitoring and evaluation of the spread of SRM.

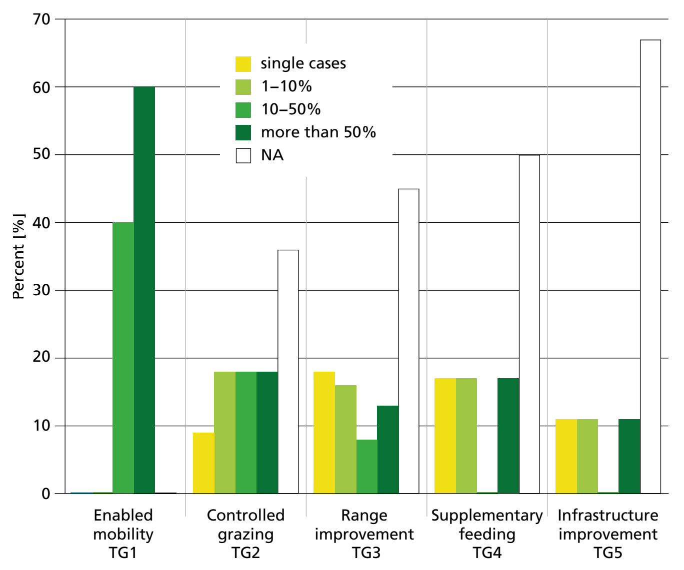


Figure 4.29: Adoption trend of the SRM technologies. NA = data not available.

Closing the cycle in rangeland management: Technical interventions in rangelands will fail if impacts on the economic, political, cultural and social well-being and the people, and the health of the land and ecosystem are not positive and not recognised. Rangelands are complex socio-ecological systems. Many factors are localised in nature, and can only be tackled through an appropriate and tailored approach. Others are relevant at landscape, or national, or even transboundary scale and others at global level: their effects on the functioning of the rangeland system may be out of the control of local managers, yet interventions must account for these to ensure success (Hruska et al. 2017). The proposed 'rangeland management framework' on drivers, land management practices, health of the land resources and ESS – including human well-being – allows manager and practitioners to understand and interpret these interacting factors, and create management intervention that are holistic in nature, and recognise the complexity and dynamic interaction in rangelands.

Rangeland management involves actions at multiple scales, both temporal and spatial. Management interventions which don't appreciate the need to manage across these multiple scales, incorporating the varying political, ecological and social dynamics, will often fail to meet their goals.

The analysis of the documented practices, as well as experiences described in the literature, clearly show that there is a continuous change of drivers. It is the land management practices and their impacts on the health of the natural resources and the ecosystem services, which influence and propel the change of drivers. This ever-ongoing change, namely "what is good today might not work tomorrow" combined with the intricate complexity related to ecosystems, stakeholders and their interactions is particularly dynamic. It has even accelerated in recent years and is increasingly challenging for the rangelands of Sub-Saharan Africa. Highly flexible adaptions and coping mechanism are clearly needed, as indicated by the strong demand for knowledge and capacity building expressed by land users – echoed by SRM specialists.

Take-home messages

Adoption of technologies are by far the highest within the 'enabled mobility' group

The high number of 'no replies' to critical questions like adoption and adaption rises serious concerns about monitoring and evaluation of the spread of SRM.

Technical interventions in rangelands will fail if impacts on the economic, political, cultural and social well-being and the people, and the health of the land and ecosystem are not positive and not recognised.

Rangeland management involves actions at multiple scales, both temporal and spatial.

It is the land management practices and their impacts on the health of the natural resources and the ecosystem services, which influence and propel the change of drivers ever-ongoing change, namely "what is good today might not work tomorrow" combined with the intricate complexity related to ecosystems, stakeholders and their interactions is particularly dynamic.

Highly flexible adaptions and coping mechanism are clearly needed, as indicated by the strong demand for knowledge and capacity building expressed by land users – echoed by SRM specialists.

Chapter 5

The way forward – strengthening sustainable rangeland management in Sub-Saharan Africa

This chapter brings the book to a conclusion by synthesising and integrating the findings of the literature review and analysis of the case studies. These are assembled under the thematic headings of technologies, approaches and knowledge management. A final section then reviews the prospects for the future of sustainable rangeland management. Within the text there are "Focus boxes" – each of which highlights key issues or summarises guidelines. In summary, the conclusion underlines the conviction that there needs to be a greater emphasis on the rangelands and their management in Sub-Saharan Africa.

But first, it is important to re-iterate the **strategic importance** of the rangelands to Sub-Saharan Africa. They cover 62% of the land area, are home to over 55% of its livestock and provide livelihoods for 38% of the region's inhabitants. Rangelands also provide a wide range of ecosystems services including carbon storage and hydrological regulation – and they also host unique and globally important biodiversity. However, the state of these lands is in peril, with large-scale losses of productivity and threats to livelihoods, due to pervasive deterioration of the natural resources – increasingly exacerbated by climate change and growing demands by various stakeholders.

Focus #01: Appreciate the importance of healthy rangelands in Sub-Saharan Africa

For the future of Sub-Saharan Africa, rangelands and their ecosystem services will be increasingly crucial: but their contribution can only be guaranteed if the land and its resources are kept in a "healthy" condition through sustainable management.

A multitude of different **drivers** are involved in the current dynamic situation, all impacting and affecting rangelands and their management: these include human population growth and increasingly unsustainable resource use; in some areas, growing livestock densities and changing livestock composition; climate change with increased frequency of droughts and floods; losses of mobility as a result of policies and land fragmentation; increasing claims on resources – for mining, oil exploration, biofuels, large-scale farming, contract herding by urban elites etc.; growing conflicts between resource users; a plethora of historical development projects – many of which failed and left a legacy of pessimism. Management interventions which don't appreciate the need to manage across multiple scales, incorporating the varying political, ecological and social dynamics, will fail to meet their goals.

Focus #02: Review rangelands as social-ecological systems.

Development interventions in rangelands fail when we do not consider impacts on economic and social well-being, in addition to the ecology. Rangelands are complex social-ecological systems where climate, ecology, management, culture, institutions, policy, and market forces, all interact. Rangeland interventions thus need to address all aspects of sustainability: the social, economic and ecological dimensions of sustainable rangeland management.

Rangelands have become hotspots as their potential is better appreciated – but at the same time they are subject to increasing threats of degradation.

Focus #03: Appreciate new and growing pressures and their significant impact.

Rangelands are under intense and growing pressure, with a multitude of global and local changes. Land degradation is a clear and present danger. Simultaneously, historical views of rangelands and their people as "marginal" are rapidly receding: these are lands growing steadily and strongly in importance as claims on them, for multiple purposes, proliferate.

A **main aim of rangeland development** is to achieve improved and sustained ecosystem services and provide better livelihoods by investment in, and upscaling of sustainable rangeland management (SRM) profoundly based on experiences gained so far. Better management of the vegetation, the water and the soil must be afforded top priority for planning and further investments – for the future of the Sub-Saharan Africa's rangelands and its peoples.

What is the future of the rangelands in SSA? Transformation into other land uses due to growing alternative claims? Will an assessment of the value of the diverse services and functions of the rangelands help in clarifying the way forward?

left: Conversion of rangelands and their wetlands might yield short-term economic benefits but a loss of services related to disaster risk reduction, biodiversity and provision of water, northern Uganda (Hanspeter Liniger).

right: Assessing the value of biodiversity and rich habitats of African wildlife – and the value of grasses, in some parts of the world termed "green gold" – remains a challenge compared to assessing the value of mining mineral resources e.g. gold, South Africa (Hanspeter Liniger).

Focus #04: Spread SRM derived from experience.

To ensure relevance, impact and spread, SRM must be based on principles derived from the wealth of existing experiences. This book has collected and collated many of the most important current practices: the evidence is here.

Because of the high level of diversity and the heterogeneity of the rangelands, there needs to be a differentiation in focus between the **different rangeland use systems (RUS)**. Although there can be overlap between the different RUS, each requires specific interventions.

Focus #05: Address different rangeland use systems (RUS).

In order to deal with the high complexity and diversity, six rangeland use systems need to be addressed – separately but also the interactions between them – in the search for solutions, these comprise:

1. Large landscape pastoral rangelands **(pastoral)**.
2. Large landscape agropastoral rangelands **(agropastoral)**.
3. Bounded rangelands without wildlife management **(bounded without wildlife)**.
4. Bounded rangelands with wildlife management **(bounded with wildlife)**.
5. Parks, wildlife & nature reserves **(parks & reserves)**.
6. Small-scale settled pastures **(pastures)**.

5.1 SRM technologies for outscaling

Experiences with sustainable rangeland management have been documented using the standardised WOCAT format, and are presented in Part 2 under "technologies" and "approaches". The analysis of the practices documented revealed principles underpinning successful SRM. Some are valid for all rangeland use systems – others are more specific to certain systems.

Focus #06: Follow three guiding principles for SRM technologies.

1) Maintain healthy and productive land.
2) Employ adaptive and ecological heterogeneity-based management of livestock and wildlife.
3) Focus on resilience-based interventions that cope with shocks, threats and risks.

5.1.1 Healthy and productive rangeland

The first priority behind sound SRM technologies – valid for all rangeland use systems – is to seek to establish and maintain healthy land. Nurturing productive conditions helps land to achieve its natural potential, while maintaining and improving ecosystem function and services. Furthermore, it breaks the vicious spiral of degradation (see Box 4.12). It also provides resilience against shocks and extremes inherent to rangelands, but made worse by a changing climate (see Chapter 2.1.2). The combination of improving and maintaining both health and productivity of the land has top priority for all interventions in SRM.

Healthy rangeland can only be fostered by practices that maintain a good level of ground cover – with a special emphasis on perennial grasses, including the improvement of forage/ fodder quality: the nutritional value of the range needs to be considered alongside the productivity. Therefore, what is urgently needed is a "GRASS revolution": Grass Restoration for Africa's Sub-Saharan rangelands. As this revolution is also needed outside Africa it could also stand for Grass Restoration for Arid and Semiarid Soils. This helps achieve the objective of increasing vegetation/ biomass quality and production, which in turn increases water availability and water use efficiency by reducing surface evaporation and runoff. Collected runoff can be used productively through water harvesting.

Focus #07: Emphasize Grass Restoration for Africa's Sub-Saharan rangelands, GRASS.

A popular misconception is that deforestation is a major issue in the rangeland crescent of SSA. For donors, trees have "green credentials", and a simple appeal. However a focus on tree planting programmes should not detract from the main priority: re-establishing perennial grass cover and species for herbivores – and for protection of the land.

Other goals are an increase in soil fertility, in soil organic matter, and in soil fauna and flora and creating favourable micro-climates, SRM technologies that favour healthy land are based on grazing management systems at very different levels of scale – across all rangeland use systems (RUS). However, when working effectively, all provide rest periods for grasses to replenish their reserves. Judicious fire management may be employed in some situations to prevent or control bush and tree encroachment by invasive exotic – but also native – species and allow perennial grasses to establish.

Focus #08: Maintain healthy and productive land.

- Improve and maintain grass and herbaceous cover for production and protection.
- Increase water availability by reducing water loss from direct evaporation from the surface and by uncontrolled runoff; harvest runoff water for productive purposes.
- Maintain and increase soil fertility by reduction of water and wind erosion and improved manure management.
- Reduce or prevent encroachment of invasive bush and tree species.

5.1.2 Adaptive and ecological heterogeneity

Enabling mobility and movement through opportunistic (large-scale pastoral and agropastoral systems), or controlled, rotational grazing (in bounded systems) allowing natural regeneration and resting periods is central to utilising heterogeneity in vegetation and climate.

The key elements are grazing intensity, timing and pressure that need to be carefully – and opportunistically – adjusted in order to allow the grass and herbaceous cover to regenerate from use and to remain productive. It is of paramount importance to guarantee sufficient duration and regularity of resting periods to maintain rangeland health. Rangelands evolved with a wide range of different herbivores. However, land users – through selecting different livestock species with their specific browsing and grazing habits – have changed the composition of rangeland vegetation.

A vital intervention is to improve infrastructure including the number and distribution of water points and reservoirs. The key here is strategic placement to regulate water availability at different periods. Markets and slaughterhouses are always important – but access is imperative when lengthy droughts occur. Another area of attention is adjusting the balance between grazing and browsing: the mix between types of livestock, or in combination with wildlife.

Wildlife and biodiversity should be seen as an opportunity rather than an obstacle. Many systems can benefit from wildlife for more efficient use of vegetative resources, for tourism and income generation for game meat. Furthermore, new strategies are needed to integrate pastoral and conservation objectives. Pastoralists can create "functional heterogeneity" that facilitates co-existence of wildlife and livestock and the interrelation of their grazing with savannah and grassland plant communities. There is now a strong conceptual basis for wildlife-livestock co-existence and empirical evidence to show that these concepts work. Thus community and private conservancies can play a role in restoring wildlife movement across large landscapes in African savannahs. But conservancies are not a panacea for development in the rangelands and cannot replace public institutions that function at a broader spatial level.

Focus #09: Employ adaptive and ecological heterogeneity-based management of livestock and wildlife.

- Adjust grazing intensity, timing and pressure by movement of livestock.
- Allow regular resting periods for productive regeneration.
- Select livestock species and composition according to availability and change of the rangeland vegetation.
- Improve number and distribution of water points to access diverse grazing lands.
- Give attention to markets and slaughterhouses: location and accessibility especially during droughts.
- Manipulate herd composition (grazers and browsers; largestock and smallstock) to make use of the heterogeneity.
- Manage livestock and wildlife interaction.

5.1.3 Resilience based practices: dealing with shocks, external threats and risks

As noted, good rangeland management practices lead to healthy landscapes which build up resilience and make systems "climate-smart" – namely productive and more robust to climate extremes and changes, while simultaneously sequestering carbon in vegetation and the soil. Further, specific measures include installing emergency mechanisms for situations where the shock is too large to be absorbed by even a healthy system. This may include securing additional emergency feed by building up a hay reserve (e.g. in 'pasture' but also in 'bounded' systems) or securing an emergency grazing area – though such areas are very vulnerable to competition and conflicts. Another key aspect of this strategy is sourcing emergency markets: possibilities for sale and slaughter during critical periods. Finally contingency plans should be drawn up in case of exceptional droughts or other disasters where food (or cash) aid is required: in these cases the World Food Programme may step in and propose "work-for-asset" programmes where the "assets" comprise infrastructure for community benefit.

Left: Large-scale restoration grass cover is a key, if not the key, challenge for the rangelands in Sub-Saharan Africa (Hanspeter Liniger).

right: Clearing of invasive bushes and spreading their branches on the bare ground enables grasses to grow under the cover, due to the favourable microclimate and the activities of termites breaking the soil crust, near Johannesburg, South Africa (Hanspeter Liniger).

Diversifying production and sources of income is another option – though not available to all, for example those systems characterised by opportunistic movement and transhumance. Diversification can include using wildlife and tourism for additional income: this is an opportunity for two RUS, namely 'bounded with wildlife' and 'parks'. Other diversification pathways may include expansion of agropastoral and settled pasture systems, though this is limited by climatic factors. Non-livestock rangeland products (e.g. honey, medicinal and cosmetic products) are an option for exploitation, to a greater or lesser extent, under all RUS. An option for the future could be acquiring carbon credits for sequestering carbon under climate change mitigation programmes – for example as is being pioneered in the Chyulu Hills of Kenya.

Focus #10: Focus on resilience-based interventions that cope with shocks, threats and risks.

- Adapt through becoming resilient: invest in climate-smart systems.
- Install emergency mechanisms for feed and market access.
- Diversify production and sources of income (tourism/ wildlife, non-livestock rangeland products).
- Be prepared for disaster interventions: develop plans for disaster relief programmes.

5.1.4 Principles of SRM in each technology group

Whereas all the three principles elaborated above have their potential and role in the different groups of technologies, some of them have a special emphasis in particular technology groups:

Enabled mobility (TG1)

- Incorporates the principles of reaching a healthy state by avoiding overuse through movement and providing rest periods, while exploiting gradients of forage quality and quantity. Has best potential to exploit rainfall variability.
- Requires strong governance systems to ensure adherence to grazing rules and arrangements.
- Even though mobility has high potential to cope with shocks and variability, access to emergency areas and emergency markets is a growing constraint.

Controlled grazing (TG2)

- Smaller-scale form of mobility: rotation and regular resting is a key principle to avoid detrimental impacts on vegetation of non-rotational regimes.
- Arrangements with neighbours are needed to agree on dry season/ drought forage.
- Securing the rested areas from use or invasion is essential; this also helps to ensure enough dry season/ drought forage.
- Because of pressure from other rangeland users and drought, additional strategies may be required, such as emergency markets.

Range improvement (TG3)

- Improved land is directly addressed through restoring grass cover e.g. by reseeding, water conservation and harvesting, clearing of invasive and unproductive species.
- As with 'controlled grazing' the rights and security over the land in times of crisis (droughts etc.) is a major issue. Range improvements are often done under 'bounded' or 'pasture' systems, where land rights are firmly regulated.

Supplementary feeding (TG4)

- The impact on the land and its health is restricted in area but where applied, it is usually well done and productivity is improved.
- Resilience to shocks and emergency feeding is usually better prepared for than in other groups.
- In more intensive systems for animals at particularly stages (young, gravid, lactating), feed is often from residues, or fodder – fresh or preserved as hay.

Infrastructure improvement (TG5)

- Water availability is effectively a grazing management tool: water and forage access go hand-in-hand. Areas without water may be underutilised. When water points dry – or are turned off – animals are obliged to move: this helps to introduce resilience into the system.
- However, this group also has the greatest potential to accelerate degradation especially in the vicinity of infrastructure through prolonging access to water and thus forage. Specific management options are needed (e.g. the movement of corrals, temporary closure of water points, change of stock routes). Development of water resources and its management must be designed carefully to avoid this pitfall.
- Emergency situations can be addressed through infrastructure (stock routes for example) that permits ready access to forage, and through improved market opportunities.

5.2 SRM approaches towards upscaling SRM technologies

In order to facilitate the implementation of SRM technologies six guiding basic principles for successful SRM approaches are:

Focus #11: Follow guiding principles for SRM approaches.

1) Improve the enabling environment.
2) Consider livelihoods, gender and youth.
3) Enhance planning through participation and evidence-based decision-making.
4) Build in strategic resilience to drought/ shocks and climate change adaptation.
5) Improve marketing and labelling of products.
6) Integrate wildlife where possible/ relevant.

5.2.1 Enabling environment

An enabling environment constitutes the factors that support or "surround" the implementation of SRM practices. Many are out of the direct control of project or programme implementers – such as as national policies. Some, though, are closer to home such as the development of local rangeland management committees. Before selection of an SRM practice, an analysis of the "hindering environment" and how to turn it into an "enabling environment" is a must. This requires attention to the following issues:

Focus #12: Improve the enabling environment.

- Improve and utilise legal frameworks, institutions, governance, and policies.
- Ensure security of rights to land and resources (formal, informal or customary).
- Assure financial resources are available to support SRM.
- Ensure better knowledge and capacities for decision-making and implementation.
- Includie social/ cultural/religious norms & values as part of an enlightened approach.

5.2.2 Livelihoods, gender and youth

Clarification and communication of the potential benefits and the impact on land users' livelihoods for each of the SRM practices are a prerequisite to encourage adoption of SRM. There needs to be particular attention to gender and youth. The following are the main considerations:

Focus #13: Consider livelihoods, gender and youth.

- Clarify impact of SRM technologies on the land (vegetation, soil, water) and implications for livelihoods.
- Reduce out-migration by promoting profitable and productive SRM.
- Calculate costs and inputs needed for the implementation of SRM.
- Estimate overall benefits as well as trade-offs: short-term and long-term.
- Weigh up the potential for additional income through diversification of activities.
- Improve access to services
- Consider gender-related differences related to technologies and livelihood.
- Assess the relevance to the youth: some '"high-tech" options may appeal to them.
- Analyse consequences of different technologies on risks and security.

left: Local people sowing indigenous trees, shrubs and grass seeds in microbasins opened up by the Vallerani Delfino plough into a extended degraded area. Sowing days are important and joyful events for the communities, Oudalan, Gorom-Gorom, Burkina Faso (Lindo Grandi).

centre: During the rainy season the microbasins collect rain and runoff and the grasses re-establish quickly and first cover the microbasins while the unploughed soil remains bare (Amadou Boureima).

right: After five years in the same area, the grass cover also between the ploughed lines is almost closed and desirable trees and bushes establish. The area has changed from basically unproductive degraded land to high value pasture land (Verena Grandi).

5.2.3 Evidence-based planning

Multi-use with multi-users at multi-scales in a world of multiple claims is a great challenge that has to be met while planning. To turn a barrier into an opportunity, the following issues must be considered:

Focus #14: Enhance planning through participation and evidence-based decision-making.

- Tap the wealth of experiences in good rangeland management and the lessons learnt from mistakes.
- Assess costs and benefits of different land management options.
- Identify and negotiate multiple claims, functions and uses of rangelands involving all stakeholders.
- Engage in open dialogue and develop consensus during negotiations.
- Plan for conflict resolution; if resolution is required, full stakeholder involvement is best.
- Involve multiple stakeholder and users at all stages from planning onwards.

5.2.4 Build-in strategic resilience

Droughts and their implications for the rangelands have been identified as a key, and sensitive issue for all rangelands use systems and SRM practices. While resilience has already been discussed in terms of appropriate technologies, resilience strategy is integral to sound approaches:

Focus #15: Build in strategic resilience to drought/ shocks and climate change adaptation.

- Select and implement SRM practices that have proven levels of resilience.
- Establish drought risk management plans and strategies.
- Facilitate establishment of fodder stock and storage.
- Enable access to dry season/drought/ emergency grazing grounds and water points.
- Set-up early warning systems for preparedness.
- Facilitate "fair/ honest trading" emergency selling.
- Establish insurance schemes where this is an option.
- Manage a range of livestock and wildlife species for optimum use of land's resource.
- Encourage breeding strategies and natural selection which favour resilience.

5.2.5 Marketing

Better marketing of livestock, and high-end livestock products as well as branding and origin-labelling can help in adding value to products. Additionally, there is unexploited potential for marketing of non-livestock rangeland products – and finally the potential for carbon credit schemes based not on trees but on rangeland vegetation.These are summarised below.

Focus #16: Improve marketing and labelling products.

- Improve marketing of livestock: high-end products, branding and origin-labelling.
- Explore non-livestock rangeland products: medicines, cosmetics etc.
- Establish functioning carbon credit schemes for rangelands.

5.2.6 Wildlife

Wildlife, and its role, is controversial within the debate surrounding rangeland management. Some see new opportunities for mixing wildlife and livestock, others view wildlife as a threat to livestock production. There are rangeland users who are caught up in wildlife-livestock or human-wildlife conflicts, while others make profitable use of wildlife and protected areas. Those growing crops on the rangeland fringes are especially vulnerable to wildlife: here lies the greatest potential for conflict. Below, some of the main issues are summarised.

Focus #17: Integrate wildlife.

- Continue exploring benefits and potentials of integrating wildlife.
- Reduce human-wildlife conflicts and identify if wildlife corridors are feasible options.
- Seek new opportunities and philosophies to incorporate wildlife and protected area benefits for local people.
- Further explore a 3-circle approach often promoted in parks: from (1) protected areas in the centre, to a middle ring (2) for livestock grazing, and an outer ring (3) for settlement/ cultivation.
- Further identify and document SRM practices related to parks & reserves and identify their potential for outscaling, especially in West Africa.

5.2.7 Principles of SRM in each approach group

Whereas all the six principles elaborated above have their potential and role in the different groups of approaches, some have a special emphasis in particular approach groups:

Community based NRM (AG1)
The main concern is to build from the community level, involving land users and their initiatives from the beginning to the end. It stresses participatory planning and decision-making and identification of community-based traditions, innovations and adaptations, and mobilises a wide span of stakeholders from community-based organisations (CBOs), to non-governmental organisations (NGOs) to the government (GOs), and international organisations.

Land & water use planning (AG2)
Particular emphasis is on evidence-based decision-making informing participatory planning: as this has been identified as one of the key shortcomings, leading to widespread failures of interventions. Planning involves another set of "multi-challenges" involved in success: multi-stakeholders, multi-functions and multi-levels of scale. It also builds up a strong, well-informed knowledge base covering SRM already applied in the region. This is a real challenge, but approaches addressing improved planning and knowledge-based decision-making surely speak to a core issue within successful implementation of urgently needed SRM. Furthermore, planning for in-built resilience to deal with shocks and extremes has an important role in this group.

Marketing & alternative income (AG3)
All approaches need to address the economics of land degradation and SRM. The group 'marketing & alternative income' is focussed on efforts to identify improved marketing of livestock and non-livestock products, improved labelling and value-addition to rangeland products, and synergies including marketing of wildlife and nature, and exploring the potential carbon credits for CC mitigation.

The choice of livestock breeds in management systems with restricted mobility is generally fine-tuned to meet market demands. While the herd composition in sedentary systems on rangelands is mainly adjusted to market demands, the composition of herds in pastoral systems further needs to consider type and availability of forage vegetation in an area as supplementary feeding is limited. In turn, changing herd composition may influence, over a long period, plant composition. There are complex dynamics and even paradoxes: for example bush encroachment is considered a form of degradation, but management systems with camels and goats may benefit – and herders may respond by increasing the proportion of browsers in their herds.

For poor families both goats and sheep can be readily sold to realise cash. Cattle are large, so less of a "liquid" asset than small stock. In fact some communities refer to sheep and goats as their "ATM cash machines".

Wildlife & nature tourism (AG4)
Some of the rangeland use systems combine wildlife and nature resource management: for example 'bounded with wildlife' and 'parks & reserves'. The unique wildlife and nature of the African rangelands is a key asset and offers possibility and potential in many ways for improved management. The approach is strongly linked to improved marketing and seeking alternative income sources. The rich biodiversity and unique attractiveness of the rangelands provide a great asset for improved marketing and livelihoods of rangeland users.

5.3 Awareness, knowledge and capacities

Clearly, there are a series of important and crucial awareness and knowledge gaps surrounding rangelands and their management. The compilation of the guidelines has been a stark reminder of how little is known, or understood, about the complexity and multitude of factors.

Focus #18: Follow the guiding principles: awareness, knowledge & capacity.

1) Improve awareness to induce a shift in perception.
2) Identify current and future knowledge gaps.
3) Address knowledge gaps and improve knowledge management and at all levels.
4) Enhance capacity throughout: from land users to decision-makers.

5.3.1 Awareness

Heightened awareness is needed to ensure that recognition of the status of rangelands and the changing and growing claims on them for the services they provide by a multitude of users is enhanced, and a general shift in perception about rangelands potential is encouraged – to reflect their growing importance yet increasing vulnerability.

left: Hawai Gufu, a community member from Badana Village makes her contribution in community consultation meeting, Garbatulla, Kenya (Hussein Konsolle).

centre: Herero pastoralist planning meeting, Namibia (William Critchley).

right: Livestock insurance in remote rangelands illustrates the importance of risk reduction by an insurance against extreme events link droughts or ourbreaks of diseases. The insurance is as important as the basic goods sold in a small shop in the remote north of Kenya (Hanspeter Liniger).

Focus #19: Improve awareness to induce a shift in perception.

- Disseminate proven sustainable rangeland management practices.
- Give voice to the various rangeland users to spread their experiences.
- Raise awareness about the challenges and opportunities of SRM solutions.
- Illustrate the complexity of human interaction with rangeland ecology.
- Demonstrate the multiple impacts of good rangeland management.
- Support platforms for awareness-raising, knowledge sharing and solution finding.
- Bridge the barriers between the French and English speaking regions of SSA by creating multi-lingual knowledge sharing platforms.
- Implant rangeland development issues into the policy level debate.
- Involve researchers, postgraduates in training to address rangeland-related questions and help raising awareness.

Focus #20: Identify current and future knowledge gaps.

- Clarify changing and evolving claims about rangelands.
- Better understand the complexity of rangeland management.
- Assess and quantify *on-site* impacts – social, economic and ecological – of different land management practices.
- Identify and assess *off-site* impacts – social, economic and ecological – of changes in land management related to drought, floods and sedimentation, or deposition of windblown particles.
- Explore *off-site* impacts of climate change and especially climate extremes such as droughts.
- Carry out cost-benefit analysis, with quantification of synergies and trade-offs.
- Map and monitor of change of different land management practices, land health and ecosystem services.
- Invest in better understanding of aspects of ecological, habitat and climatic heterogeneity.
- Clarify about roles of protected zones, riverine areas, wetlands and mountains.
- Clarify the role of improved rangeland management with regard to conflict resolutions and reduction of migration.

5.3.2 Knowledge gaps

Development initiatives have seen successes as well as failures – the latter including controversial recommendation (e.g. promotion of exotic trees which have become invasive). The current analysis underlines the complexity of the challenge: a vast range of different land use systems combined with knowledge gaps and inadequate skills to address the challenges related to SRM. The requirements for knowledge about ecosystems and their processes, vegetation, hydrology, fire, conflict occurrence, population dynamics (people, livestock and wildlife) – and the different rangeland use systems and practices currently applied are vast and are increasing. This includes understanding of the land users, their customs, traditions, claims and aspirations. Involving research organisations as well as academic institutions and students must be seen as a vital precondition to address the complexity and wide array of issues that emerged from the analysis of experiences.

5.3.3 Knowledge management

While it is true that policies and governance are a limiting factor, ignorance of specific aspects, including impacts of interventions and indeed how to use previous experiences is a basic bottleneck to implementation of SRM.

WOCAT tools and methods are already available, and are being increasingly applied to further elaborate the database and fill current knowledge gaps. In order to enhance the sharing and use of the existing knowledge local land users, practitioners and implementers need enhanced capacity-building and the assignment of time for monitoring. However, this needs political, institutional and global conviction and support. If experiences are not shared and monitoring of the impacts is not an integral part of any rangeland project, both time and resources are being wasted. Multiple development experiences and research projects have a long history in SSA – it is simply foolhardy to let these lessons and findings lie untouched on dusty shelves.

Focus #21: Address knowledge gaps and improve knowledge management at all levels.

- Involve researchers and postgraduate field workers in knowledge gaps including spread of SRM practices, cost-benefit analysis and impacts on- and off-site.
- Improve compilation of and sharing SRM experiences using standardised tools.
- Improve knowledge management and evidence-based decision making in implementation projects and agencies, in planning processes at local to national levels and in advisory services.
- Improve support for a knowledge sharing platform for the rangelands of SSA and other rangelands worldwide.

5.3.4 Capacity development

Given the complexity and diversity of rangelands, the accelerated dynamics of change and their management practices, particular human capacity needs to be developed at all levels. The list of knowledge required already points to the need to sharpen skills. When working in rangelands – more than in cropping systems – there is a need to be aware of both traditions and traditional knowledge and their integration with modern "scientific" notions. A further point has been made many times over the last 50 years: the mutual benefits that can be derived from exchange and interaction across SSA, especially those bridging the linguistic divide between West and East Africa.

Focus #22: Enhance capacities throughout: from land users to decision makers.

- Understand of rangeland use systems and sustainable rangeland management.
- Improve exchange of knowledge and networking – sharing, analysing and using knowledge from different regions of Africa and applying it in local and regional contexts.
- Continue documentation of multiple unrecorded SRM practices and experiences.
- Develop skills for impact and cost-benefit assessments on- and off-site.
- Improve capacities in evidence-based decision making at local, landscape and national levels.
- Use high-tech satellite image data, combined with participatory assessment and mapping.
- Use scenario building to project impacts of different land management options.

5.4 The future of sustainable rangeland management

The vital importance of rangelands for various users and uses has been one clear outcome of this exercise. So has the need to improve land management and push for significant outscaling of SRM practices. Impact can be achieved, but only if a large area is simultaneously improved by rangeland users who agree to jointly implement SRM practices – then pressure on the land can be reduced, conflicts averted, and the vicious spiral of land degradation can be broken. To make a real difference, externally sponsored initiatives need also to break out of the typical project cycle of 3–4 years and become long-term investment and capacity building programmes.

Specific areas have been identified as key to the wider spread of SRM. These are: the potential for outscaling, the need to understand how rangelands function, in terms of their heterogeneity and how this can be best utilised; the prerequisite of reducing overcoming conflicts over land and its resources; and the need to be sensitive to rangeland users and their aspiration and values.

Focus #23: Secure the future of SRM.

1) Enhance "vast and fast" outscaling of SRM through direct and indirect pathways.
2) Embrace complexity, heterogeneity and opportunism.
3) Address hidden and open conflicts in the search for SRM.
4) Embed values, perceptions and aspirations of rangeland users into solutions.

5.4.1 "Vast and fast" spreading of SRM

In areas with higher land productivity – on the wetter fringe of the rangelands – and higher population of land users with small plots of land, people can make a significant difference in spreading SRM and improving land health if the majority of the land users work together. If they have the same goal and mobilise themselves in the implementation of SRM practices, the impact can be clearly seen.

However, in most of the drier parts of the rangelands, the population density is lower and labour is restricted, and thus the potential to mobilise land users in large-scale and long-term endeavours is low. Here, to make a change to the land, there are two possible technical pathways: indirectly,

left: Open surface water as drinking supply for cattle in pastoral systems (Friederike Mikulcak).

centre: Transhumant herdsmen water their livestock at Dig Diga well, Niger (Abdoulaye Soumaila).

right: Wind pump for lifting borehole water from a deep groundwater table, Laikipia, Kenya (Hanspeter Liniger).

through the management of animals e.g. through agreed grazing plans or regulating and providing water as a measure to control and guide grazing; and directly, through large-scale vegetative and structural measures e.g. micro-catchments or clearing invasive species.

Focus #24: Enhance "vast and fast" outscaling of SRM through direct and indirect pathways.

Direct:

- Support approaches for mass mobilisation for small-scale interventions involving the majority of land users.
- Promote large-scale mechanised practices covering vast areas in a short period.

Indirect:

- Find agreement on joint actions for SRM involving the majority of land users within a Rangeland Use System (RUS) and land users from neighbouring RUS.
- Find consensus on how to regulate availability and use of water points and access to grazing pastures.

5.4.2 Complexity, heterogeneity and opportunism

The "mainstream view" that was widespread in the mid-20th century held that overgrazing was the central problem, and therefore widespread destocking was necessary. This would then bring animal populations down to a theoretical equilibrium based on calculated and regulated "carrying capacity". In the late 20th century new theories challenged this view. They said that rangelands were not predictable nor homogenous, but unpredictable and heterogeneous, and the best way to use them was to be opportunistic. Indeed opportunistic strategies based on mobility have indeed always been used by pastoralists to make use of heterogeneity. But there is also a role for rotational grazing strategies especially in 'bounded systems' (RUS 3 and 4) – as long as these do not involve overemphasis on complex fencing infrastructure and intensive rotation: a successful example of using "functional heterogeneity" – in other words careful planning and allowing animals to use heterogeneity. Whereas diversification, intensification and expansion of area are common strategies to improve and increase agriculture productivity on cropland, for rangeland this needs modification. In SSA rangelands, the potential for expansion is – in most situations – limited and in many cases, it is the opposite: rangelands are being "devoured by other land uses" and reduced in area. However, the potential for diversification and intensification remains and a new strategy emerges to replace expansion. That is "enhanced heterogeneity" meaning tapping and broadening natural heterogeneity, both for production and for protection of ecosystem services.

There isn't any grazing system that fits all situations: for example the 'Holistic Management' system has proved only marginally suitable in Kenya. Creation of grassland heterogeneity by strategic grazing of livestock has potential for conservation strategies at the livestock-wildlife interface.

Focus #25: Embrace complexity, heterogeneity and opportunism.

- Appreciate that there are more complex and multiple interacting factors than in other land uses.
- Embrace that it requires to understand terms & concepts and their evolution over the last 50 years.
- Acknowledge that heterogeneity needs to be integrated into management systems as a strategy to replace expansion.

5.4.3 Hidden and open conflicts

A clear differentiation between rangeland use systems (RUS) is not only fundamental for the selection of SRM practices, but it is crucial at the planning and policy levels for understanding of the potential for conflict. It is important at the political level between countries – as well as within countries – in order to settle old conflicts or avoid new conflicts and disputes. Hidden and open conflicts often arise over access to forage and water, and rights or property over them. Without accepted and followed agreements at local, national and even cross boundary levels, there can be no peace and effective sustainable rangeland management – though SRM can be a tool in helping to resolve conflict.

Focus #26: Address hidden and open conflicts in the search for SRM.

- Give conflict resolution top priority, and if possible strengthen local institutions in their role of resolving conflicts.
- Address and resolve common conflicts about access to forage and water and property as part of all SRM approaches.
- Support the formation of user groups within the same RUS, focusing on making joint decisions about implementation and reducing conflicts over resources.
- Between different RUS (e.g. pastoral-agropastoral and settled crop farmers), and other users and claimants (e.g. mining industries and settlement developers) identify increasing disputes and seek to mitigate them by clear arrangements incorporated in SRM.
- Avoid concentration of power or introduction of discrimination which can become a source of conflict.

5.4.4 Values, perceptions and aspirations

Pastoralists (with the exception of private and community ranchers) often have no, or little, security over the land or guarantee to its resources for the future – in contrast to most crop farmers. And the age-old question is: why should they care for the future of the land and its resources? If they improve their land it may attract others to lay claim to it. Thus, pastoralists often have slender incentive to maintain their land and protect its health.

For many communities, livestock still form their savings, as well as being their pride and an historical symbol of wealth and prosperity. Additional off-farm income (remittances in particular) from a family member often means that this is converted into buying additional livestock – and additional grazing areas and water resources then have to be identified. Areas that are not well protected and even those that are (e.g. private ranches, game reserves and national parks) may be overrun and invaded especially during periods of droughts. The urge to increase herds is therefore a constraint to sustainable land management.

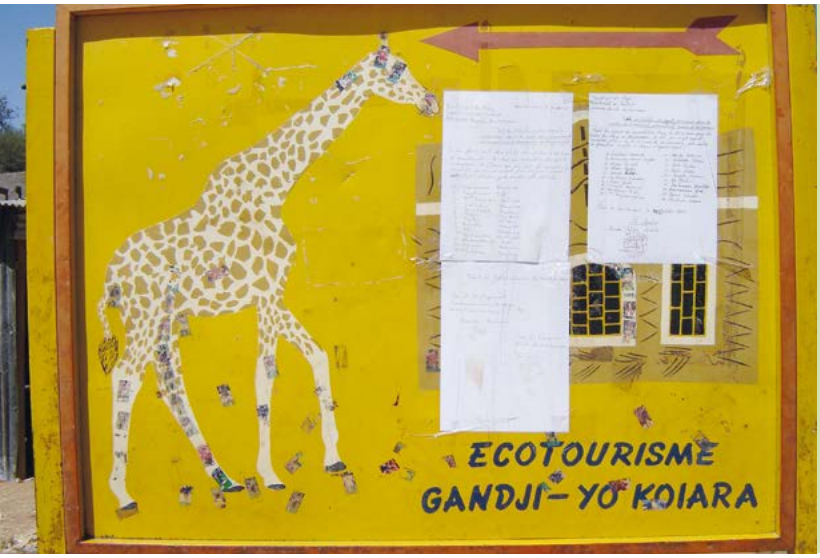
Focus #27: Embed values, perceptions and aspirations of rangeland users into solutions.

- Respect that pastoralists' cultures are rich, historically embedded in their livestock and the land.
- Embrace that cultural identity is usually strong and traditions longstanding.
- Clarify the role of land and water rights and tenure security as incentives to maintain land and its health.
- Address the issue that, for many pastoralists, livestock represent savings and a visible symbol of wealth and prosperity.

5.4.5 Sustainable rangeland management: complex – but with emerging trends

Sustainable land management on cropland is a question of radically modifying and simplifying natural systems: growing one or more crops on fields, that are made more or less uniform through intensive land husbandry. Rangelands are very different in that they are highly variable, semi-natural ecosystems, where the interference of people is limited. Thus while croplands are typified by "homogeneity", rangelands are characterised by "heterogeinity". Historically the main methods of altering vegetation have been through range users' management of livestock, control of wildlife – and through burning. Vegetation can further be influenced by enrichment seeding of grasses and other species, and through assisting natural regeneration and regrowth, but the ecosystem remains essentially heterogenic and semi-natural with its own dynamics and responses to change. If indigenous perennial grasses are overgrazed, for example, they disappear and allow space for less desirable annuals – or invasive species whether indigenous or alien.

Nature responds to human interference and changes. Therefore, the challenge to rangeland management is to understand and use the power of nature and its principles, cycles, responses and interactions with human interference, and to find a productive but nature-based system for the benefit of people – while maintaining a healthy, functioning ecosystem. This poses an enormous challenge and requires profound knowledge, continuous observation and responses to environmental change through adaptations in management.



left: Heavy pressure with potential conflicts on springs in the drylands. Different tribes of pastoralist come from far to Chafa Spring, northern rangelands of Kenya (Hanspeter Liniger).

centre: Big Life anti-poaching Rhino unit goes out for their morning patrol looking for tracks and camera traps in the field, Chyulu Hills, Kenya (© Charlie Shoemaker).

right: Nearby the Kouré Giraffe Zone in Niger, local subsistence farmers are angry that giraffes are causing damage on their farms (William Critchley).

Given the wide range of topics, environments, cultures and institutions, rangeland management is much more complex than productive systems under other land uses. Visions, beliefs and doctrines needed to be faced and filtered out. There have been – and continue to be – endless discussionsand disputes related to the state of the rangelands, whether there is overgrazing or not, overstocking or not, if fire is good or malign, whether "holistic rangeland management" can work: the list goes on. A basic issue is whether rangeland users can or indeed cannot afford to balance their short-term productive interests with a longer term vision of healthy land and water resources. If they reach the state of being detached from the land, a fresh crisis and renewed vicious spiral of degradation will be inevitable. Happily, just as many rangelands have become degraded, there is huge potential for improvement. However the most fundamental question is whether viable options actually exist for rangeland management in the future, given continued fragmentation, limitation of movement, claims on resources, and reduction of the land available with a growing population?

Indeed, rangeland management and pastoralism have experienced shifting perceptions and attracted increased attention from African governments, stakeholders, and their international partners over the last decades. This has translated into a host of projects and programmes throughout SSA. Experience has been far from universally positive – nevertheless efforts continue to be made to invest in the rangelands for their improvement. And design simply must be informed by past experience. Indeed there is strong demand for evidence-based decision making, tapping on the experiences gained so far in SSA[1] on SRM approaches and technologies to support implementation of these developments now. This can be strengthened by continued documentation and sharing of knowledge.

Is there a future for the rangelands? If so, what might it look like? It is not within the scope of this book to answer those questions. The question here is whether sustainable rangeland management can make a difference. Certainly rangeland health has been, and is increasingly being, seriously affected in vast areas through West, East and Southern Africa. Nevertheless, there are many development initiatives in the rangelands that have been uncovered, brought together and analysed here. They demonstrate a very wide range of ways in which the rangelands can be improved – and the livelihoods of its peoples uplifted. If there is a future for the rangelands, it has to be founded in sustainable rangeland management, and in the positive trends are summarised below:

Focus #28: Recognize fifteen positive trends for sustainable rangeland management in Sub-Saharan Africa:

1. A huge number of experiences in SRM are yielding important lessons: continuing this process will uncover further trends & visible achievements.
2. Enlightened policies are emerging at national and regional levels recognising the growing importance of rangelands.
3. Traditional institutions are being revived and strengthened.
4. Wildlife is increasingly being seen as compatible with livestock.
5. "Non-Livestock Rangeland Products" can help diversify livelihoods.
6. Agropastoralism is no longer underestimated in its extent and potential.
7. Novel marketing mechanisms and partnerships are being developed.
8. Water points are opening up new areas, and being used to control grazing.
9. Conflict management is being addressed at all levels from local to regional.
10. Livestock – and wildlife- corridors are becoming legitimised and protected.
11. Participatory planning of land use has become the accepted norm.
12. Using nature-based solutions to strengthen SRM is backed by evidence: e.g. opportunistic use of heterogeneity.
13. There is growing recognition that solutions must be tuned to specific rangeland use systems but also embedded in interactions and synergies with others.
14. Rangelands are now being taken seriously for products & services: where once these areas were ignored, they are now desired for their resources.
15. Specific modern technologies – for example the use of mobile phones and satellite image interpretation – are being used to guide rangeland management.

[1] Including the following World Bank financed operations: Regional Sahel Pastoralism Support Project, Regional Livelihoods Resilience Project, and Ethiopia Second Pastoral Community Development Project.

Focus #29: Use the checklist to identify healthy rangelands:

1 Soil is more than 50% covered in the wet season and more than 30–50% in the dry season.
2 There are no patches or extensive areas with bare soil, hard surfaces and crusts (with exceptions: e.g. the natural system of the "tiger bush" or brousse tigrée).
3 Perennial grasses constitute more than 50% of the vegetation cover.
4 Undesirable and unpalatable species of weeds, herbs or bushes are less than 30% of the cover.
5 Tree and shrub encroachment and impenetrable thickets (especially by non-native species) do not dominate over a larger area.
6 There are no clear signs of surface water runoff or rill and gully erosion.
7 Trees or shrubs are present except at the dry fringe of the rangelands in the grasslands towards the desert and in temporarily waterlogged grasslands.
8 Native riparian forest/ woodlands are intact and not destroyed by cutting or river bank erosion.
9 Wetlands are not drying up or are overused by livestock.
10 Water sources are not polluted and infrastructure damaged by unprotected and regulated access of large numbers of animals.

Focus #30: Use the checklist to identify and promote "healthy" rangeland management practices:

1 Knowledge about implementation of good rangeland management is easily available.
2 People use knowledge to improve or initiate SRM.
3 Institutional cooperation and support is sufficient to facilitate large-scale interventions.
4 Rights and access to grazing land and water are clearly defined and secured
5 Users feel less vulnerable to droughts as there are clear arrangements for drought and emergency situations.
6 There are mechanisms to deal with multiple claims for specific rangeland resources and times.
7 Conflicts over the use of the rangelands are addressed and mechanisms for resolving conflicts are in place.

left: Rangeland users and specialists discussing the rangeland health and appreciating the good perennial grass cover as one of the key indicators for good rangeland health, Enonkishu conservancy, Kenya (Lippa Wood).

right: Four different management practices: from very recent bush clearing (below) to current heavy grazing (left) to resting (above) and clearing and fertilizer use (right) Ghanzi, Botswana (Hanspeter Liniger).

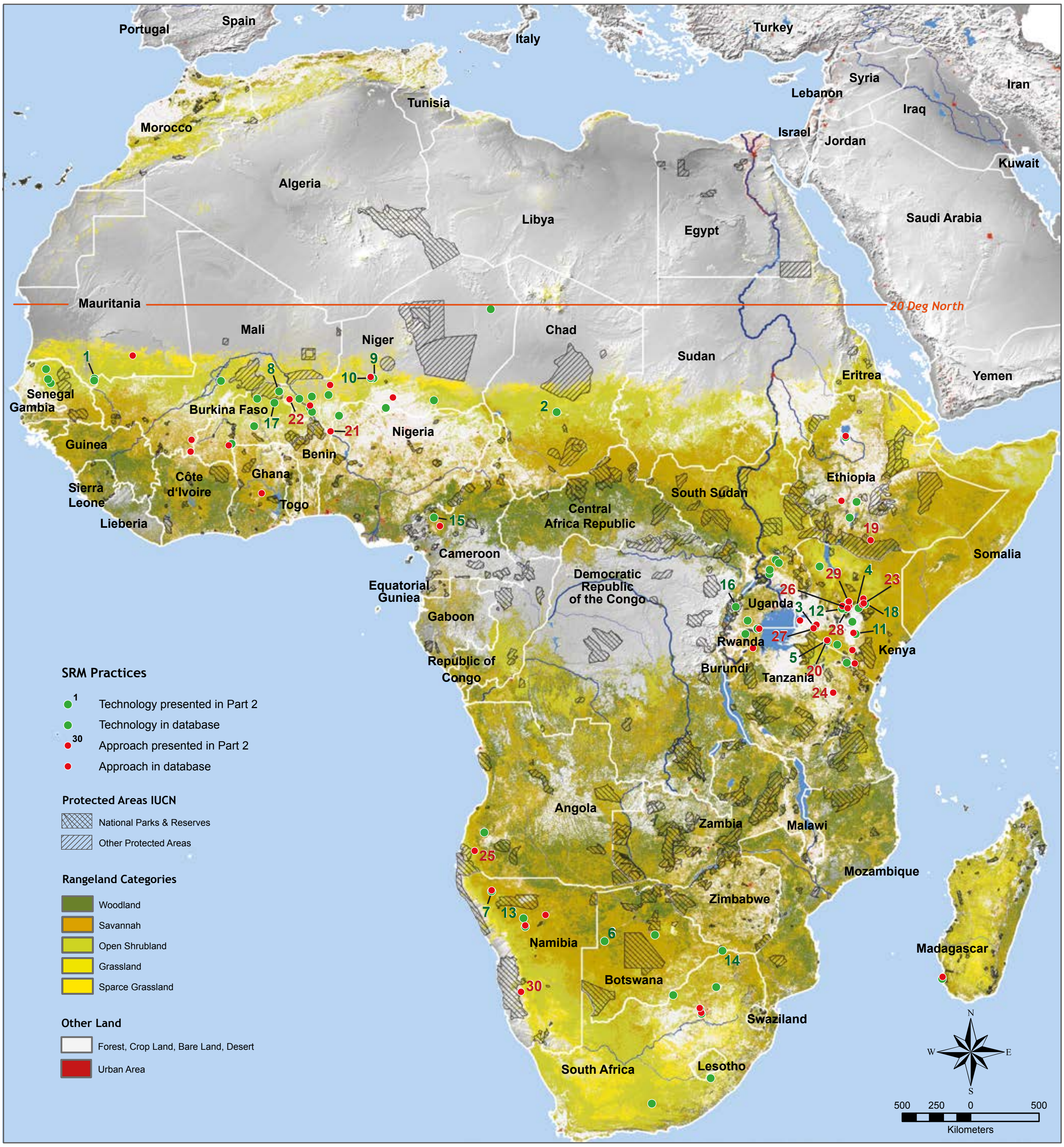
[1] Including the following World Bank financed operations: Regional Sahel Pastoralism Support Project, Regional Livelihoods Resilience Project, and Ethiopia Second Pastoral Community Development Project.

Part 2

Goats in Wajir (ILRI).

Examples of SSA rangeland technologies and approaches in groups

Part 2 showcases examples of SRM technologies and approaches classified under the five SRM technology groups and four SRM approach groups. Each group starts with a 2-page summary, entitled "In a nutshell" followed by examples of "good practice" case studies. Selection of the 30 examples presented took into account a wide range of countries and good practices as well as recognition of compilers and institutions. This "strategy"– and the limited number of examples that could be included – made it impossible to present technology-approach "packages" but rather a selection of either the approach or the technology. The case study table in the Annex is an overview of all the SRM technologies and approaches that were studied in these guidelines and records which technologies were linked to which approaches.



Enabled mobility TG 1

1 Implementing the ecological monitoring of locally managed sylvo-pastoral resources: Vegetation cover index
Mauritania p 127

2 Securing the mobility of pastoralism through consultation and access to water sources
Chad p 133

3 Social Tenure Domain Model (STDM)
Kenya p 141

4 Dedha grazing system as a natural resource management technology
Kenya p 149

Controlled grazing TG 2

5 Il Ngwesi Group Ranch Grazing with Holistic Management principles
Kenya p 157

6 Split Ranch Grazing Strategy
Botswana p 165

7 Combined herding for planned grazing
Namibia p 173

Range improvement TG 3

8 Vallerani system
Burkina Faso p 183

9 Firebreaks
Niger p 195

10 Assisted Natural Regeneration on agro-pastoral, sylvo-pastoral and pastoral land
Niger p 205

Range improvement TG 3

11 Grass reseeding
Kenya p 215

12 Rangeland restoration by cutting invasive species and grass reseeding and managing grazing
Kenya p 221

13 Bush thinning and biomass processing by manual or mechanised means
Namibia p 229

14 Reshaping of gully erosion through integration of silt fences, erosion blankets and brush packing
South Africa p 235

Supplementary feeding TG 4

15 Alliance Farming
Cameroon p 245

16 Dairy cattle fed with supplementary fodder
Uganda p 253

Infrastructure improvement TG 5

17 'Forage Christine'
Burkina Faso p 263

18 Subsurface dams
Kenya p 271

Community based NRM AG1

19 Pastoralist field schools
Ethiopia p 279

20 Community-based rangeland management in the southern Kenyan rangelands
Kenya p 287

Land & water use planning AG 2

21 Management of transboundary transhumance
Niger p 297

22 Community participation in large-scale land restoration for Africa's Great Green Wall programme
Niger p 303

23 Participatory mapping database building and monitoring of rangeland resources
Kenya p 311

24 Joint village land use planning
Tanzania p 319

25 Restoration of traditional pastoral management forums
Angola p 327

Marketing & alternative income AG 3

26 Kenya Livestock Insurance Program (KLIP)
Kenya p 337

27 Mara Beef: value added beef for for improved rangeland management livelihoods and conservation
Kenya p 345

28 Northern Rangelands Trust - Livestock to Markets
Kenya p 351

Wildlife & nature tourism AG 4

29 Holistic Rangeland Management combined with high end tourism
Kenya p 359

30 Restoration of game migration routes across the Namib Desert
Namibia p 367

ENABLED MOBILITY (TG1)

Transhumant livestock keeper in the region of Maradi, Niger (VSF Belgium).

In a nutshell

Short description

Technologies that help enable the mobility needed to graze over large areas or diverse zones to seek forage, water and mineral licks using traditional knowledge and innovations, or new technologies e.g. satellite image analysis, early warning systems at a large-scale.

Mobility is a key characteristic of pastoralism. It enables access to water, pastures and markets, maximizes animal productivity, and reduces risks. By moving herds, rangeland users respond to fodder and water availability, and to challenges from diseases. Mobility relates to both livestock managers, herder families and animals (livestock and wildlife). The term pastoralism is used when mobility is opportunistic and follows pasture resources (nomadism), or characterized by regular back-and-forth movements between relatively fixed locations to exploit seasonality of pastures (transhumance); and agropastoralism when pastoralists settle and also cultivate significant areas to feed their families from their own crop production. This technology group includes measures that regulate or facilitate access to wet and dry season grazing areas and drought/ emergency reserves.

Principles

- Enables a healthy state of the land by avoiding overuse through movement and providing rest periods, while exploiting gradients of forage quality and quantity.
- Has good potential to exploit rainfall variability.
- Copes with shocks and variability by enabling access to emergency areas and emergency markets.
- Requires strong governance systems to ensure adherence to grazing rules and arrangements.

Most common technologies

Interventions that contribute to improved and more secure mobility include water points that allow better access to underexploited rangelands, land use planning designed to facilitate movement of herds through migration corridors to dry season grazing areas and access to markets.

Traditional knowledge: (i) drawing on inherited knowledge (adapt) – accumulated over many generations – plus their personal experience, pastoralists are skilled at moving their animals to take advantage of seasonal feed and water resources, and set-aside grazing areas that they use as a bank during the dry season or droughts. They often use a mixture of grazers and browsers to make better use of the available forage. (ii) modernize and upgrade "traditional" pastoralism to continue to integrate variability and take advantage of it. One path is intensification in rangeland management by e.g. carefully supporting current mobile practices and focusing on improving livestock-related value chains.

Innovations: include securing pastoral mobility, ecological monitoring, data platforms (e.g. RADIMA[1]), livestock insurance (e.g. Index-Based Livestock Insurance (IBLI)), and new IT based technologies: such as improving early warning and response systems at larger

Health of land resources addressed	
rangeland vegetation	+
invasive alien species	+/–
soil loss	+/–
soil resources (OM, nutrients)	+
water resources	+
biodiversity	+
ESS addressed	
fodder production	++
fodder quality	+
water availability	++
stream flow	++
food security/ self-sufficiency	+
SRM knowledge	++
conflict mitigation	++
equity (gender, disadv. group)	++
governance	++
DRR (drought, floods, fire)	++
CC adaptation	++
C and GHG emissions	+

Benefit-cost ratio		
Inputs	short-term	long-term
Establishment	++	+++
Maintenance	++	++

Importance: +++ high, ++ medium, + low, +/– neutral, na: not available

scale, access to and use of geo-satellite derived data (biomass availability and quality, surface water availability, herd concentration and market prices for livestock and grain), geographic information systems to map the state of rangeland resources and image analysis, models, indexes calculations. Development of early warning and response systems can support early destocking when a drought shock is impending. Modelling and mapping as a tool can also play an important role in reducing exposure to shocks, in conflict resolution in areas in which livestock-keeping competes with other livelihood activities, to ensure cooperative land use. Conflict resolution must be an integral part of drylands development. Telecommunication (radio, mobile phones) can be used to transmit detailed information to mobile communities.

Rangeland use system (RUS)
Mainly large landscape 'pastoral', transhumance and 'agropastoral' rangeland systems.

Main benefits
- Allows space and flexibility for securing livelihoods in dryland marginal land.
- Adapted to climate change/ extremes and its impacts: strengthens risk management and resilience.
- Favours following the availability of water and forage, and allowing resting for recovery and deal with unpredictability of available resources.
- Helps to provide essential ecosystem services, such as carbon sequestration and biodiversity conservation.
- Maintains conflict resolution mechanisms (e.g. traditional agreements between pastoral groups), can help prevent organized crime and international terrorism.

Main disadvantages
- Adaptations or changes take time especially where land is communal and customs are key.
- Limited recognition of the rights of mobile pastoralists. "Modern" tenure systems have largely failed to consider the way land is used in mobile pastoral systems.
- Underrepresentation of pastoralists and little participation in design, land planning and monitoring.
- Often no laws protecting mobility.
- Inadequate basic service delivery in relation to mobile lifestyles.
- Modern information technology supporting knowledge about the availability of fodder and water resources is inadequate, inappropriate to people's needs or simply not available.

Applicability and adoption
Enabled mobility is applicable in semi-arid and arid regions where seasonal movement is required because of long dry periods, fluctuations in rainfall and inherently poor soils. Interventions that contribute to improved and more secure mobility have potential. They ensure consultation and conflict prevention and identification of conflicting issues.

Most of the technologies under this group showed a moderate to high trend of spontaneous adoption.

Index-Based Livestock Insurance (IBLI), Kenya

ILRI

IBLI is designed to help protect pastoralists and their livestock against the effects of prolonged forage scarcity. IBLI triggers payment to pastoralists when the forage situation deteriorates to levels considered to be severe, as compared to historical conditions over time. IBLI uses Normalized Difference Vegetation Index (NDVI), a satellite-derived indicator of the amount and vigour of vegetation, based on the observed level of photosynthetic activity. It measures forage conditions over a defined time period and compares the observed NDVI over a particular season, with the observed NDVI over a given historical period (e.g. 15 years). A set threshold below which payouts must be made is called the trigger level.
https://qcat.wocat.net/en/summary/4012/

Satellite Assisted Pastoral Resource Management (SAPARM) in Ethiopia and Tanzania

Custom grazing maps help pastoralists make better migration decisions in the face of increasing drought risks. Automatically updated every 10 days, grazing maps are generated using community knowledge digitized and integrated with satellite derived vegetation data, and distributed to pastoralists to improve their herd management and migration decision-making. In the first half year of use, livestock deaths were cut in half.
https://www.wfp.org/climate-change/initiatives/satellite-assisted-pastoral-resource-management

© WFP/Judith Schuler

Mobile innovations for Sahelian pastoralists

In the Netherlands Space Office funded 'Sustainable Technology Adaptation for Mali's Pastoralists' (STAMP) and 'Mobile Data for Moving Herd Management and better incomes' (MODHEM) projects in Mali and Burkina Faso, SNV and private sector partners (including Orange, Hoefsloot Spatial Solutions, Ecodata and SarVision) provide pastoralists with detailed information on biomass and water availability and quality, herd concentrations, weather information and market prices – all easily accessible through their mobile phones. This supports them in planning their transhumance, and in selling their animals at a good price, enabling them to better adapt to droughts. The information is derived from a combination of data collected in the field and from geo-satellites.
http://www.snv.org/public/cms/sites/default/files/explore/download/cc_drylands_20-10.pdf;

www.snv.org

[1] RADIMA, http://www4.unfccc.int/sites/nwp/pages/item.aspx?ListItemId=25554&ListUrl=/sites/nwp/Lists/MainDB

Field survey of the vegetation cover index (Winfried Kremer).

Implementing the ecological monitoring of locally managed sylvo-pastoral resources – Vegetation cover index (Mauritania)

ICV

DESCRIPTION

A system for ecological monitoring provides accurate observations on the development of sylvo-pastoral resources, the management of which is handed over to land users who are organized in a local association. In order to monitor the ecological status of the land, a method to record the Vegetation Cover Index (VCI) was developed to register changes compared with an initial survey.

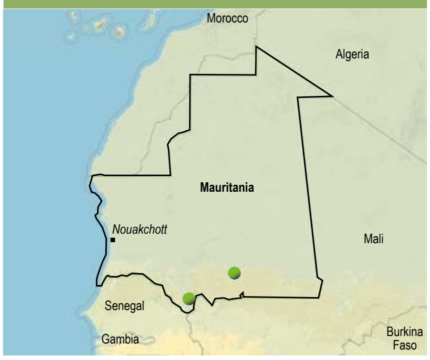
Ecological monitoring, based on the index of vegetation cover, is a suitable technology for the following purposes: (a) to check to which degree the objective to mitigate land degradation is achieved; (b) to provide authorities with a tool to assess sustainable land management; (c) to increase the transparency of the procedure to assess efforts from land users to protect the environment; (d) to implement corrective measures through specific management regimes (for instance prohibition on grazing); (e) to assess changes in income at the level of individual households, at the level of areas which are managed collectively, or at the level of the entire intervention zone; (f) to monitor the carbon stocks of woody vegetation.

The vegetation cover is therefore the target variable of the technology. The main components of the vegetation cover are described, which are the cover of woody and herbaceous vegetation. The woody vegetation cover consists of three sub-strata: the tree cover, the cover of regenerating trees and the shrub cover. Each of these strata is assessed in square meters (m2) below the top of the woody plants. The total of the three strata of woody vegetation provides the indicator of the woody vegetation cover. The herbaceous cover is indirectly assessed through the extent of soil surfaces which are clearly without vegetation (crusts, hard pans or glacis slopes). Furthermore, the diversity of woody species is considered through an indicator. The three indicators are weighted to obtain the Vegetation Cover Index (VCI).

The vegetation cover varies in space. The following major zones are distinguished: savannah with vegetation ranging from shrubs to woody vegetation (C), forested savannah (S), wooded mountainous savannah (M), forest galleries or wet zones (G). As part of the ecological monitoring, the development of the Vegetation Cover Index (VCI), calculated for the four zones (C, S, M and G) of an area, is compared with the development of the VCI in a control area. The control area represents the ecological state of a shrubland to which the rules for the management of natural resources, which are adopted in the Local Convention or in special arrangements, are not applied. The control area consists of equal parts of the four ecological zones (C, G, M and S).

Fixed plots for observation are selected once, in such a way that all zones in the target area are represented. The first surveys are done after the area managed by a Collective Local Management Organisation (AGLC) has been demarcated. The monitoring is carried out annually or every two years by teams consisting of three parties: a State agent (a

LOCATION



Location: Regions of Guidimakha and Hodh El Gharbi, Mauritania

No. of Technology sites analysed: 10-100 sites

Geo-reference of selected sites
- -12.09229, 15.43722
- -9.79615, 16.6935

Spread of the Technology: evenly spread over an area (approx. 10,000 km²)

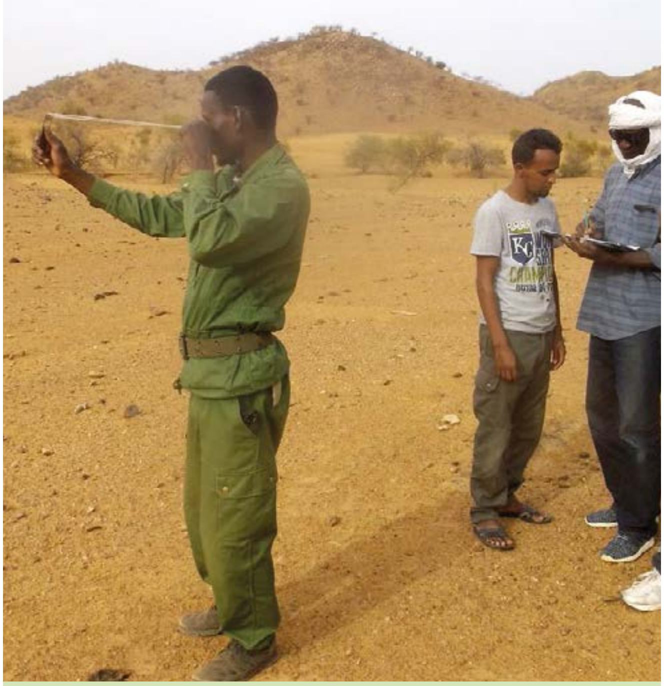
Comment: 7,000 km² in the region of Guidimakha (coverage 61%), the main drinking water points for livestock on the three axes of transhumance in Hodh El Gharbi.

Date of implementation: 2004

Type of introduction

- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ☑ through projects/ external interventions

Targeting with the 'Kramer'dendrometer (© GIZ).



Field surveys, participatory work (© GIZ).

forester), a member of the AGLC and a technician of ProGLN. The surveys in the control area are carried out simultaneously with the surveys in the areas of the AGLC. The data are processed manually in the survey forms. The baseline of the Vegetation Cover Index (VCI) is 100. This value represents the ecological status of the control area. The comparison of the development of the VCI in an area of an AGLC to the VCI of the control area refers to the same period of monitoring. The average change of the Vegetation Cover Index (VCI) in the area of Guidimakha amounted to 2,24 (from 100 to 102,24) in the period from 2004 to 2011. This indicates that the condition of the natural resources has improved overall in the areas which are managed by the local organisations through a local convention. The average increase of the VCI is in the order of magnitude of 0.55 units per year.

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- improve production
- reduce, prevent, restore land degradation
- conserve ecosystem
- protect a watershed/ downstream areas – in combination with other Technologies
- preserve/ improve biodiversity
- reduce risk of disasters
- adapt to climate change/ extremes and its impacts
- mitigate climate change and its impacts
- create beneficial economic impact
- create beneficial social impact
- ✓ assessment of the restoration of natural resources

Land use

Mixed (crops/ grazing/ trees), incl. agroforestry – Silvopastoralism

Water supply

- ✓ rainfed
- mixed rainfed-irrigated
- full irrigation

Number of growing seasons per year: 1
Land use before implementation of the Technology: sylvopastoral
Livestock density: Changing between the seasons due to transhumance. On average, 2.9 hectares per tropical livestock unit (TLU).

Purpose related to land degradation
The technology enables to assess the prevention and reduction of land degradation.

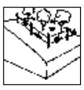
Degradation addressed

biological degradation – Bc: reduction of vegetation cover, Bq: quantity/ biomass decline, Bf: detrimental effects of fires.

SLM group

- natural and semi-natural forest management
- pastoralism and grazing land management
- improved ground/ vegetation cover

SLM measures



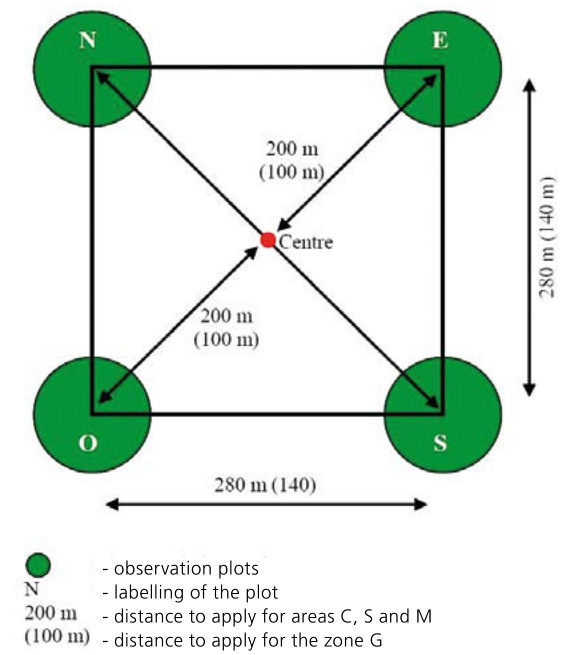
management measures – M2: Change of management/ intensity level

TECHNICAL DRAWING

Technical specifications

Fixed plots for observation are selected once in such a way that all zones in the target area are represented. Concentrating the field work in space by handling groups of plots saves labour time. A group of plots consists of four plots. The four plots in a group are located at 200 m (zones S, C, M) from a fixed point in the centre (see the technical drawing). The plots are positioned at the north, east, south and west respectively of the fixed central point.

In general, due to the limited surface area of the forest galleries or wet zones, the distance between the plots should be modified, and is therefore fixed at 100 m. The total number of observation plots for the control area is 64, or 16 groups of 4 plots. The 16 groups are distributed evenly over the four ecological zones C, G, M and S (four groups per zone). As for the control area, the total number of plots in each area of an AGLC is fixed at 64. The number of groups per ecological zone is proportional to the fraction of the surface area of the zone in the total area.



Author: Frank Richter

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Currency used for cost calculation: **US Dollars**
- Exchange rate (to USD): 1 USD = 365.00 UM
- Average wage cost of hired labour per day: 5

Most important factors affecting the costs

Labour costs.

Establishment activities

The time required for the field surveys, including the manual processing of the data, for a team of three persons varies between 3 and 5 days per area of an AGLC, depending on the distance from the area and the extent of the vegetation cover, particularly of the forest galleries. When the data are processed and analysed by computer, an extra half day is needed for an AGLC area. The costs of implementing the ecological monitoring are between 200.00 and 310.00 US$ per area and per annual survey. For the total extent of the areas managed by AGLCs in Guidimakha and Hodh el Gharbi (37 organisations), over a period of ten years and with three surveys per area, the costs are estimated at 25,000.00 to 30,000.00 US$.

Maintenance activities

1. field surveys (Timing/ frequency: None)
2. manual data processing (Timing/ frequency: None)
3. computer analysis (Timing/ frequency: None)

Comment: The survey of the Vegetation Cover Index (VCI) is done once a year or once in two years.

Maintenance inputs and costs

Specify input	Unit	Quantity	Cost per unit (US Dollars)	Total cost per input (US Dollars)	% of costs borne by land users
Labour					
field surveys	person-days	6	20.00	120.00	30.0
manual data processing	person-days	3	30.00	90.00	15.0
computer analysis	person-days	1	40.00	40.00	
Total costs for establishment of the Technology				**250.00**	

If land user bore less than 100% of costs, indicate who covered the remaining costs

Regional service of the Ministry of Environment and GIZ.

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [x] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [ ] humid
- [ ] sub-humid
- [x] semi-arid
- [ ] arid

Specifications on climate
Name of the meteorological station: Sélibaby and Ajoun El Atrous.

Slope
- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [x] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landform
- [x] plateau/ plains
- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [x] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [x] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [ ] medium (1-3%)
- [x] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [x] > 50 m

Is salinity a problem?
- [ ] yes
- [x] no

Occurrence of flooding
- [ ] yes
- [x] no

Species diversity
- [ ] high
- [ ] medium
- [x] low

Habitat diversity
- [ ] high
- [ ] medium
- [x] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Relative level of wealth
- [ ] very poor
- [x] poor
- [ ] average
- [ ] rich
- [ ] very rich

Sedentary or nomadic
- [x] sedentary
- [x] semi-nomadic
- [ ] nomadic

Gender
- [x] women
- [x] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Scale
- [ ] small-scale
- [ ] medium-scale
- [x] large-scale

Comment: The VCI is applied on communal land, which is owned by the state. Land use rights are communal.

Land ownership
- [x] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled

Land use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor	✓			good
education	poor		✓		good
technical assistance	poor		✓		good
employment (e.g. off-farm)	poor	✓			good
markets	poor		✓		good
energy	poor	✓			good
roads and transport	poor		✓		good
drinking water and sanitation	poor	✓			good
financial services	poor	✓			good

IMPACTS – BENEFITS AND DISADVANTAGES

Socio-cultural impacts

SLM/ land degradation knowledge	reduced							✓	improved	**Before SLM:** -3 **After SLM:** 3 **Comment:** The discussion of the monitoring results in the General Assemblies contributes to building knowledge on SLM and land degradation.
conflict mitigation	worsened						✓		improved	**Before SLM:** -3 **After SLM:** 2 **Comment:** The results of the monitoring are used in the mitigation of conflicts.

Benefits compared with establishment costs

Short-term returns	very negative				✓				very positive
Long-term returns	very negative						✓		very positive

Benefits compared with maintenance costs

Short-term returns	very negative				✓				very positive
Long-term returns	very negative						✓		very positive

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- single cases/ experimental
- 1-10%
- ✓ 10-50%
- more than 50%

Of all those who have adopted the Technology, how many have did so without receiving material incentives?

- ✓ 0-10%
- 10-50%
- 50-90%
- 90-100%

Comment: The ecological monitoring is a sovereign task, and therefore is a service of the State.

Number of households and/ or area covered

All the areas managed by the Collective Local Management Organisation in the two provinces apply the monitoring.

Has the Technology been modified recently to adapt to changing conditions?

- yes
- ✓ no

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Strengths

Land user's view

- To improve the transparency for land users of the procedure to assess their efforts to manage sylvo-pastoral resources sustainable through their compliance with the rules of the local convention.

Key resource person's view

- Enabling supporting organisations to check to what extent the objective to mitigate land degradation is achieved, based on indicators of impact.
- Provides information to apply and refine the rules for land management and specific arrangements (for instance the prohibition on grazing).

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view

- Dependency of local organisations on the technical services due to the sovereign nature. → not possible

Key resource person's view

- The resources of the technical services for an annual survey are limited. → A frequency of once in five years could be justified, given that the impact of the sustainable land management will only be visible after that period.

REFERENCES

Compiler: Karl-Peter Kirsch-Jung (kpkirs@web.de)

Resource persons: Karl - P. Kirsch-Jung (ioejuu@lie.de) - SLM specialist; Dah ould Khour (ucadconseil@yahoo.fr) - SLM specialist

Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/technologies/view/technologies_2081/

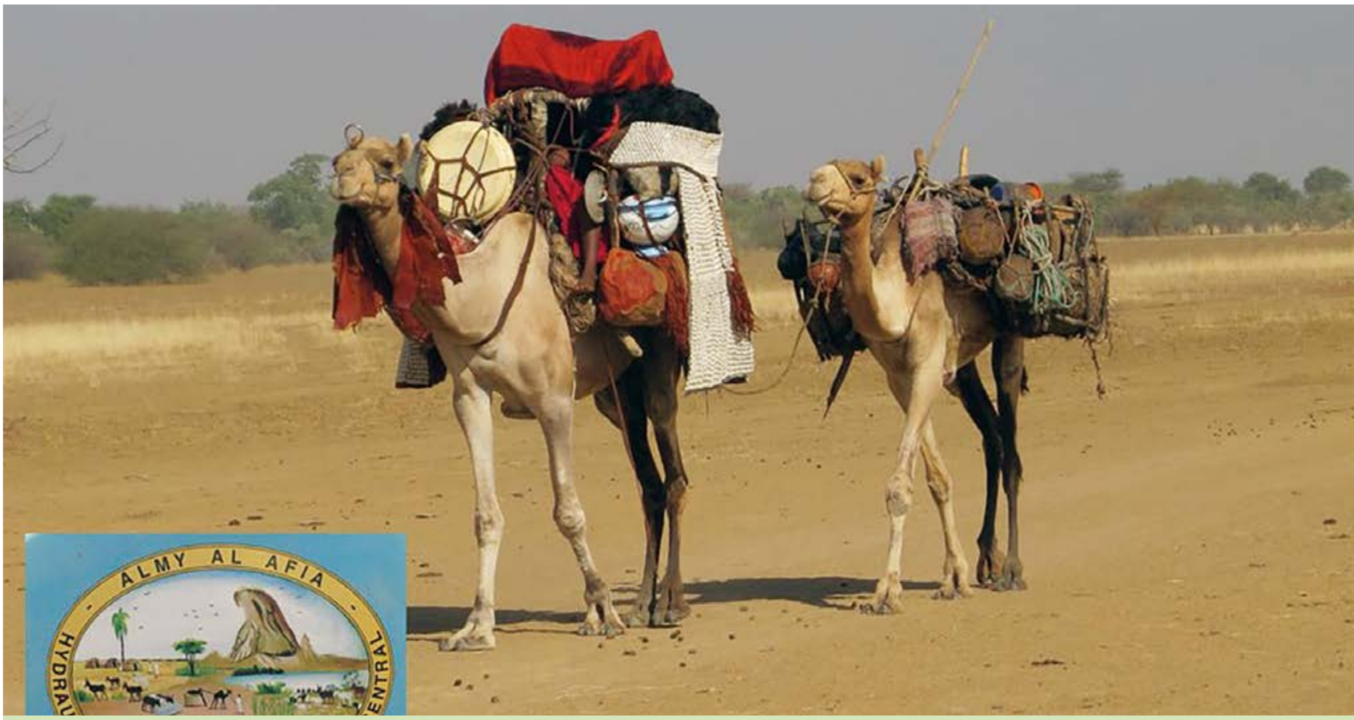
Linked SLM data: SLM Approach: Gestion locale collective des ressources naturelles https://qcat.wocat.net/en/wocat/approaches/view/approaches_1980/

Documentation was facilitated by: Institution: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) - Germany. Project: Programme Gestion des Ressources Naturelles, Mauretanie (ProGRN)

Date of documentation: April 7, 2017; **Last update:** May 31, 2018

Links to relevant information which is available online

Mise en place d'un suivi écologique de la gestion locale des ressources sylvopastorales - Indice du couvert végétal, ProGRN, 2011 : https://wocatpedia.net/wiki/Indice_du_couvert_v%C3%A9g%C3%A9tal_-_Suivi_%C3%A9cologique_de_la_gestion_d%C3%A9centralis%C3%A9e_des_ressources_sylvo-pastorales_en_Mauritanie



Camp of Arab camel herders during their seasonal migration (Project Almy Al Afia).

Securing the mobility of pastoralism through consultation and access to water sources (Chad)

Projet Almy Al Afia

DESCRIPTION

Securing the mobility of pastoralism through access to water sources (open wells and ponds in pastoral areas) and marking the livestock routes for transhumance: the case of the project Almy Al Afia in Chad and its consultative approach.

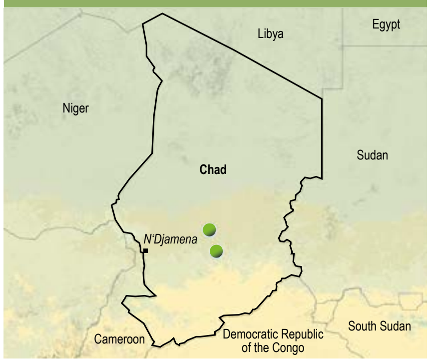
Livestock keeping is one of the main economic resources in Chad (in support of 40% of the population and 18% of the GDP, Ministry of Livestock, General census). Pastoralism in the country is based on the mobility of herds in a context of irregular precipitation and variable forage resources in time and space, and benefits from complementary relationships between the different ecological zones. In Chad, herds are taken in regular movements with the seasons between the Sahelian and the Sudanese grazing areas. The former are nutritious but limited in quantity, while the latter are more abundant but of lower quality, and not accessible until the fields are cleared after the harvest (meta-evaluation of projects on pastoral water sources, IIED, 2013). Thus, pastoral livestock keeping is founded on mobility and rangeland management, and on building complementary relationships and trade around farming systems and cultivated areas. The pastoralist systems are economically competitive (limited use of food inputs), and occur in marginal land which is characterized by conflicts, riots and a high level of insecurity (Conference of N'Djamena: 'Pastoral livestock keeping: a sustainable contribution to development and security in Saharan and Sahelian regions'). In the pastoral zone of Chad, where access to water is limited, the management and control of water sources by a social group in practice also leads to the monitoring and control of the use of grazing land which becomes available when water is present.

The project Almy Al Afia (2004-2016), developed by a partnership between the AFD and the Ministry of Water of Chad, operated in two regions of central Chad. The project Almy Al Afia was based on an entry 'development', concurrently with a process to consult and involve joint agencies. The project has improved approaches of preceding initiatives: concerted action and identification of water sources derived from the dialogue between users and authorities, and development of the local management of infrastructures and rangeland. The latter counteracts an exclusively private management or, instead, an ineffective public management which promotes free access to water sources and grazing land.

The project has enabled to address the following points:

1. Support mobility in pastoralism by enhancing the access to water (rehabilitation and construction of 160 wells; digging of 31 ponds for pastoral use);
2. Maintain or build processes of consultation and restoring security (joint committees for consultation and prevention of conflicts during transhumance);
3. Promote the proper use of water supply structures, in time and space (rehabilitated and new wells, excavated ponds) by context-specific management (strengthening of traditional management systems) and encourage the maintenance of infrastructure.

LOCATION



Location: Although the sites where the technology was applied are at the local scale, the project has considered pastoralism and the relationships between the two regions at the broader landscape scale. Regions of Batha and of Guéra, Chad.

No. of Technology sites analysed: 100-1,000 sites

Geo-reference of selected sites
- 18.33618, 13.2239
- 18.69324, 12.1736

Spread of the Technology: evenly spread over an area (approx. 10-100 km^2)

Date of implementation: 2018

Type of introduction

- ✓ through land users' innovation
- ✓ as part of a traditional system (> 50 years)
- during experiments/ research
- through projects/ external interventions

Use of a well as a water source for herds in the north of Batha (Project Almy Al Afia).

Picture of the demarcation of livestock corridors (Project Almy Al Afia).

The pastoral ponds should be constructed in locations of existing water sources (natural ponds in suitable places, i.e. with a clayey soil capable to retain water). The existing water source is enlarged and improved by rural engineering (enlargement of the surface, deepening).

The wells are rehabilitated. Most wells were constructed several decades ago and are severely damaged. The water supply structures all have different and complementary functions. The deep wells in the pastoral zone are generally used throughout the year, and are overexploited. The way in which these structures are managed is strongly anchored in the region. The District officer delegates the management to 'Heads of Wells'. These old wells, which are used day and night, are often in a poor condition. Rehabilitating degraded wells is given priority over digging new wells because of the substantial potential for conflict. The water supply structures in areas of dry forest are less old and smaller in number. These wells are less frequently used and function as an alternative water source when the traditional ponds, water reservoirs and wells have dried up. They allow to delay the movement of the herds towards grazing areas in the Sahelian zone.

The strip between these two zones is used for agropastoralism. Herds cannot remain there. Therefore the project has facilitated the movement of the herds to the zones further south. The pastoral ponds close to the livestock routes for the transhumance were created in a way to be easily used by the herders, but also to encourage short stays.

The approach was combined with consultation through joint committees for the prevention of conflicts, and at a later stage by marking of sections of the livestock routes for the transhumance. Many meetings were held with the users of the land management structures and policy makers, with the aim to identify and negotiate the target sites and to anticipate methods for the management and maintenance of the structures. This has enabled to maintain an atmosphere of social stability conducive to cooperation. Along almost 550 km of the livestock routes for the transhumance, sections were marked ('mourhals' in Chadian Arabic). The demarcation was not intended to enclose the herds in the livestock corridors (from which they can move freely outside the growing seasons for agricultural crops), but rather to implement the results of the consultations on the land use on the ground. The committees for the prevention of conflicts, which were supported by the project, also played a major role.

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- ☐ improve production
- ✓ reduce, prevent, restore land degradation
- ✓ conserve ecosystem
- ✓ protect a watershed/ downstream areas – in combination with other Technologies
- ✓ preserve/ improve biodiversity
- ✓ reduce risk of disasters
- ☐ adapt to climate change/ extremes and its impacts
- ☐ mitigate climate change and its impacts
- ✓ create beneficial economic impact
- ✓ create beneficial social impact

Land use

Grazing land – Extensive grazing land: Nomadism, Seminomadism/ pastoralism

Water supply

- ✓ rainfed
- ☐ mixed rainfed-irrigated
- ☐ full irrigation

Comment: In these zones, rainfall is erratic in terms of spatial distribution and in quantity. Hence, grazing areas are not uniformly covered from year to year. The mobility of herds is the only way to adapt to this variability.

Number of growing seasons per year: 1
Land use before implementation of the Technology: The target areas of the project Almy Al Afia vary with regard to their context and issues. The structures which were implemented in the framework of the project had the following objectives: – In the zones with dry forest in the south, to slow down the return of the herds to the grazing areas in the north. The wells thus function as a substitute for the other traditional systems of water supply. – In the pastoral zone, the wells which have been rehabilitated or replaced have limited the impacts of the concentration of herds around operational water supply structures. – In between these two zones, the herds should be able to cross a large strip of land allocated to agricultural use (valley bottoms, zones with rainfed cropping).
Livestock density: Variable depending on zones and seasons.

Purpose related to land degradation

- ✓ prevent land degradation
- ✓ reduce land degradation
- restore/ rehabilitate severely degraded land
- adapt to land degradation
- not applicable

Degradation addressed


soil erosion by water – Wt: loss of topsoil/ surface erosion


soil erosion by wind – Et: loss of topsoil, Eo: offsite degradation effects


physical soil deterioration – Ps: subsidence of organic soils, settling of soil

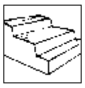

biological degradation – Bc: reduction of vegetation cover, Bq: quantity/ biomass decline

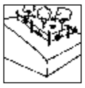

water degradation – Hs: change in quantity of surface water, Hg: change in groundwater/aquifer level, Hp: decline of surface water quality, Hq: decline of groundwater quality

SLM group

- pastoralism and grazing land management.
- ground water management.

SLM measure


structural measures – S8: Sanitation/ waste water structures

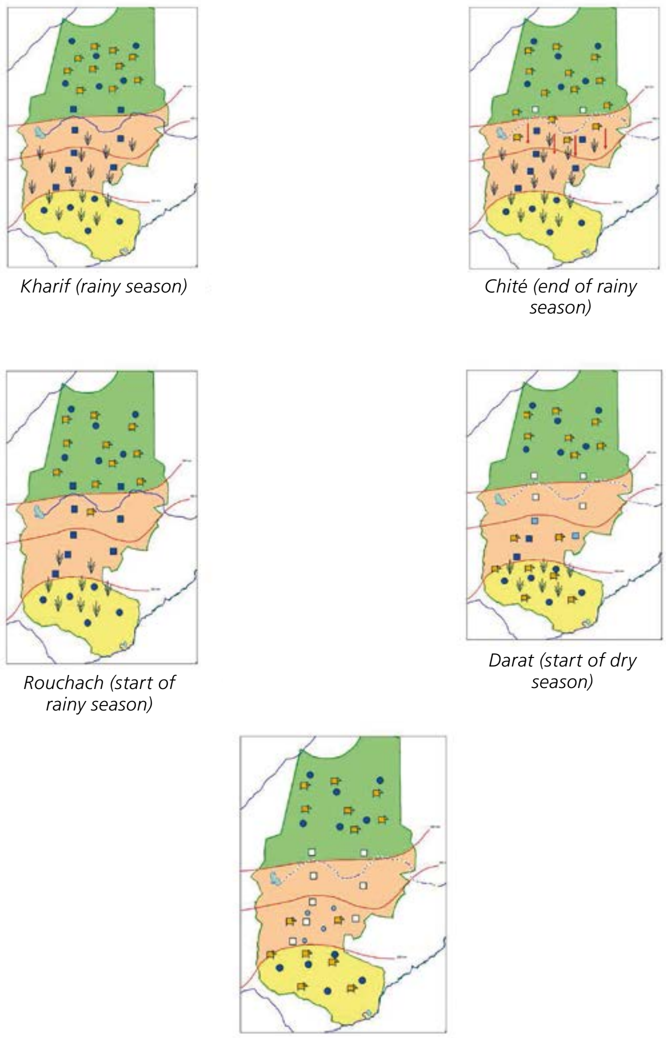

management measures – M2: Change of management/ intensity level, M3: Layout according to natural and human environment

TECHNICAL DRAWING

Technical specifications

The wells (new and rehabilitated) and the demarcation of the livestock routes are the outcome of a long process of outreach. The communications between the local level (taking account of the views of future users) and the level of decision-making (administration) enable social agreements to be formalized. These agreements set the rules for the selection of the locations of the water supply structures, their management and maintenance.

Complementarity in the use of different hydraulic and pastoral resources



Kharif (rainy season)

Chité (end of rainy season)

Rouchach (start of rainy season)

Darat (start of dry season)

Seyf (dry season)

Source: Capitalization of the second phase of the Almy Al Afia project

Author: Project Almy Al Afia.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit **Structure**.
- Currency used for cost calculation: **FCFA**
- Exchange rate (to USD): 1 USD = 561.71 FCFA
- Average wage cost of hired labour per day: 1,000 FCFA

Most important factors affecting the costs

The costs of the constructions are highly dependent on their location (costs for the supply and disposal of equipment and materials), on the price of inputs (cement, etc.), and especially on the type of structure (depth of the wells, geological environment). The costs of the supply and disposal of equipment and materials include costs for the installation of the structures (water, cement, labour, machinery) on the construction sites (which are often far away from routes and towns), and costs for the disposal of the equipment after the construction is completed. The costs of supply and disposal can be significant with respect to the costs of the structure itself.

Establishment activities

1. Outreach/ awareness raising (Timing/ frequency: Four to six meetings prior to the signing of the social agreements).
2. Construction of the facilities (Timing/ frequency: Four to six months, depending on the type of structure and its depth).
3. Monitoring the management (Timing/ frequency: Regular visits of the project team to support the implementation of adapted management practices).

Comment: The implementation of the different phases varies greatly in terms of the location of the outreach activities and the duration of the construction work.

Establishment inputs and costs (per Structure (new well, rehabilitation or km of markings))

Specify input	Unit	Quantity	Cost per unit (FCFA)	Total cost per input (FCFA)
Labour				
Rehabilitated wells (mean depth 56 m)	1	93	10,497,939.00	976,308,327.00
Geophysical assessment for new wells	1	158	17,979,914.00	2,840,826,412.00
Exploration drilling for new wells (mean depth 96 m)	1	220	6,005,415.00	1,321,191,300.00
New wells (mean depth 45 m)	1	62	45,145,740.00	2,799,035,880.00
Pastoral ponds (6,000 m^3 on average)	1	31	23,008,065.00	713,250,015.00
Markers (8 signs/ km)	1	492	1,069,203.00	526,047,876.00
Other				
Outreach on new wells (/site)	1	62	213,428.00	13,232,536.00
Outreach on rehabilitation (/site)	1	93	248,695.00	23,128,635.00
Outreach on marking (/km)	1	492	52,088.00	25,627,296.00
Total costs for establishment of the Technology				**9,238,648,277.00**

Comment: The context of pastoralism has taken the project approach to not ask compensation from users: if the users are never the same, then who should be charged? Who will collect the payments and manage the collected funds? In addition, most of the water supply structures are far from financial institutions, which causes problems in securing these funds. Therefore the users contribute in terms of day-to-day maintenance of structures, by mobilizing labour in particular.

Maintenance activities

1. Mobilising indigenous groups for day-to-day maintenance of structures (dredging, cleaning) (Timing/ frequency: Depending on the type of structure (generally monthly))

Maintenance inputs and costs (per Structure (new well, rehabilitation or km of markings))

Specify input	Unit	Quantity	Cost per unit (FCFA)	Total cost per input (FCFA)
Labour				
Support missions for the management and maintenance of the water supply structures (2 missions per structure for the entire project)	1	155	53,000.00	8,215,000.00
Support mission for the management and maintenance of the markings	1	100	53,000.00	5,300,000.00
Total costs for establishment of the Technology				**13,515,000.00**

Comment: The amount of financial support varied with the type of structure (more support for management and maintenance is needed for new structures than for rehabilitated structures) and with their location or specific problem (in the case of structures located in the agropastoral zones). Financial support to the markings of the livestock corridors was indirectly provided through the committees for the prevention and management of conflicts.

NATURAL ENVIRONMENT

Average annual rainfall
- < 250 mm
- ✓ 251-500 mm
- 501-750 mm
- 751-1,000 mm
- 1,001-1,500 mm
- 1,501-2,000 mm
- 2,001-3,000 mm
- 3,001-4,000 mm
- > 4,000 mm

Agro-climatic zone
- humid
- sub-humid
- ✓ semi-arid
- ✓ arid

Specifications on climate

One rainy season per year (from June to September) Name of the meteorological station: Ati.

The target region includes large areas extending over important gradients (encompassing boundaries of the desert zone, the forested zone and the cotton-growing zone).

Slope
- ✓ flat (0-2%)
- gentle (3-5%)
- moderate (6-10%)
- rolling (11-15%)
- hilly (16-30%)
- steep (31-60%)
- very steep (>60%)

Landform
- ✓ plateau/ plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

Altitude
- 0-100 m a.s.l.
- ✓ 101-500 m a.s.l.
- 501-1,000 m a.s.l.
- 1,001-1,500 m a.s.l.
- 1,501-2,000 m a.s.l.
- 2,001-2,500 m a.s.l.
- 2,501-3,000 m a.s.l.
- 3,001-4,000 m a.s.l.
- > 4,000 m a.s.l.

Technology is applied in
- convex situations
- concave situations
- ✓ not relevant

Soil depth
- ✓ very shallow (0-20 cm)
- shallow (21-50 cm)
- moderately deep (51-80 cm)
- deep (81-120 cm)
- very deep (> 120 cm)

Soil texture (topsoil)
- ✓ coarse/ light (sandy)
- medium (loamy, silty)
- fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- ✓ coarse/ light (sandy)
- medium (loamy, silty)
- fine/ heavy (clay)

Topsoil organic matter content
- high (>3%)
- medium (1-3%)
- ✓ low (<1%)

Groundwater table
- on surface
- < 5 m
- 5-50 m
- ✓ > 50 m

Availability of surface water
- excess
- good
- medium
- ✓ poor/ none

Water quality (untreated)
- ✓ good drinking water
- poor drinking water (treatment required)
- fine/ heavy (clay)
- for agricultural use only (irrigation)
- unusable

Is salinity a problem?
- ✓ yes
- no

Occurrence of flooding
- yes
- ✓ no

Species diversity
- high
- ✓ medium
- low

Habitat diversity
- high
- ✓ medium
- low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- subsistence (self-supply)
- ✓ mixed (subsistence/ commercial
- commercial/ market

Off-farm income
- ✓ less than 10% of all income
- 10-50% of all income
- > 50% of all income

Relative level of wealth
- ✓ very poor
- ✓ poor
- average
- rich
- very rich

Level of mechanisation
- ✓ manual work
- animal traction
- mechanized/ motorized

Sedentary or nomadic
- sedentary
- ✓ semi-nomadic
- ✓ nomadic

Individuals or groups
- individual/ household
- ✓ groups/ community
- cooperative
- employee (company, government)

Gender
- ✓ women
- ✓ men

Age
- children
- ✓ youth
- ✓ middle-aged
- elderly

Area used per household
- < 0.5 ha
- 0.5-1 ha
- 1-2 ha
- 2-5 ha
- 5-15 ha
- 15-50 ha
- 50-100 ha
- 100-500 ha
- 500-1,000 ha
- 1,000-10,000 ha
- ✓ > 10,000 ha

Scale
- small-scale
- medium-scale
- ✓ large-scale

Comment: Transhumance, and more generally pastoral mobility, applies to large geographical scales and long periods. The areas involved are very large, far above 10,000 ha.

Land ownership
- state
- company
- communal/ village
- ✓ group
- individual, not titled
- individual, titled

Land use rights
- open access (unorganized)
- ✓ communal (organized)
- leased
- individual

Water use rights
- open access (unorganized)
- ✓ communal (organized)
- leased
- individual

Access to services and infrastructure

health	poor	✓			good
education	poor	✓			good
technical assistance	poor	✓			good
employment (e.g. off-farm)	poor	✓			good
markets	poor		✓		good
energy	poor	✓			good
roads and transport	poor	✓			good
drinking water and sanitation	poor	✓			good
financial services	poor	✓			good

IMPACTS – BENEFITS AND DISADVANTAGES

Socio-economic impacts

water availability for livestock	decreased							✓	increased
water quality for livestock	decreased						✓		increased

Comment: Expansion of the areas covered by water supply points. Reduced closure of water supply points (rehabilitation), opening-up of new grazing land, securing the movement of livestock and people.

Socio-cultural impacts

food security/ self-sufficiency	reduced						✓		improved
land use/ water rights	worsened						✓		improved
community institutions	weakened							✓	strengthened
conflict mitigation	worsened							✓	improved
situation of socially and economically disadvantaged groups (gender, age, status, ethnicity etc.)	worsened							✓	improved

Comment: Preserving the capacity of herders and their families to move, to choose their trajectories rather than responding to imposed conditions.

Comment: Upgrading of traditional management systems of water supply structures.

Ecological impacts

soil cover	reduced						✓		improved
soil organic matter/ below ground C	decreased						✓		increased
vegetation cover	decreased						✓		increased
plant diversity	decreased						✓		increased
drought impact	increased							✓	decreased

Comment: Reduction of the impacts of the concentration of livestock and people in small areas. Promotes the complementary relations between the zones (pressure relief in some zones and use and maintenance of other zones), and over the seasons.

Off-site impacts

water availability (groundwater, springs)	increased							✓	reduced

Comment: Increased access to groundwater through the rehabilitation of wells and the construction of new wells.

Comments regarding impact assessment: As explained above, in these zones with low rainfall and scarce natural water sources of temporary character (ponds), it is essential to combine the use of surface water with the use of water from deep permanent groundwater bodies. When they have the choice, herders almost exclusively choose sources with surface water (avoiding effort to extract the water). But when these sources run dry, they fall back on using wells (and deep groundwater). The rehabilitation of old wells and the construction of new wells in zones without wells contributes to increasing the availability of water.

Benefits compared with establishment costs

Short-term returns	very negative						✓		very positive
Long-term returns	very negative							✓	very positive

Benefits compared with maintenance costs

Short-term returns	very negative						✓		very positive
Long-term returns	very negative						✓		very positive

Comment: The profitability is considered in relation to the number of animals/herds involved. The costs of construction and rehabilitation are certainly significant, but the water supply structures are used for thousands of animals (in case of the most heavily used wells); most animals drink every two days. Therefore the costs per head of livestock are limited. The wells are long lasting, and therefore the returns are positive in the short and the long term.

CLIMATE CHANGE

Climate change/ extreme to which the Technology is exposed	How the Technology copes with these changes/ extremes	
Gradual climate change		
annual temperature increase	not well at all ☐ ✓ ☐ ☐ ☐ very well	
seasonal temperature increase	not well at all ☐ ✓ ☐ ☐ ☐ very well	Season: wet/ rainy season
Climate-related extremes (disasters)		
drought	not well at all ☐ ☐ ☐ ✓ ☐ very well	

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ☐ single cases/ experimental
- ☐ 1-10%
- ☐ 10-50%
- ✓ more than 50%

Of all those who have adopted the Technology, how many have did so without receiving material incentives?

- ☐ 0-10%
- ☐ 10-50%
- ☐ 50-90%
- ✓ 90-100%

Comment: Access to water is such a large problem that it requires all the land users who enter the zone to be informed when a water supply structure is rehabilitated or constructed. The involvement of traditional leaders in the management of the structures, and the system of representatives of the traditional leadership in the various other zones (Khalifas) contributes to the spontaneous dissemination of the information.

Number of households and/ or area covered

The technology responds to a substantial need, but also corresponds to the capacity of land users to use and maintain the structures. The energy supply is provided by animal traction, and does not require external energy sources.

Has the Technology been modified recently to adapt to changing conditions?

- ☐ yes
- ✓ no

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Strengths

Land user's view

- Permanent access to water.
- Reopening of water supply structures and consolidation of access to water at some degraded sites.
- Agencies and authorities for conflict prevention.
- Marking of sections of livestock corridors with conflict situations.

Key resource person's view

- Full commitment of groups (access to water is a major problem).
- Continuation of the approach through the development of other projects and inclusion at the national level.

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view

- Interventions are limited with regard to the needs (rehabilitation in particular). → By larger investments and better integration of the approach in public action.
- There is a need to extend the approach, in particular the support to the consultative bodies. → Formalize support to the consultation process.

Key resource person's view

- Recognition of the experiences, the approach and the methodology in other interventions. Outreach and awareness raising are performed during the project, but at the end the management of the infrastructure is no longer supported. The government should be able to follow up on the support (mechanism for monitoring and maintenance). → Formalize support to the consultation process.
- There is a need to mainstream outreach and consultation (lengthy process). → Formalize support to the consultation process.

REFERENCES

Compiler: Bonnet Bernard (b.bonnet@iram-fr.org)
Resource persons: Bonnet Bernard (b.bonnet@iram-fr.org) - SLM specialist
Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/technologies/view/technologies_3356/
Date of documentation: Jan. 18, 2018; **Last update:** May 28, 2018

Key references

Capitalisation des enseignements de la deuxième phase du projet Almy Al Afia, Main document, DHP, Antea/Iram, March 2016: Republic of Chad, General Secretariat, Ministry of Water, Directorate of Pastoral Water Resources

Document de Suivi-Evaluation des activités du PHPTC II, tableau de bord des activités du projet, DHP, Antea/Iram, mars 2016: Republic of Chad, General Secretariat, Ministry of Water, Directorate of Pastoral Water Resources

Note Entretiens Techniques du PRAPS, Accès et gestion durable des espaces pastoraux (chemins de transhumance, aires de pâturages et de repos), PRAPS, 2016, B. Bonnet, A. H. Dia, P. Ndiaye, I. Touré: Republic of Chad, General Secretariat, Ministry of Water, Directorate of Pastoral Water Resources

Evaluation et capitalisation de 20 ans d'intervention du Groupe AFD portant sur le secteur de l'Hydraulique Pastorale au Tchad, IIED, May 2013, S. Krätli, M. Monimart, B. Jallo, J. Swift, C. Hesse: Republic of Chad, General Secretariat, Ministry of Water, Directorate of Pastoral Water Resources

Links to relevant information which is available online

Platform on pastoralism in Chad: www.plateforme-pastorale-tchad.org/
Website of PRAPS-TD: www.praps.cilss.int/index.php/praps-pays-tchad/
Website of Iram: https://www.iram-fr.org/elevage-pastoralisme-et-hydraulique-pastorale.html
AFD in Chad: http://www.afd.fr/fr/page-region-pays/tchad

Enumerators in the field (Ken Otieno).

Social Tenure Domain Model (STDM) (Kenya)

STDM

DESCRIPTION

The Social Tenure Domain Model (STDM) is about people and their relationships with land. The tool as applied secures tenure through the recognition of tenure diversity and social contexts. In the management of land and resources use, STDM facilitates proper land use and management to minimize practices that lead to degradation.

Technology application: The Social Tenure Domain Model is applied in order to relate natural and human environments. It is a social tool that defines the relationship of persons to natural resources such as land, their utilization of it, and sharing – for sustainable development. To realize optimal resource utilization, the tool enables the direct engagement of the resource users in a collective and participatory way. The technology allows communities to be part of a guided data collection and data entry into an STDM platform. The data includes social and economic data based on what is needed. The platform also can enable storage of information and documents such as title deeds. Names, gender, properties where the community members needs to have such information. These details can be updated and can inform planning and resource allocation by government and development partners.

Main characteristics of the technology: STDM is a relational database built on an open source GIS platform called Quontum GIS (QGIS), running on Postgres SQL. This tool was built by Global Tools Land Network (GLTN). The tool captures both spatial information related to locations of land parcels, natural resources captured in points and defined in maps. Secondly, the technology captures socio-economic aspects of a resource, and allows definition of the type of relationship that exists between the resource and the person, as well as an indication of the percentage particular tenure regime in the areas including the existing rights and how they play out. The system recognizes the different level of rights thus appreciating that they are multiple and overlaid resulting to multiple uses. Therefore the technology enables the capture of bundles of rights that people have/ should enjoy in a resource. The technology allows generation of reports and performs the desired analysis by the proponents and the beneficiaries of the information stored within the databases. It is open source, thus available free -hence its sustainability.

The purposes/ functions of the STDM: The functions of the technology as have been piloted by RECONCILE and partners has focused around land tenure. It addresses security of tenure for vulnerable poor communities living within informal settlements, through participatory common resource identification, mapping and documentation, key resources including cattle dips, salt lick areas/ fields and water points management has improved. This is due to the recognition of boundaries anticipatory defined leading to revival of and establishment of community resources management committees especially around water and grazing lands. This in return has improved/ increased production of both plants and animals. However, the technology can be customized to serve other purposes of information storage and management.

LOCATION

Location: Kembu sub-county, Bomet county, Kenya

No. of Technology sites analysed: 10-100 sites

Geo-reference of selected sites
- 35.33463, -0.90414
- 35.29908, -0.91926
- 35.42976, -0.82013

Spread of the Technology: evenly spread over an area (approx. 10-100 km²)

Date of implementation: 2016

Type of introduction
- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ☑ through projects/ external interventions

Enumerators practicing the on how to use a GPS (Ken Otieno).

The enumerators get instructions from the GIS expert on the use of the GPS (Ken Otieno).

The major activities/ inputs needed to establish/ maintain the technology: Major inputs are needed in empowerment of local communities through building their capacity to apply the technology through their own initiative. Building community-based resource centres and equipping them with computers installed with the software ensures that the technology is centred on the day-to-day activities of the communities and institutions.

Benefits/ impacts: The technology has left better organised communities in terms of managing land and other resources. The technology has assisted local governments to manage issues of land ownership, especially within the context of customary land tenure and ownership. The county governments of Kenya, for instance, have spatial data and information that can help in planning and resources allocation. In areas where the technology has been used in the context of RECONCILE's work, better services and resources can be acquired given accurate information of Mapping land tenure, boundaries, water points and the water rights, infrastructure, different grazing lands and plans for the utilization of the grazing land and the rights of different users. It can result in improved and sustainable use of natural resources which in turn have a direct impact on production.

Small-scale dairy farmers have been able to manage grazing lands, water and salt licks to improve production of animal products. Information captured and managed by the technology has enabled communities within informal settlements to negotiate with government authorities to enable land allocation and thus security of tenure and improved livelihoods.

What do land users like/ dislike about the technology?

Likes: The technology is flexible, it can be customized to capture information in any form desired. It is based on a GIS platform which is easy to manipulate and is open source.

Dislikes: Users sometimes encounter errors that are a result of incorrect information entered, and these errors are written with the programming format: thus it requires good knowledge of the technology to remedy this.

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [x] improve production
- [x] reduce, prevent, restore land degradation
- [x] conserve ecosystem
- [x] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [ ] create beneficial economic impact
- [ ] create beneficial social impact

Land use

Extensive grazing land: Semi-nomadism/ pastoralism
Intensive grazing/ fodder production: Cut-and-carry/ zero grazing
Main animal species and products: The cattle kept in Ndaraweta are mainly cross-breeds between local animals and Friesian or Ayrshire cattle. The communities are currently in an advance stage of upgrading, but they still keep some short-horned local zebu cows as well.

Mixed (crops/ grazing/ trees), incl. agroforestry – Agropastoralism
Main products/ services: The cattle are kept for multiple uses including milk, meat, and hides. The communities grow hay for local use and sale within.

Comment: The technology did therefore help the communities to appreciate the common resources that support the livestock keeping.

Water supply

- [x] rainfed
- [ ] mixed rainfed-irrigated
- [ ] full irrigation

Number of growing seasons per year: 2
Land use before implementation of the Technology: Before the mapping exercise, the management of most common resources were not given much attention. After participatory mapping and documenting these resources and the establishment of information on encroachment, degradation and the neglected water points, communities took up the management of the resources more seriously and therefore improved knowledge and clarity around the land tenure rights for the communities and the need for tenure security and protection of rangelands and the resources therein.

Purpose related to land degradation

- [ ] prevent land degradation
- [x] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [x] adapt to land degradation
- [ ] not applicable

Degradation addressed

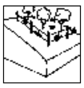
water degradation – Hs: change in quantity of surface water, Hw: reduction of the buffering capacity of wetland areas.

Comment: Land degradation in rangelands is a problem that is being experienced and other challenges especially in the areas where agro-pastoralism is practiced include sustainable land use and management. The mapping process while not having direct response to these issues, it demonstrated that the communities can use sustainable means in land use through land use planning.

SLM group

- natural and semi-natural forest management
- pastoralism and grazing land management
- integrated crop-livestock management

SLM measures

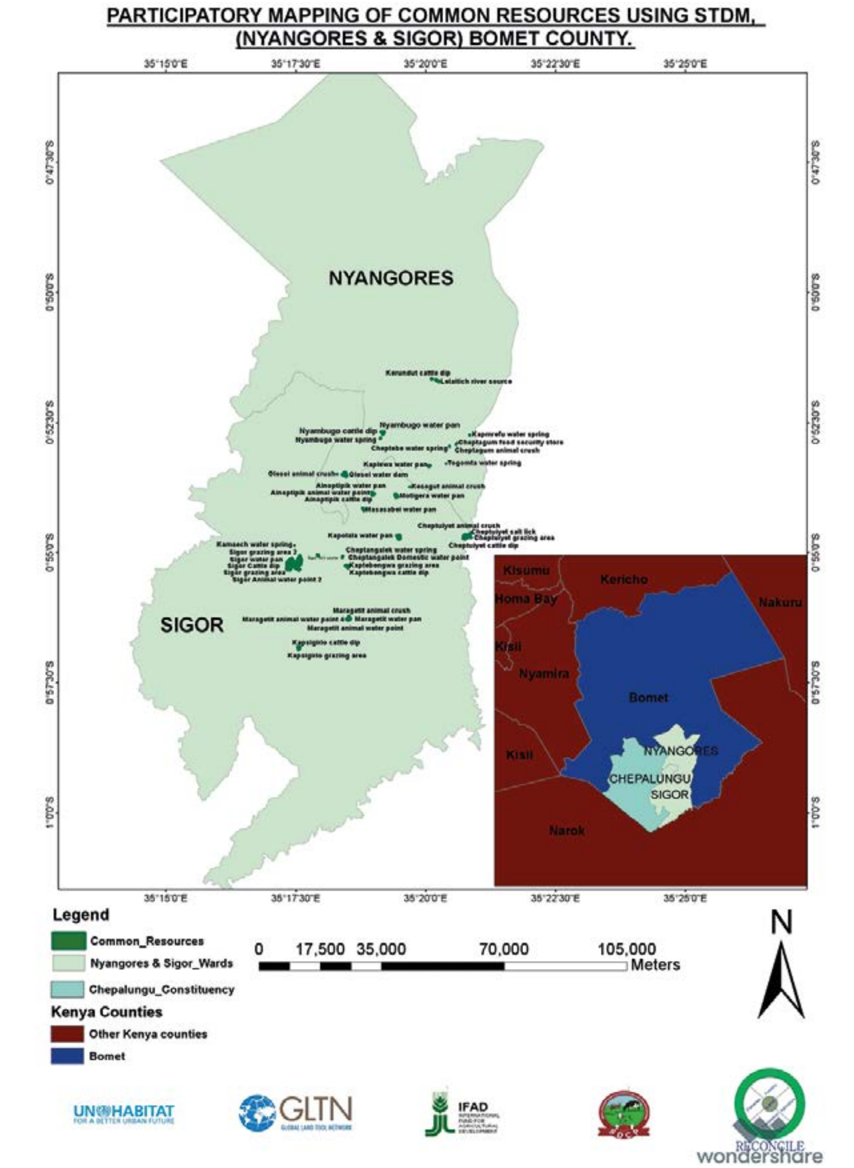


management measures – M1: Change of land use type, M2: Change of management/ intensity level, M3: Layout according to natural and human environment.

TECHNICAL DRAWING

Technical specifications

The overall space or measurements for the project areas were within the range of 25 to 75 square kilometres.



Author: RECONCILE.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **Each project area 25 km^2 (Project areas of three Sub-Counties 75 km^2))**
- Currency used for cost calculation: **US Dollars**
- Exchange rate (to USD): 1 USD = 101.0
- Average wage cost of hired labour per day: between Ksh. 2,000 to 3,000 depending on the kind of labour required and can go down to a compromised rate of Ksh. 1,000.

Most important factors affecting the costs

The technology costs are dependent on the size and number of resources targeted by the process. It will therefore define the costs accordingly.

Establishment activities

1. Enumeration of at least 1000 farmers (Timing/ frequency: 9 months)
2. Mapping of communal resources water points, salt lick areas, cattle dips etc. (Timing/ frequency: 9 months)
3. Mapping of private resources water points within the private areas (Timing/ frequency: 9 months)
4. Data Management (Timing/ frequency: 3 months)
5. Preparation of data collection including testing of the tools (Timing/ frequency: 1 month)
6. Dialogue sessions with community leaders (Timing/ frequency: 2 months)
7. Negotiations on the methodology for data collection and the kind of information to be collected/asked (Timing/ frequency: 1 month)
8. Technical reviews and reflection with project team and partners (Timing/ frequency: 1 month)

Comment: The kind of tasks undertaken in this process is more project oriented combined with advocacy and policy processes.

Establishment inputs and costs (per Each project area 25 km^2 (Project areas of three Sub-Counties 75 km^2))

Specify input	Unit	Quantity	Cost per unit (US Dollars)	Total cost per input (US Dollars)
Labour				
Enumerators	persons	90	50.00	4,500.00
Consultants	persons	6	1,000.00	6,000.00
Technical Staff contribution and time	persons	5	750.00	3,750.00
Data processing and management	persons	24	60.00	1,440.00
Equipment				
Data entry and analysis	persons	20	40.00	800.00
GPS hiring		120	55.00	6,600.00
GPS purchase		5	320.00	1,600.00
Computers		4	750.00	3,000.00
Conferences		9	1.500.00	13,500.00
Other				
Administrative costs	9 months	9	1,400.00	12,600.00
Logistical support		36	600.00	21,600.00
Preliminary activities including targeted dialogue etc.	Travels and associated costs	5	300.00	1,500.00
Documentation of the project (to be finalized)	Video documentary	2	3,000.00	6,000.00
Total costs for establishment of the Technology				**82,890.00**

If land user bore less than 100% of costs, indicate who covered the remaining costs
UNHABITAT, RECONCILE, Smallholder Dairy Commercialization Programme (SDCP).

Comment: The project was supported by the UNHABITAT with contributions from RECONCILE and partners. the community contribution in kind is not included since it has not been tabulated in terms of cash.

Maintenance activities
The project did not have physical structures developed. However, as a result of the work structures like cattle dips have been rehabilitated and are currently being maintained by the the communities themselves. This does not need recurrent costs for maintenance or otherwise by the project.

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [ ] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [x] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [ ] humid
- [x] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate
The area is sub-humid.

Name of the meteorological station: Kenya Meteorological department.

The average temperature in Bomet is 17.5 °C. Precipitation averages 1,247 mm.

Slope
- [ ] flat (0-2%)
- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [x] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landform
- [ ] plateau/ plains
- [ ] ridges
- [ ] mountain slopes
- [x] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [x] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [x] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [x] medium
- [ ] poor/ none

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [ ] medium
- [x] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial
- [ ] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [x] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanisation
- [x] manual work
- [x] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [x] sedentary
- [x] semi-nomadic
- [ ] nomadic

Individuals or groups
- [ ] individual/ household
- [x] groups/ community
- [x] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [x] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [x] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [x] small-scale
- [ ] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [x] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [x] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor			✓	good
education	poor		✓		good
technical assistance	poor		✓		good
employment (e.g. off-farm)	poor			✓	good
markets	poor		✓		good
energy	poor		✓		good
roads and transport	poor			✓	good
drinking water and sanitation	poor			✓	good
financial services	poor		✓		good

IMPACTS – BENEFITS AND DISADVANTAGES

Socio-economic impacts

fodder production	decreased	☐☐☐☐☐✓☐	increased	**Comment:** The production in the farms increased for milk.
fodder quality	decreased	☐☐☐☐☐✓☐	increased	**Comment:** The size of fodder producers also increased. The production trend is stable based on the number of farmers involved.
animal production	decreased	☐☐☐☐✓☐☐	increased	
farm income	decreased	☐☐☐☐☐✓☐	increased	**Comment:** Resulting from the proper land use and increased milk production based on more pasture, costs increased.

Ecological impacts

drought impacts	increased	☐☐☐✓☐☐☐	decreased

Off-site impacts

water availability (groundwater, springs)	decreased	☐☐☐☐✓☐☐	increased
reliable and stable stream flows in dry season (incl. low flows)	reduced	☐☐☐☐☐✓☐	increased
buffering/ filtering capacity (by soil, vegetation, wetlands)	reduced	☐☐☐☐✓☐☐	improved
impact of greenhouse gases	increased	☐☐☐✓☐☐☐	decreased

Benefits compared with establishment costs

Short-term returns	very negative	☐☐☐☐☐✓☐	very positive
Long-term returns	very negative	☐☐☐☐☐☐✓	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	☐☐☐✓☐☐☐	very positive
Long-term returns	very negative	☐☐☐☐☐✓☐	very positive

CLIMATE CHANGE

Climate change/ extreme to which the Technology is exposed

How the Technology copes with these changes/ extremes

Gradual climate change

annual rainfall decrease	not well at all	☐☐✓☐☐	very well

Other climate-related consequences

reduced growing period	not well at all	☐☐✓☐☐	very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ☐ single cases/ experimental
- ☐ 1-10%
- ☐ 10-50%
- ✓ more than 50%

Number of households and/ or area covered

The technology covered around 500 individual farmers.

Of all those who have adopted the Technology, how many have did so without receiving material incentives?

- ☐ 0-10%
- ✓ 10-50%
- ☐ 50-90%
- ☐ 90-100%

Comment: The technology application did not attract any material gains or incentives but, the process was community centred thus the adoption.

Has the Technology been modified recently to adapt to changing conditions?

- ✓ yes
- ☐ no

Comment: The technology was more of the urban oriented tool but had to be modified to adopt to the local demands.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Strengths

Land user's view
- Ability to define spatial space and common and private resources including those resources associated with milk production such as milk coolers, water points, cattle dips, food stores, grazing areas, salt licks, crushes, animal corridors, forest etc.
- Establishes the carrying capacity of communal shared resources.
- Establishment of the land tenure system of shared communal resources and issues arising.
- Status (management) of private resources within the rangelands.
- Production and income generated against household size.

Key resource person's view
- The nature of the problem required innovative use in the mapping of the land and natural resources.
- The technology addressed immediate needs and provided a foundation for future updates and demands.
- The technology benefited from the existing data and improved delivery of output without any impediments.
- The technology bridged the gap through skills transfer and capacity building and in facilitating dialogue on issues affecting the community (Maps, reports).
- Ability to adapt the technology in a simple manner that the users can relate to, and find value in their use contributed immensely to success Introduced even a more user-friendly use of mobile and smartphones.
- The 'quick win' could be seen in the transformation of mobile phones into data collection tools and the data can be seen, verified and shared, replacing the tedious manual process which many were struggling with.
- STDM databases accommodate the inclusion of social, economic and spatial data that can be maintained, accessed and updated by the communities anytime.
- Provided visual representation of available resources and their distribution and people can relate to spatial information on the map.
- Ownership of technology by local people who are now leading on data collection, customizing the template, developing reports and innovating on its use.

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view
- The design of the tool was more urban oriented and it took time to be adapted for rural use especially where land is communal and customary rights are key. → Created more awareness.

Key resource person's view
- Difficult to set-up the server environment where no internet is available. → The internet component remains a challenge.
- Technology is evolving and needs systematic information channels between the community members.
- Engaging other service providers may be difficult and takes time (Internet service provider need to authorize setting up additional server). → The process requires proper funding in order not to have a break in between.
- Appropriate devices for capturing data may require an additional budget.

REFERENCES

Compiler: Ken Otieno (peterkenotieno009@gmail.com)
Resource person: Ken Otieno (peterkenotieno009@gmail.com) - SLM specialist
Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/technologies/view/technologies_3318/
Documentation was facilitated by: Book project: Guidelines to Rangeland Management in Sub-Saharan Africa (Rangeland Management)
Date of documentation: Dec. 13, 2017; **Last update:** June 4, 2018

Links to relevant information which is available online
Food security in Bomet county: awsc.uonbi.ac.ke/sites/default/files/chss/arts/.../Bomet-final.doc

Boran livestock in a wet season grazing area (Ibrahim Jarso).

Dedha grazing system as a natural resource management technology (Kenya)

Jars Dedha

DESCRIPTION

The Dedha grazing system is an ancient, traditional governance system for land and its resources practiced by Boran pastoralists. It carefully balances how pastoralists use rangeland resources. The basis of the technology is three grazing rangeland governance zones: wet season grazing, dry season grazing, and drought reserves. There is also water governance based on a traditional hierarchy of rights. Through this system, Boran pastoralists adapt to severe and recurrent droughts.

This grazing system is applied in Isiolo County, Northern Kenya. The Waso rangelands are inhabited by Boran pastoralists with Somali, Samburu, Rendille and Turkana herders sharing cross-border resources through negotiation. The technology is based on the maintenance of a delicate balance between livestock numbers, the supply of water, and the amount/ quality of standing pasture within the vast grazing area which is water scarce and prone to extreme seasonal variations. Through its main tenet of governing grazing patterns (wet, dry season grazing area and drought reserve) planned use of pasture is decided in large pastoralists' assemblies attended by elders from a particular 'Dedha' (a grazing area, which administratively can be as big as two wards). This process is complicated by dry seasons and droughts of unknown length, with pressure from the community to open grazing reserves. Wrong decisions can spell the end of livelihoods for some families. An ability, which has been gradually eroded over time and by external factors which don't understand its enormous benefit but there is a project which is using an integrated approach to revive and empower this system.

The Jars a Dedha use water points to manage grazing. Different types of water sources need specific forms of management. The most intensive management occurs during droughts at deep wells and boreholes which require the most labour to operate and maintain, and are the most reliable sources of water. Due to the strategic importance of these resources, management falls to the Jarsa Dedha (council of elders). The use of shallow wells is tightly controlled by both the aba ella (the person who first dug it) and aba erega (the owner of the rotter) working together. Aba ella is assigned first rights to water. If there is spare capacity then 'second rights' are decided by aba erega. Second rights would typically fall to those of a different clan, while 'third rights' might fall to a different ethnic group. The Borana customs and culture defines both access to certain wells but also the order of priority for watering animals.

In addition, in consultation with the Dedha council of elders, aba erega manages the use of dams and access to rivers. Generally, use of flowing river water is restricted to the dry season and access is limited to designated watering points. These are located some distance downriver from settlements to minimize disruption to inhabitants and to reduce contamination. Temporary water sources during and after the rains are not subject to control except when their use conflicts with restrictions on grazing areas. After watering their livestock, pastoralists traditionally fill their troughs for wildlife at night. This is intended to prevent wildlife from falling into wells – and to seek God's blessings.

LOCATION

Location: Kinna town, Kinna Ward, isiolo County, Isiolo, Kenya

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 438.20614, 0.31837

Spread of the Technology: evenly spread over an area (approx. > 10,000 km^2)

Comment: Isiolo County has area of 25,000 km^2 but 80% of the area is used for Nomadic pastoralism.

Date of implementation: more than 50 years ago (traditional)

Type of introduction
- [ ] through land users' innovation
- [x] as part of a traditional system (> 50 years)
- [ ] during experiments/ research
- [ ] through projects/ external interventions

A young Boran pastoralist leads livestock to Kinna Kanchoradhi Springs (Ibrahim Jarso).

Patoralists loading donkeys with water for domestic use at Duma borehole in Merti Sub County (Ibrahim Jarso).

The high variability of rainfall in pastoral areas leads to similarly variable pasture availability. Therefore, management of grazing resources needs to balance maximizing productivity while ensuring survival. Long-term viability of the system depends on the maintenance of adaptive traits within local breeds, and both maintaining and managing resources strategically. Only within these broader goals is the concept of 'maximizing productivity' meaningful.

Mature livestock (gues) which are not lactating are moved to remote pastures. The guess, which make up the majority of community livestock, are herded by young unmarried men. By utilizing remote pastures, grazing resources closer to permanent water sources can be preserved for the dry season and droughts. Pasture within the vicinity of homesteads (maar qaae – literally 'near grass') is protected from grazing by non-lactating livestock (this is similar to kalo but a kalo reserve need not be next to the homestead). This pasture is set aside for young animals (calves, lambs, and kids). Migrating livestock have predefined routes that maintain distance from maar qaae. The Dedha council of elders, therefore, controls settlement patterns to preserve key migratory routes. Movement of livestock between different Dedhas must be prearranged with the respective Dedha council of elders who assess spare capacity in terms of water and grazing.

The floodplain grazing area (chaafa) is crucial because it acts as a refuge for livestock during extreme drought. Grazing in chaafa is strictly prohibited during the wet season and one of the critical decisions for the Jarsa Dedha is when to open chaafa after rains have failed. Due to the relatively moist conditions in chaafa, there are additional challenges to animal and human health: namely trypanosomiasis, ticks, pneumonia, and malaria. Jarsa Dedha make decisions primarily concerning seasonal movements from wet to dry season grazing and also the opening of boreholes and chaafa. The overwhelming local consensus is that efficient resource use depends on the ability of Jarsa Dedha to enforce these regulations

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [ ] improve production
- [x] reduce, prevent, restore land degradation
- [x] conserve ecosystem
- [x] protect a watershed/ downstream areas – in combination with other Technologies
- [x] preserve/ improve biodiversity
- [x] reduce risk of disasters
- [x] adapt to climate change/ extremes and its impacts
- [x] mitigate climate change and its impacts
- [x] create beneficial economic impact
- [x] create beneficial social impact

Comment: The pastoralists depend on attendant pasture after the rains which are bi-modal in Isiolo County (Long and Short rains).

Land use

Extensive grazing land: Nomadism, Semi-nomadism/ pastoralism
Intensive grazing/ fodder production: Improved pastures

Water supply

- [x] rainfed
- [ ] mixed rainfed-irrigated
- [ ] full irrigation

Number of growing seasons per year: 2
Livestock density: Isiolo county is endowed with a substantial livestock resource base that includes 198,500 cattle, 399,000 goats, 361,900 sheep and 39,100 camels.

Purpose related to land degradation

- [x] prevent land degradation
- [ ] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [x] adapt to land degradation
- [ ] not applicable

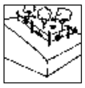
Degradation addressed

biological degradation – Bc: reduction of vegetation cover, Bh: loss of habitats, Bf: detrimental effects of fires, Bs: quality and species composition/ diversity decline.

water degradation – Ha: aridification, Hs: change in quantity of surface water, Hp: decline of surface water quality, Hw: reduction of the buffering capacity of wetland areas.

SLM group
- pastoralism and grazing land management.

SLM measure

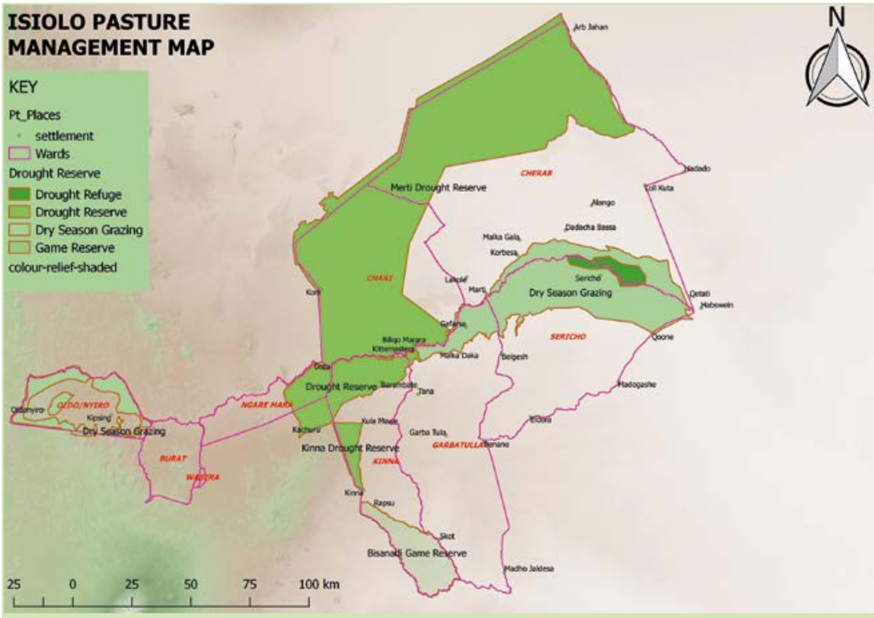


management measures – M2: Change of management/ intensity level, M3: Layout according to natural and human environment, M4: Major change in timing of activities.

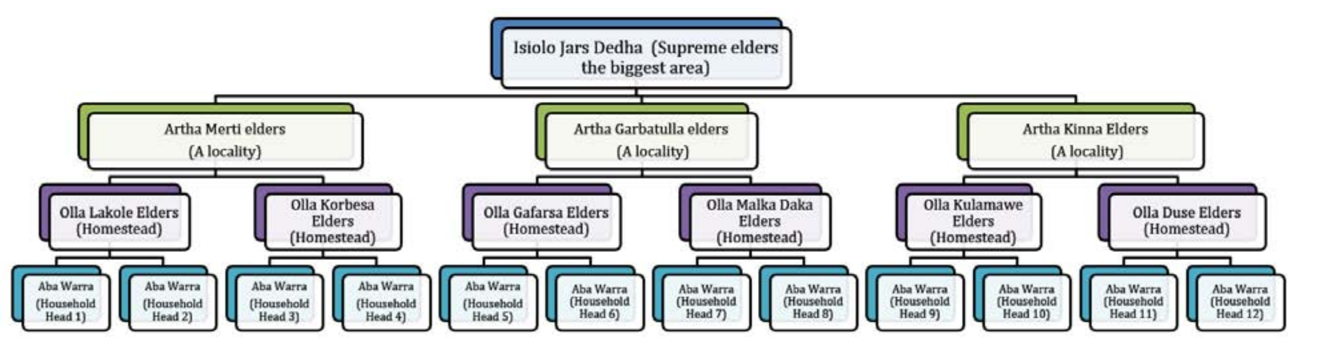
TECHNICAL DRAWING

Technical specifications

The technology is implemented in a vast area of rangelands in Isiolo County which covers around 20,000 km² inhabited by Boran pastoralists under common management of Isiolo Jars Dedha (Council of elders). The rangelands are subdivided into around 14 arthas (localities) which are separately managed by artha elders and within which there are also ollas (homesteads) which the elders oversee. The elders manage key resources that are essential for pastoral livelihood. The resources are; prime pasture/ grazing areas, water points e.g. streams, rivers, springs, shallow wells and pans, wildlife, forests, minerals, sand and other valuable stones e.g. gemstones (bojimine) and quarry, Trees and their products e.g. makuti, medicinal herbs, wild, fruits, resins, gum arabic.



Author: Ibrahim Jarso.



Author: Ibrahim Jarso.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs
- Costs are calculated: per Technology area (size and area unit: **20,000 km²**)
- Average wage cost of hired labour per day: 2,500 Kenya Shillings

Most important factors affecting the costs

This is a traditional technology of governing rangelands which was started and done voluntarily by the pastoralists. The costs considered are for subsistence of elders undertaking the meetings and discussions on range governance but the process still goes on even without the financial support as the actors involved do it for their own benefits.

Establishment activities
1. Dedha elders meetings (Timing/ frequency: All seasons)
2. Surveillance of grazing areas (Timing/ frequency: Largely after the rains)
3. Settling resource based disputes (Timing/ frequency: Largely during dry seasons and drought)
4. Deciding on when to access reserved pasture lands (Timing/ frequency: Dry seasons and drought reserves)
5. Negotiations on access to pasture within and across borders (Timing/ frequency: Drought and Long dry seasons)

Comment: Regarding Surveillance of grazing areas, they observe pasture conditions and unwarranted access to preserved grazing areas and report on conditions. The surveillance is elevated after the rains as communities are in wet season grazing area depending on sub-surface water from the rains.

Maintenance activities
1. Meetings (Timing/ frequency: All seasons)
2. Surveillance of grazing lands (Timing/ frequency: After the two rainy seasons)

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [x] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [ ] humid
- [ ] sub-humid
- [x] semi-arid
- [x] arid

Specifications on climate
The rains are bimodal (Long rains of March-April-May and Short rains of October-November-December). The rains are unpredictable, erratic and not evenly distributed but pastoralists move to take advantage of difference in pasture quality and quantity.

Name of the meteorological station: Garbatulla automatic weather station 5% of the area is semi-arid and 95% is arid.

Slope
- [x] flat (0-2%)
- [x] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landform
- [x] plateau/ plains
- [ ] ridges
- [ ] mountain slopes
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- [x] footslopes
- [ ] valley floors

Altitude
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- [ ] 101-500 m a.s.l.
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- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [x] high (>3%)
- [x] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [x] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [x] medium
- [ ] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] fine/ heavy (clay)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Is salinity a problem?
- [x] yes
- [ ] no

Occurrence of flooding
- [x] yes
- [ ] no

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [x] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [x] subsistence (self-supply)
- [ ] mixed (subsistence/ commercial
- [ ] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [x] very poor
- [x] poor
- [ ] average
- [ ] rich
- [ ] very rich

Level of mechanisation
- [x] manual work
- [x] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [ ] sedentary
- [x] semi-nomadic
- [x] nomadic

Individuals or groups
- [x] individual/ household
- [x] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [x] men

Age
- [ ] children
- [x] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [x] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [ ] medium-scale
- [x] large-scale

Land ownership
- [ ] state
- [ ] company
- [x] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled

Land use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor	□✓□	good
education	poor	✓□□	good
technical assistance	poor	✓□□	good
employment (e.g. off-farm)	poor	✓□□	good
markets	poor	✓□□	good
energy	poor	✓□□	good
roads and transport	poor	✓□□	good
drinking water and sanitation	poor	□✓□	good
financial services	poor	✓□□	good

IMPACTS – BENEFITS AND DISADVANTAGES

Socio-economic impacts

animal production	decreased	□□□□□✓□	increased	**Befor SLM:** 0 **After SLM:** 2 **Comment:** The frequent and Severe drought has reduced the number of livestock and created a big group of pastoral dropouts but with improved rangeland management through the revived traditional systems animal production is gradually improving.
land management	hindered	□□□□□✓□	simplified	**Befor SLM:** 0 **After SLM:** 2
drinking water availability	decreased	□□□□✓□□	increased	**Befor SLM:** 0 **After SLM:** 1
water availability for livestock	decreased	□□□□□✓□	increased	**Befor SLM:** 0 **After SLM:** 2

Ecological impacts

water quantity	decreased	□□□□□✓□	increased	**Befor SLM:** 0 **After SLM:** 2
harvesting/ collection of water (runoff, dew, snow, etc.)	reduced	□□□□□✓□	improved	**Befor SLM:** 0 **After SLM:** 2
vegetation cover	decreased	□□□□□✓□	increased	**Befor SLM:** 0 **After SLM:** 2
invasive alien species	increased	□□□□✓□□	reduced	**Befor SLM:** 0 **After SLM:** 1
habitat diversity	decreased	□□□□□✓□	increased	**Befor SLM:** 0 **After SLM:** 2
drought impacts	increased	□□□□□✓□	decreased	**Befor SLM:** 2 **After SLM:** 2
micro-climate	worsened	□□□□□✓□	improved	**Befor SLM:** 0 **After SLM:** 2

Off-site impacts

water availability (groundwater, springs)	decreased	□□□□□□✓	increased	**Befor SLM:** 0 **After SLM:** 2 **Comment:** The preserved grazing lands regenerate and is less degraded. The improved environment in the preserved areas lead to less erosion and proper recharge of underground water. This was observed in Kinna Village where the Odha Springs improved its flow and also the recharge to Moliti shallow wells were improved with proper grazing management in Kinna.
reliable and stable stream flows in dry season (incl. low flows)	reduced	□□□□□□✓	increased	**Befor SLM:** 0 **After SLM:** 2

Benefits compared with establishment costs

Short-term returns	very negative	□□□□✓□□	very positive
Long-term returns	very negative	□□□□□✓□	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	□□□□✓□□	very positive
Long-term returns	very negative	□□□□✓□□	very positive

CLIMATE CHANGE

Climate change/ extreme to which the Technology is exposed | **How the Technology copes with these changes/ extremes**

Climate change/ extreme		1	2	3	4	5		
Gradual climate change								
seasonal temperature increase	not well at all					✓	very well	Season: dry season
seasonal rainfall decrease	not well at all					✓	very well	Season: dry season
Climate-related extremes (disasters)								
drought	not well at all					✓	very well	
land fire	not well at all				✓		very well	
general (river) flood	not well at all			✓			very well	
flash flood	not well at all			✓			very well	
epidemic diseases	not well at all					✓	very well	**Comment:** Tick moderately.
Other climate-related consequences								
reduced growing period	not well at all					✓	very well	

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- [ ] single cases/ experimental
- [ ] 1-10%
- [ ] 10-50%
- [x] more than 50%

Of all those who have adopted the Technology, how many have did so without receiving material incentives?

- [ ] 0-10%
- [ ] 10-50%
- [ ] 50-90%
- [x] 90-100%

Number of households and/ or area covered
80% of Isiolo County (Around 24,500 Households).

Has the Technology been modified recently to adapt to changing conditions?

- [x] yes
- [ ] no

To which changing conditions?

- [x] climatic change/ extremes
- [ ] changing markets
- [ ] labour availability (e.g. due to migration)

Comment: The grazing patterns were made more flexible and the rules made stricter.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Strengths

Land user's view

- It is the cheapest and easiest way of managing the rangelands for now and for posterity.
- It provides room for flexibility of decision making as seasonal variations occur.

Key resource person's view

- It is conservative and less costly to implement in the vast rangelands with few incentives.
- It is a legitimate system recognized by all pastoralist for management of their rangeland resources.
- It can easily be adapted to govern any pastoral rangelands all over the world (Universal).

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view

- There is no law protecting it. → Government needs to establish a law that recognizes and protects this technology.
- Rich pastoralists can forego local rules and corrupt the systems overseeing the grazing plans. → Ensuring accountability for decisions made. As few lead elders can be corrupted and their decisions compromised but when the decisions on grazing are largely made in common meetings of all elders, the decisions are normally watertight and cant be influenced negatively.

Key resource person's view

- Cross-border pastoralists are not aware of the Technology and tend to undermine it. → Improve awareness of the technology among the cross-border pastoralists that also access Isiolo rangelands.

REFERENCES

Compiler: Ibrahim Jarso (jarsoibra@gmail.com)
Resource person: Ibrahim Jarso (jarsoibra@gmail.com) - SLM Specialist
Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/technologies/view/technologies_3403/
Linked SLM data: SLM Approach: Empowering Dedha Institutions of governing natural resources in Isiolo Rangelands https://qcat.wocat.net/en/wocat/approaches/view/approaches_3345/; SLM Approach: Participatory mapping, database building and monitoring of vegetation types and other community resources in the rangelands https://qcat.wocat.net/en/wocat/approaches/view/approaches_3439/; SLM Approach: Inclusive strategic planning for water, energy and climate change in the rangelands https://qcat.wocat.net/en/wocat/approaches/view/approaches_3441/
Documentation was facilitated by: Institution: Resource Advocacy Programme (RAP) - Kenya. Project: Strengthening Adaptation and Resilience to Climate Change in Kenya Plus (StARCK+)
Date of documentation: Feb. 21, 2018; **Last update:** April 27, 2018

Links to relevant information which is available online
Evolving customary institutions by patison and tari: pubs.iied.org/pdfs/10076IIED.pdf
Strengthening Customary institutions the case of Isiolo County Northern Kenya by Caroline, Tari and Jarso: www.celep.info/wpcontent/ uploads/2015/11/Strengthening-local-institutions.pdf

CONTROLLED GRAZING (TG2)

Controlled grazing in western Kenya (ILRI/Dorine Odongo).

In a nutshell

Short description

Controlled grazing includes any system in which the producer controls the grazing pattern of the livestock. It covers seasonal grazing, may involve enclosures, physical or social fencing, rotations, grazing reserves (fodder banks), regulation of grazing and mobility. The manipulation of animal movement is used to control when, what and how much the animals graze. Grazing management involves evaluation of the nutritional and forage needs of animals, assessment of forage quality and quantity, and then the regulation of access to the pasture/ range.

Fencing plays a critical role in the success of controlled grazing. Controlled grazing is often equated to 'rotational grazing' where pasture is subdivided into several smaller paddocks by fencing. Livestock then graze in one of the paddocks until the forage has been eaten, and then are rotated sequentially to the next paddock, leaving the grazed paddock to recover.

Principles

- Rotation and regular resting is a key principle.
- Arrangements with neighbours to agree on conservation of specific areas for dry season/ drought forage.
- Securing the rested areas from invasion to ensure enough dry season/ drought forage.
- Additional strategies against pressure from other rangeland users and droughts may be needed, e.g. emergency markets.

Most common technologies

Enclosures involves temporary or permanent access control of livestock to a designated area by physical/ social fencing. Fencing is most often used to exclude livestock from cropland, along livestock corridors as well as environmentally sensitive areas such as streambanks, wetlands and woods, including restored wildlife habitats and buffer strips for conservation purposes. National grazing reserves are areas set aside for the use of pastoralists. They are not assigned to individual ethnic groups, but are held in reserve for usage during emergency conditions.

Rotational grazing and rangeland resting is based on the subdivision of the grazing area/ pastures into a number of physical enclosures or areas with social fencing. There is systematic, sequential grazing of these paddocks or areas by livestock in rotation to prevent overgrazing/ selective grazing and to optimise grass growth. Rotational grazing can be considered a management-intensive grazing system.

Combined herding: (a) daily combining of livestock into a single herd to be driven to different designated portions of the communal grazing area; (b) separate, planned grazing in villages during the rains, then "bunching" and moving of all animals in herds during the dry season.

Health of land resources addressed	
rangeland vegetation	+++
invasive alien species	+/-
soil loss	++
soil resources (OM, nutrients)	++
water resources	++
biodiversity	++

ESS addressed	
fodder production	+++
fodder quality	++
water availability	++
stream flow	+
food security/ self-sufficiency	++
SRM knowledge	++
conflict mitigation	+/-
equity (gender, disadv. group)	+
governance	++
DRR (drought, floods, fire)	++
CC adaptation	++
C and GHG emissions	++

Benefit-cost ratio		
Inputs	short-term	long-term
Establishment	+	+++
Maintenance	++	+++

Importance: +++ high, ++ medium, + low, +/– neutral, na: not available

Holistic Management is based on planned rotational grazing that 'mimics nature' with the aim of building up organic matter and water in soils and thus increasing pasture productivity. To simulate this function livestock are "bunched" in large herds and frequently moved between different areas. Denuded land is recovered by a "Boma" technology: i.e. strategic corralling of animals overnight, and reseeding.

Split ranch grazing involves grazing half the available area for a full year - concentrating livestock. The consequent grazing pressure maintains the grassland in an immature, high-quality state, while resting the other half, allowing optimal recovery from the previous full year's grazing.

Rangeland use system (RUS)
Mainly in 'bounded' systems with and without wildlife and 'parks & reserves'.

Main benefits
- Resting periods followed by intensive grazing mimics the "nature" of the rangelands as they evolved.
- Better grass cover and greater abundance of high-quality perennial grasses. Control of less desirable vegetation.
- Increased forage production reducing need for supplementary feeding and salt and mineral licks.
- Increased resistance of system to drought.
- Regulates the coexistence of wildlife, domestic livestock, and people.

Main disadvantages
- High costs and labour input for construction and maintenance of physical fences.
- Social acceptance to maintain and manage social fencing including high labour input.
- Concentration of livestock in a fenced area can increase the risk of predation by carnivores/ rustling by people.
- Danger of disease outbreaks in big herds, and from wildlife – livestock interaction.
- Potential over/under use of certain habitat type through mismanagement.

Applicability and adoption
Developing a controlled grazing system and putting it into practice requires planning and rangeland users involvement. Each area differs in soil type, availability of water, forage species, pasture conditions, availability of labour, slope of land, type of livestock. These factors should be assessed in order to ensure successful applicability of the controlled grazing system. 'Controlled grazing' is typical of commercial ranches. All other technology groups are mainly mixed, or subsistence in their market orientation.

Most of the technologies under this group showed a moderate to high trend of spontaneous adoption.

Borana ranch grazing with holistic management principles, Kenya

Borana cattle (Michael Herger).

Borana is a private ranch which combines extensive livestock production (beef, dairy, sheep) with conservation and tourism. There is strategic fattening and offtake for sales in harmony with conservation principles. Grazing comprises "bunching" and planned rotational movement of all animals in herds acting as a "plough" by breaking the soil to help incorporate seeds and nutrients. Water also infiltrates better. The aim is to improve plant growth and soil.

https://qcat.wocat.net/en/summary/4029/

Ecosystem-wide seasonal grazing in community land, Kenya

In Olkiramatian and Shompole, seasonal livestock movements and herding practices are formalised by group ranch grazing plans governed by local committees. The wet season grazing areas are termed "livestock rearing zones" (east of the Ewaso Ng'iro river). The dry season grazing areas are retained as "grass banks", and since the early 2000s, have been used additionally as wildlife conservancies for ecotourism (west of the Ewaso Ng'iro river). Creating a gradient of quality and quantity of pasture across the landscape is achieved through clearly designated seasonal grazing areas for livestock and tight controls on settlement areas, grazing patterns and water points.At the individual herder level, traditional ecological knowledge plays a strong role in the decisions made to improve livestock.

https://qcat.wocat.net/en/summary/4026/

Wildebeest and livestock grazing in the wet season (Guy Western).

Assisted natural regeneration of degraded land, Burkina Faso

Three hectares of degraded land are enclosed with a fence. A dense living hedge of local thorny trees (e.g. *Acacia nilotica, Ziziphus mauritiana* etc.) is planted. A strip of 10 m along the hedge is dedicated to agriculture, equivalent to approximately 10% of the protected area. The rest is dedicated to natural regeneration of the local forest and woodland. The protected area is of paramount importance for biodiversity conservation and fodder production. The grass is cut and carried to feed livestock outside the regeneration area.

https://qcat.wocat.net/en/summary/1359/

Dense vegetation in the protected area (New Tree, Franziska Kaguembèga-Müller).

Goats grazing in Sanga village during dry season (Michael Herger).

Il Ngwesi Group Ranch Grazing with Holistic Management principles (Kenya)

DESCRIPTION

A group ranch belonging to the Masai (traditionally, nomad pastoralists) has applied 'Holistic Management' grazing principles. The principles consist of separate, planned grazing in villages during the rains, then 'bunching' and moving of all animals in herds during the dry season. Denuded land is recovered by a 'Boma' technology: i.e. strategic corralling of animals overnight, and reseeding.

On Il Ngwesi Masai Group Ranch, livestock production management is a combination of traditional livestock keeping and holistic grazing management principles which were introduced in 2007. Livestock production at Il Ngwesi is for subsistence and sales – and has very high cultural significance. 80% of the land is used for conservation, where wildlife and their habitat are protected. The vision is to integrate community development and sustainable environmental management.

Holistic Management (HM) was originally conceived by Allan Savory (1988), and is promoted by the Laikipia Wildlife Forum. It integrates decision-making, planning, and livestock keeping. On the land, this means bunching of all livestock close together (in order to act as a 'plough' and break the soil to allow seeds, nutrients, and water to infiltrate) resulting in better plant growth. By moving the animals together from block to block, HM aims at managing high numbers of livestock while restoring degraded land. Instead of individual livestock-owning families herding and trekking their own animals, consolidated herds are now managed and moved together, and overseen by herders and supervisors. This allows intensive grazing in restricted areas while resting the remaining land – instead of continuous open grazing. However, Holistic Management principles are still a matter of controversy. While advocates of these management principles do not limit herd sizes, opponents see the root cause of degradation exactly in too high stocking rates. Criticism is plentiful and reviews of the method state that there are no peer-reviewed studies that prove that Holistic Management is superior to conventional grazing systems in outcomes (Carter et al. 2014, Briske et al. 2014).

The group ranch land consists of a settlement and a conservation area. The conservation area is further subdivided into a small core zone, measuring 500 hectares and a larger buffer zone of 6,000 hectares. Within this buffer zone, pastoralists are permitted to graze livestock during the dry season.

Besides these two main grazing areas in their group ranch, they use additional grazing areas outside their territory such as pasture in forests. In one forest – Mukogodo – they have settled officially; in Ngare Ngare and on Mount Kenya, on the other hand, it is more of an informal agreement. In Il Ngwesi, HM principles are very strictly applied in the conservation area; elsewhere only partly or not at all. During the movements to the forest glades and Mount Kenya, HM principles are maintained as far as possible.

This documentation describes the combined grazing management system. During the rains, the grazing system is largely by traditional management: animals remain in and around villages managed individually by households. During the dry season, all livestock are bunched together and managed as one herd.

LOCATION

Location: Mukogodo Divison, Laikipia, Kenya

No. of Technology sites analysed: 2-10 sites

Geo-reference of selected sites
• 37.35378, 0.27867

Spread of the Technology: evenly spread over an area (approx. 10-100 km²)

Comment: Il Ngwesi has an area size of 87 km². However, the total affected land by livestock is 157 km². The technology is also applied on other ranches (mainly private ranches, see the documentation for neighbouring 'Borana') in Mukogodo division.

Date of implementation: 2007

Type of introduction

- ☐ through land users' innovation
- ✓ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ✓ through projects/ external interventions

Comment: It was introduced by Richard Hartfield, Laikipia Wildlife Forum and funded by Laikipia Wildlife Forum (LWF), Lewa Conservancy and Northern Rangeland Trust (NRT).

Livestock from Il Ngwesi Group Ranch. Il Ngwesi Group Ranch, Laikipia (Michael Herger).

Example of a (permanent) boma. Mobile bomas are usually only constructed with cut thorn bush. This boma is not on Il Ngwesi. (Michael Herger).

During the wet season, grazing at Il Ngwesi Group Ranch is organized by elders within their seven villages. HM principles are only partly applied. During the dry season, once all the grazing land is eaten, livestock are bunched together and managed by a few herders and overseers. The block system rotation starts. To seek new pasture and water, cattle and smallstock are led to forest glades, and then to the Il Ngwesi conservation area. As soon as the forest pasture is gone, they move on to the conservation area. Usually, this movement of livestock to forests and conservation area starts in February; then they return to the villages in April; and then back to the forests and conservation area until the next rains in November.

Whilst the livestock are bunched together, large bomas (corrals in Kiswahili) are constructed for overnight enclosure. Bomas are sited on bare land where dung accumulation and crust breaking by hooves helps rehabilitate land. Every year the boma sites are shifted slightly according to a plan. The total area that can be restored per year is almost 1% of the area of Il Ngwesi.

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- ✓ improve production
- ✓ reduce, prevent, restore land degradation
- ✓ conserve ecosystem
- protect a watershed/ downstream areas – in combination with other Technologies
- ✓ preserve/ improve biodiversity
- reduce risk of disasters
- adapt to climate change/ extremes and its impacts
- mitigate climate change and its impacts
- create beneficial economic impact
- create beneficial social impact

Land use

Grazing land – Extensive grazing land: Semi-nomadism/ pastoralism.
Main animal species and products: Livestock: Cattle, goats, sheep, donkeys, camels Meat and milk production (also blood) and as a bank/ value asset. Mainly subsistence and local production. Livestock: 4,800 TLU; Stocking rate: 3.3 ha/TLU (calculated with the total affected land by livestock: 157 km^2) Pressure on land including wildlife: 3.3 ha/TLU (stays the same, calculated with wildlife biomass density estimated by Georgiadis et al. 2007). Livestock numbers: Lower Il Ngwesi: 4,000 cattle, 20,000 shoats, 50 donkeys, 100 camels. Sanga: 700 cattle, 2,000 shoats, 20 donkeys. Mukogodo: 1,500 cattle, 5,000 shoats, 20 donkeys Livestock fluctuations (per year): -10% sales, -5% loss due to drought/diseases, -5% slaughtered, +30%natural breeding, new purchase and deaths are mutually offsetting. Steers are for fattening on private ranches and during droughts other livestock can be moved to private ranches (up to 3,000). Wildlife: elephant, antelope/ gazelle (like gerenuk, impala, Thomson's gazelle, dik-dik), hares, predators and more.

Settlements, infrastructure – Settlements, buildings Remarks: Villages, bomas, manyattas. 8,000 inhabitants. Lodge for Tourism.

Water supply

- ✓ rainfed
- mixed rainfed-irrigated
- full irrigation

Number of growing seasons per year: 2
Livestock density: 4'800 TLU; Stocking rate: 3.3 ha/TLU.
Pressure on land: 3.3 ha/TLU.

Purpose related to land degradation

- ☐ prevent land degradation
- ☑ reduce land degradation
- ☑ restore/ rehabilitate severely degraded land
- ☐ adapt to land degradation
- ☐ not applicable

Degradation addressed


soil erosion by water – Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying.


soil erosion by wind – Et: loss of topsoil.


physical soil deterioration – Pc: compaction, Pk: slaking and crusting, Pi: soil sealing.

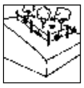

biological degradation – Bc: reduction of vegetation cover, Bh: loss of habitats, Bq: quantity/ biomass decline, Bs: quality and species composition/ diversity decline, Bl: loss of soil life.

Comment: Across the grasslands and rangelands an increase in bare land and bush has been a clear trend all over Laikipia for many years, both on community-owned lands and private ranches. Major identified ecological problems (partly) caused by livestock production are: bare ground, low contents of soil organic carbon and plant-available nutrients, soil erosion (sealing, crusting, rills and gullies, water flow patterns, sheet erosion, pedestals), poor soil properties, undesirable species, and (increasing) woody and invasive species. The technology aims at improving vegetation cover of the land and thereby reducing further degradation and restoring degraded land.

SLM group

- pastoralism and grazing land management
- improved ground/ vegetation cover

SLM measures


management measures – M2: Change of management/ intensity level, M4: Major change in timing of activities

TECHNICAL DRAWING

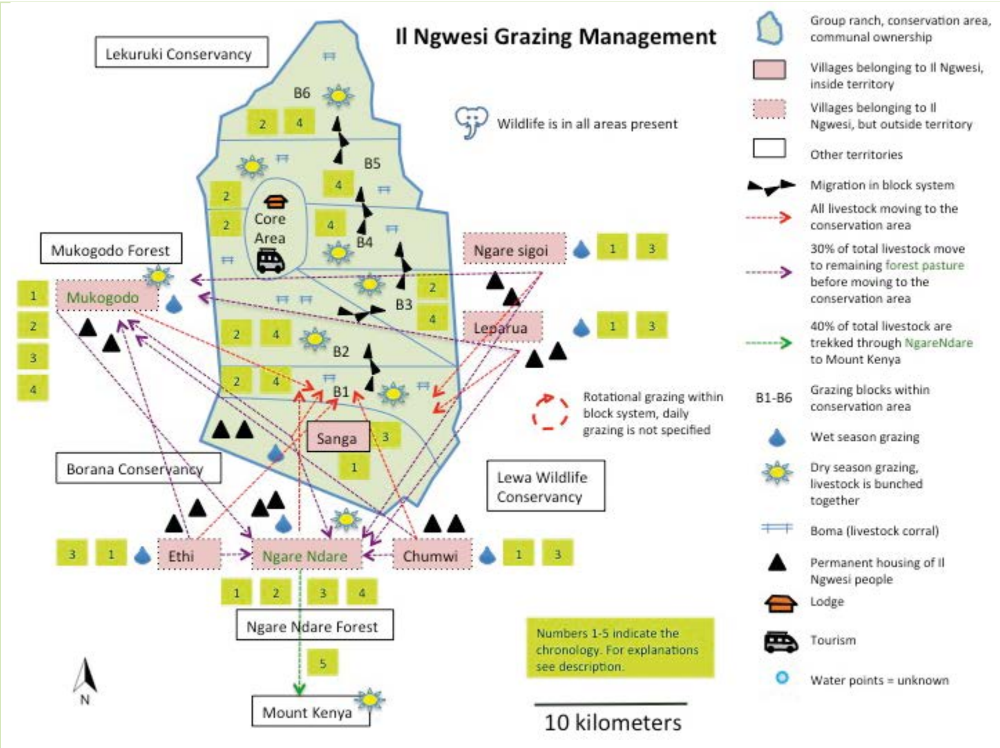
Technical specifications

Grazing map of Il Ngwesi in Mukogodo Division

Grazing Principles:
- Rotational, planned grazing
- Bunching
- Resting periods for pasture
- Bomas for bare patches (night corrals)

Value Chain:
- Natural Breeding/buying (Ranches & individually).
- Grazing.
- Settlement area (in red, during the wet season, until pasture is gone, organised by elders, bunching of all animals as soon as it gets dry).
- Mukogodo Forest/ Ngare Ndare Forest (30% of total livestock, remainder to conservation area for grazing directly).
- Conservation area (6 blocks).
- Mukogodo Forest/Ngare Ndare Forest/Mount Kenya (Ngare Ndare Forest as corridor to Mount Kenya, about 40%of total livestock goes to Mount Kenya).
- Need-driven sales to local butcheries/NRT/Ranches.

Il Ngwesi Masai also started to buy land outside their Group Ranch.



Author: Michael Herger.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit (unit: **Herders, animals treatment. For the whole area affected by livestock (157 km²)**)
- Currency used for cost calculation: **US Dollars**
- Average wage cost of hired labour per day: USD 2.5

Most important factors affecting the costs

Managing of one big herd, many supervisors needed. -Movement of bomas – Livestock-owning families (although they obviously don't receive any salary): this is simultaneously their livelihood and used for subsistence. But once all their livestock is bunched in a big herd, they lose their nutritional source (milk, blood) and livelihood (sometimes they keep back a few units for this reason).

Establishment activities

1. Training of elders and community by project leaders (Timing/ frequency: None).
2. Grazing planning for bunched animals (livestock from all households) (Timing/ frequency: None).
3. Hiring herders, supervisors, watchmen etc. (Timing/ frequency: None).

Comment: Trainings were funded by NRT, LWF and Lewa Conservancy. No figures on this.

Maintenance activities

1. Herders, supervisors, watchmen etc. (Timing/ frequency: None).
2. Animal treatments (vaccination, spraying, injections) (Timing/ frequency: None).
3. Planning activites (Timing/ frequency: None).
4. Boma Management (mainly movement of Bomas) (Timing/ frequency: None).

Maintenance inputs and costs (per Herders, animals treatment. For the whole area affected by livestock (157 km²))

Specify input	Unit	Quantity	Cost per unit (US Dollars)	Total cost per input (US Dollars)	% of costs borne by land users
Labour					
Herders, watchmen	Person-days	250	540.00	135,000.00	100
Supervisors	Person-days	3	720.00	2,160.00	100
Planning activities, management	Person-days	20	1,500.00	30,000.00	100
Livestock-owning families (for wet season, no wages paid, livelihood)	Person-days	8,000	300.00	2,400,000.00	
Construction material					
Boma Movement					
Construction material					
Animals treatments (spraying against ticks)		5,000	5.00	25,000.00	100
Injections, vaccine		5,000	3.00	15,000.00	100
			Total costs for establishment of the Technology	**2,607,160.00**	

Overall additional costs since introduction of new technology are estimated at 20% higher than before. 50% are covered by project funding (LWF, NRT, Lewa Conservancy).

Comment: Costs per unit are multiplied by days. According to the interviewed manager, total costs are only USD 18,000 (without herders). However, the listing of all costs results in much higher total costs. Total animal treatment costs for Makurian Group Ranch in comparison are USD 428,000 (labour USD 380,000, animal treatment USD 48,000, without livestock-owning families).
Also, people living in the area (population of 8,000 inhabitants) are involved in livestock keeping and are included here in calculations as labour (for 3 months, wet season, 10% of total population).
Cost/ benefit is currently negative for livestock keeping. Income due to livestock sales is roughly estimated USD 340,000 (price for cattle on average USD 400 per unit, sales around 500 p.a., price for goats and sheep each USD 40 per unit, sales around 2,000 p.a., slaughtered units (for subsistence use) cattle: 50, shoats: 1,000 – detailed figures available Herger 2018).

NATURAL ENVIRONMENT

Average annual rainfall

- < 250 mm
- ✓ 251-500 mm
- 501-750 mm
- 751-1,000 mm
- 1,001-1,500 mm
- 1,501-2,000 mm
- 2,001-3,000 mm
- 3,001-4,000 mm
- > 4,000 mm

Agro-climatic zone

- humid
- sub-humid
- ✓ semi-arid
- arid

Specifications on climate

Average annual rainfall in mm: 497.0

Rainfall gauge Borana HQ average from 2013-2016 (neighbouring ranch). Strong local (and temporal) variation, changing rainfall regimes. Il Ngwesi is generally drier than Borana. Name of the meteorological station: Rainfall gauge Borana HQ.

Slope
- [x] flat (0-2%)
- [ ] gentle (3-5%)
- [x] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landform
- [x] plateau/ plains
- [ ] ridges
- [ ] mountain slopes
- [x] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [x] 1,001-1,500 m a.s.l.
- [x] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Soil depth
- [ ] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [x] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [x] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [x] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [ ] medium (1-3%)
- [x] low (<1%)

Comment: Red and brown sandy soils. Black cotton soil. Luvisol, Regosol, Vertisol.

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [x] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [x] medium
- [ ] poor/ none

Water quality (untreated)
- [ ] good drinking water
- [x] poor drinking water (treatment required)
- [ ] fine/ heavy (clay)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Is salinity a problem?
- [ ] yes
- [x] no

Occurrence of flooding
- [ ] yes
- [x] no

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [x] medium
- [ ] low

Comment: Grassed acacia bushland. Bare land up to 70% during the dry season. Loss of (native) vegetation. Invasive species coming in. Dominant grasses: Eragrostis species, Cynadon species, Hyparrhenia species, Kelenger species. Dominant shrubs: Solyneum inconum, Ipomea hildebranditi, Lyceum europaeum, Barleria acuthodies. Dominant trees: Acacia tortilis, Acacia mellifera, Acacia nilotica, Acacia etbaica, Boscia angustifolia. Detailed list of all species (also wildlife) available (see Herger 2018).

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial
- [ ] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [x] poor
- [ ] average
- [ ] rich
- [ ] very rich

Level of mechanisation
- [x] manual work
- [ ] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [ ] sedentary
- [x] semi-nomadic
- [ ] nomadic

Individuals or groups
- [x] individual/ household
- [x] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [x] youth
- [x] middle-aged
- [ ] elderly

Comment: Masai people. 8,000 Masai living in Il Ngwesi. Traditional lifestyle. Livestock with very high cultural value. About 10% subsistence use, 90% is sold for local and national markets (mainly local).
Very little agriculture; tourism (award-winning eco-lodge in conservation area); people start to diversify. Schooling of children has a high importance today (e.g. smallstock is sold for school fees). Children and young warriors are traditionally herders, however, it is shifting towards hiring herders and sending children to school. Have been historically 'squeezed' from all sides into smaller areas for livestock keeping. Future of pastoralism is in question.

Area used per household

- < 0.5 ha
- ✓ 0.5-1 ha
- 1-2 ha
- 2-5 ha
- 5-15 ha
- 15-50 ha
- 50-100 ha
- 100-500 ha
- 500-1,000 ha
- 1,000-10,000 ha
- > 10,000 ha

Scale

- ✓ small-scale
- medium-scale
- large-scale

Land ownership

- state
- company
- ✓ communal/ village
- group
- individual, not titled
- individual, titled

Land use rights

- open access (unorganized)
- ✓ communal (organized)
- leased
- individual

Water use rights

- ✓ open access (unorganized)
- communal (organized)
- leased
- individual

Access to services and infrastructure

		1	2	3	
health	poor	✓			good
education	poor		✓		good
technical assistance	poor	✓			good
employment (e.g. off-farm)	poor	✓			good
markets	poor		✓		good
energy	poor	✓			good
roads and transport	poor	✓			good
drinking water and sanitation	poor	✓			good
financial services	poor		✓		good

IMPACTS – BENEFITS AND DISADVANTAGES

Socio-economic impacts

		1	2	3	4	5	6	7		
fodder production	decreased						✓		increased	
fodder quality	decreased						✓		increased	
animal production	decreased					✓			increased	
land management	hindered						✓		simplified	
drinking water availability	decreased				✓				increased	
water availability for livestock	decreased				✓				increased	
workload	increased		✓						decreased	**Comment:** 20-30% above normal (supervision, watchmen, moving big bomas). Previously, every household managed their livestock individually.

Socio-cultural impacts

		1	2	3	4	5	6	7		
food security/ self-sufficiency	reduced					✓			improved	
land use/ water rights	worsened					✓			improved	
SLM/ land degradation knowledge	reduced					✓			improved	
conflict mitigation	worsened			✓					improved	**Comment:** External! Better land cover attracts invaders (Invasion from northern tribes), envy.
situation of socially and economically disadvantaged groups (gender, age, status, ethnicity etc.)	worsened						✓		improv ed	**Comment:** Poorest livestock-owning families are better off now since their livestock are also bunched together with all the others. For instance, before they couldn't afford to trek their 5 cows to Mount Kenya for pasture, now their livestock are trekked with all the others – all have the same opportunities. Other households are complaining about this since they can't decide on their own anymore where they want to bring their livestock for grazing.

Ecological impacts

		1	2	3	4	5	6	7		
water quantity	decreased					✓			increased	**Comment:** Less runoff, more water stored in the soil.
surface runoff	increased						✓		decreased	
groundwater table/ aquifer	lowered					✓			recharged	
evaporation	increased					✓			decreased	
soil moisture	decreased					✓			increased	
soil cover	reduced					✓			improved	
soil loss	increased					✓			decreased	
soil crusting/ sealing	increased							✓	reduced	
soil compaction	increased							✓	reduced	
nutrient cycling/ recharge	decreased					✓			increased	
soil organic matter/ below ground C	increased					✓			decreased	
vegetation cover	decreased						✓		increased	
plant diversity	decreased					✓			increased	
invasive alien species	increased			✓					reduced	**Comment:** Il Ngwesi is not affected by the huge invasion of the exotic cactus, Opuntia stricta. However, there are some other invasives like Lantana in the area, but not as problematic as Opuntia. According to land users, native vegetation cover has improved, which results in fewer invasive species.
drought impacts	increased					✓			decreased	

Off-site impacts

water availability (groundwater, springs) infrastructure — decreased ☐☐☐☐☑☐☐ increased

Comment: More stored in the soil. According to the land users, no measurements conducted.

Benefits compared with establishment costs

Short-term returns — very negative ☐☐☑☐☐☐☐ very positive
Long-term returns — very negative ☐☐☐☐☐☑☐ very positive

Benefits compared with maintenance costs

Short-term returns — very negative ☐☐☐☐☐☑☐ very positive
Long-term returns — very negative ☐☐☐☐☐☑☐ very positive

Comment: All listed impacts are as perceived by land users according to Patrick Leseri, Conservation Manager. In his opinion, vegetation cover has thanks to the new technologies improved. Planning activities significantly increased and therefore also socio-economic and ecological conditions improved. Results from a rangeland health assessment (only ecological conditions) show on the other hand partly heavily degraded ecological conditions (poor soil and vegetation, erosions features, inability of producing annual grasses after rains etc.) (Herger 2018). Land users and experts are aware that the ecological conditions of this Group Ranch are still far from optimal, but do see good progress and exemplary management as well as slightly better conditions than on other Group Ranches.

CLIMATE CHANGE

Climate change/ extreme to which the Technology is exposed

How the Technology copes with these changes/ extremes

Gradual climate change

Greater variation of seasonal rainfall, higher intensity of rainfall events, change in rainfall regimes in general (see Schmocker 2013 and Imfeld 2016). increase — not well at all ☐☐☐☑☐ very well

Climate-related extremes (disasters)

heatwave — not well at all ☐☐☐☑☐ very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ☐ single cases/ experimental
- ☐ 1-10%
- ☑ 10-50%
- ☐ more than 50%

Of all those who have adopted the Technology, how many did so without receiving material incentives?

- ☑ 0-10%
- ☐ 10-50%
- ☐ 50-90%
- ☐ 90-100%

Number of households and/ or area covered

50%

Has the Technology been modified recently to adapt to changing conditions?

- ☑ yes
- ☐ no

To which changing conditions?

- ☑ climatic change/ extremes
- ☐ changing markets
- ☐ labour availability (e.g. due to migration)

Comment: Masai people have changed their livestock composition towards owning more smallstock (goats and sheep) than cattle. Goats are tolerant of drought, and as browsers, they don't need any grass. Also, they can be turned into money much quicker than a cow in times of need and because of their more rapid reproductive cycle. They can also recover number more quickly after livestock losses through drought.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Strengths

Land user's view

- Proper utilisation of pasture – controlled usage/grazing
- Land recovery (more cover, more water, more fodder, less erosion).
- Carrying capacity increased.
- Traditional knowledge is still used.
- More dialogue in community: brings everyone in the community together – they have a common point – everyone has the same interest.
- Improving breeds is easier (because all are bunched together).
- Easy vaccination of all livestock at once.
- Approving cultural lifestyle of Masai: the higher the livestock numbers – the better for the land.
- Better for disadvantaged community members: for instance for those who could not afford to move their livestock to Mt Kenya on their own before.

Key resource person's view

- The listed advantages from Patrick Leseri, the land user, are for the most part shared share with the compiler's view. Improved planning of livestock production with planned grazing and long resting periods, improved dialogue in the community, and the named advantages of a big herd (like easy vaccination etc.) are important advantages. Regarding Holistic Management (HM) principles, there remains uncertainty about land recovery. On the one hand, it is generally questionable to state as in HM: 'the more animals the better' (as long as they are managed properly they can even recover degraded land), which seems dangerous in areas with such high livestock numbers and cultural value of livestock keeping – without scientific proof of the principles in similar ecological conditions. We have witnessed rather poor condition of the land, and the much-vaunted good land was difficult to find. Favourable descriptions might also be related to funding of the project. Results from a rangeland health assessment show (partly) heavily degraded ecological conditions (bare ground, poor soil and vegetation, erosion features, partly an inability of producing perennial and annual grasses after rains etc.) (see Herger 2018). However, an evaluation of change over time is impossible to assess. Further monitoring is necessary. Land users and experts are aware that the ecological conditions of this Group Ranch are still far from optimal, but do see good progress and exemplary management as well as slightly better conditions than on other Group Ranches. However, the efforts towards good management and a sense of community was not difficult to notice.

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view

- Higher costs. Above 20% more than normal costs. Northern Rangeland Trust (NRT), Laikipia Wildlife Forum and Lewa conservancy as main funders for applying holisitc management principles. Since 2007, they covered about 50%of all costs.
- More labour intensive. 20-30% above normal (supervision, watchmen, moving big bomas).
- Challenge to bring people together (and their livestock) and agree on a joint management.
- Some families still prefer to manage their livestock on their own and make their own decisions. There are no individual decisions anymore: principles apply to everyone.
- Breeding can also be a problem – those with good genetic material (better livestock) may lose and those with poor may win by mixing.
- Conflicts among animals; bulls fight a lot. No separation of heifers, cows, steers and bulls.
- Management of high numbers of big herds is a challenge.
- Diseases are easily transmitted.
- Once livestock is collected to big herds, individual families lose their nutritional basis (milk, blood). However, some also keep a few livestock units back.
- Sometimes trees are cut for bomas.

REFERENCES

Compiler: SMichael Herger (michael.herger@scnat.ch)

Resource persons: Patrick Leresi (ilngwesi@nrt-kenya.org) - land user

Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/technologies/view/technologies_2092/

Date of documentation: April 20, 2017; **Last update:** Feb. 22, 2018

Key references

Herger, M.B. (2018). Environmental Impacts of Red Meat Production. MSc Thesis. University of Bern.

Modeling Seasonal and Annual Precipitation using long-term Climate Records and Topography. Master's Thesis. Noemi Imfeld (2016). University of Bern

Savory, A (1988). Holistic Resource Management. Gilmour Publishing, Harare, Zimbabwe: Online.

Carter, J., Jones, A., O'Brien, M., Ratner, J., Wuerthner, G. (2014). Holistic Management: Misinformation on the Science of Grazed Ecosystems. International Journal of Biodiversity.

Briske, D.D., Ash, A.J., Derner, J.D., Huntsinger, L. (2014). Commentary: A critical assessment of the policy endorsement for holistic management. Agricultural Systems 125:50-53.

Photo showing a contrast between a grazed and rested paddocks in the early dry season (June) at Tiisa Kalahari Ranch, Ghanzi. Note the reserve of forage for the mid and late dry season in the rested paddock (the cattle will moved into this rested paddock in July). Also note the even utilization of grasses in the grazed paddock by the end of the wet season (Photo Richard Fynn).

Split Ranch Grazing Strategy (Botswana)

Riaan Dames Grazing Strategy

DESCRIPTION

Split Ranch Grazing involves grazing half the available area for a full year – concentrating livestock. The consequent grazing pressure maintains the grassland in an immature, high-quality state, while resting the other half, allowing optimal recovery from the previous full years grazing. The technology is simple, requiring less fencing than more complex systems, without compromising sustainability or ecological function. These concepts can also be used for management in pastoral-wildlife systems to create habitat heterogeneity (short and tall grassland).

The Split Ranch Grazing Strategy (SRG) was developed by Riaan Dames in the North West province, South Africa. It is fundamentally different to popular rotational management systems and contains several conceptual advances. One key difference is that SRG provides a full-year uninterrupted recovery period for rangeland after grazing. This enables grasses to maximize nutrient recovery over the main pulses of nutrient mineralization in the early wet season, and to maximize root growth and associated nutrient storage over the late wet season and early dry season – when most root growth occurs. Optimal recovery periods should ideally, therefore, encompass the full wet season and the early dry season. This contrasts with rotational grazing where recovery and grazing periods are apportioned across these two periods, with resting periods often not occurring in key periods of nutrient uptake and root growth.

A major problem with having both grazing and recovery periods in the same season is that grassland is able to mature during recovery periods, greatly reducing forage quality and grass growth rates, thereby negatively impacting animal production. Another problem is that complex rotational grazing requires strategies investing much in a complex and expensive fencing infrastructure. The solution is a fundamentally different strategy where some paddocks are grazed the whole year to prevent grassland maturation and other paddocks are simultaneously rested to optimize recovery. In addition, paddocks should be as few, and as large as possible, to maximize livestock access to functional resource heterogeneity, thereby improving adaptive foraging options, while reducing costs of fencing (fencing can even be replaced by using physical boundaries (e.g. roads, rivers, etc.) and herding the livestock.

Livestock are maintained in the grazing paddocks until mid-dry season to ensure that grasses in the rested paddocks have completed root growth and ceased all other growth – thus fully rested and recovered. A full years rest allows maximum uptake and storage of nutrients in deep, strong root systems and crowns. Thus when these grasses are grazed in the next season they have not only efficient root uptake of moisture and nutrients from the soil but also can re-allocate nutrients stored in roots to leaf production after each grazing event, resulting in a productive supply of high-quality fresh leaf to livestock over the growing season.

LOCATION

Location: Ghanzi, Tiisa Kalahari Ranch, Ghanzi Province, Botswana

No. of Technology sites analysed: single 2-10 site

Geo-reference of selected sites
- 21.48969, -21.60026

Spread of the Technology: evenly spread over an area 10-100 km²

Comment: Not restricted to any size of land – any size ranch.

Date of implementation: less than 10 years ago (recently)

Type of introduction
- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ☐ through projects/ external interventions
- ☑ through interaction with Riaan Dames

Grasses in the grazed paddocks are kept in an immature, leafy state during the wet season by sufficient sustained grazing pressure (Theresa Fynn).

Photo showing a cattle preference for short high-quality green grass in the mown strip along the Charleshill road, avoiding the taller and lower quality unmown areas further away from the road. This demonstrates the importance of maintaining grazed paddocks in a short high-quality state (Photo Richard Fynn).

Movement of livestock into the year-long rested paddocks halfway through the dry season ensures that they have a large reserve of forage. Concentration of livestock on half the available area (half the paddocks are rested and the other half grazed) ensures sufficient grazing pressure to maintain grassland in an immature, high-quality and rapidly-growing state for maximizing forage quality, leaf production and livestock production, further enhanced by greater adaptive foraging options in large paddocks. The technology was started in North West province South Africa, and is now being taken up in Botswana and Namibia. A model example is Tiisa Kalahari Ranch in the Ghanzi region of Botswana. The ranch has been partitioned into several four-paddock cells, each with their own cattle herd. Cattle graze two paddocks while the other two are rested for a full year. Cattle enter the rested paddocks, which have developed a large reserve of forage, in the mid dry season (July) once forage is depleted in the two grazed paddocks. This technology (SRG), used on the award-winning Danielskuil ranch in South Africa, has been employed at Tiisa for six years after being in a degraded state. Indications are that the rangeland has been steadily recovering with increases in abundance of high-quality grasses. Monitoring programmes are being established to monitor the trends in cover of the various grass species over time.

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- ✓ improve production
- ✓ reduce, prevent, restore land degradation
- ✓ conserve ecosystem
- ✓ protect a watershed/ downstream areas – in combination with other Technologies
- ✓ preserve/ improve biodiversity
- reduce risk of disasters
- adapt to climate change/ extremes and its impacts
- mitigate climate change and its impacts
- ✓ create beneficial economic impact
- create beneficial social impact

Land use

Grazing land – Extensive grazing land: Semi-nomadism/ pastoralism, Ranching
Main animal species and products: The technology can be used for ranching cattle, sheep or goats or using planned herding of these livestock types according to the key concepts outlined in the technology. Products would be meat, wool and to a lesser degree, milk.

Water supply

- ✓ rainfed
- mixed rainfed-irrigated
- full irrigation

Number of growing seasons per year: 1
Livestock density: At conservative stocking rates to ensure that animals are able to remain in the planned grazed paddocks until the mid dry season. Stocking rate will depend upon the local rainfall and soils and associated grass production. 10-15 ha/ LSU in semi-arid regions.

Purpose related to land degradation

- ✓ prevent land degradation
- reduce land degradation
- ✓ restore/ rehabilitate severely degraded land
- adapt to land degradation
- not applicable

Comment: The key goals are to improve grass composition and cover, reduce soil erosion and to improve livestock production.

Degradation addressed


soil erosion by water – Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying

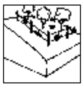

soil erosion by wind – Et: loss of topsoil


biological degradation – Bc: reduction of vegetation cover, Bq: quantity/ biomass decline, Bs: quality and species composition/ diversity decline

SLM group

- pastoralism and grazing land management

SLM measures


management measures – M2: Change of management/ intensity level, M4: Major change in timing of activities

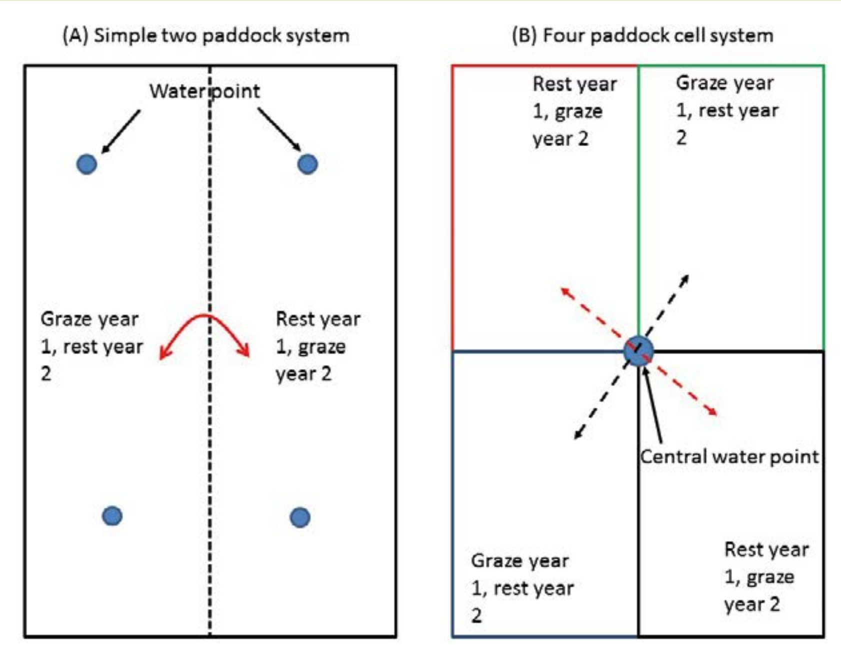
Comment: Preventing undesirable changes in grass cover and composition.

Comment: It involves grazing management. Managing stocking rate and the time spent grazing or resting a paddock.

TECHNICAL DRAWING

Technical specifications

SRG can be implemented as simply as dividing the ranch into two paddocks with livestock spending alternate years in each paddock (A) or the ranch can be divided up into several cells according to needs, such as having to separate breeding herds, bull herds and weaners (B). In scenario A it is important to ensure good water distribution in each paddock to ensure access to the whole paddock. This simple scenario (A) is ideal for rural development schemes owing to minimal infrastructure costs and is easy for rural communities to implement. Another advantage is that it gives livestock much greater adaptive foraging options. In scenario B a central water point provides a convenient way of changing the livestock between paddocks. The gates can be left open between diagonal paddocks to allow livestock freedom of access to either of the diagonal paddocks or they can be actively moved between diagonals during the grazing year according to the rancher's decisions. If paddocks are extremely large then other water points should be provided across the paddocks to allow livestock even access to all parts of the paddock.



Author: Richard Fynn.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit
- Currency used for cost calculation: **Pulla (BWP)**
- Exchange rate (to USD): 1 USD = 10,3721 Pulla (BWP)

Most important factors affecting the costs

Fencing and infrastructure have been shown to be major factors increasing establishment and maintenance costs and reducing profits. Thus SRG aims to reduce these costs by having fewer larger paddocks, which also has benefits for the animals. Another major cost is that of supplementary feeding, especially if forage is depleted during the dry season. This technology aims to ensure that a reserve of forage is created for the dry season, to overcome this. It also aims to improve the quality of forage during the wet season so that supplementary feeding is not needed for fertility improvement.

Establishment activities

1. Building fences (Timing/ frequency: at the start)
2. Digging Boreholes (Timing/ frequency: at the start)
3. Setting up water reticulation and drinking troughs (Timing/ frequency: at the start)
4. Building animal loading facilities (Timing/ frequency: at the start)
5. Handling of livestock (Timing/ frequency: throughout the year)

Establishment inputs and costs

Specify input	Unit	Quantity	Cost per unit (Pulla BWP)	Total cost per input (Pulla BWP)	% of costs borne by land users
Labour					
Labourers	paddocks	7	24,000.00	168,000.00	100
Equipment					
Water trough, fitting and piping	paddocks	7	8,000.00	56,000.00	100
Solar pump	paddocks	7	20,000.00	140,000.00	100
Fencing	paddocks	7	80,000.00	560,000.00	100
Boreholes	paddocks	7	20,000.00	140,000.00	100
Other					
Loading facilities		1	30,000.00	30,000.00	
			Total costs for establishment of the Technology	**1,094,000.00**	**100**

Maintenance activities

1. Maintenance of fences (Timing/ frequency: throughout)
2. Maintenance of water pipes and pumps (Timing/ frequency: throughout)
3. Maintenance of vehicles (Timing/ frequency: throughout)
4. Animal handling (Timing/ frequency: throughout)
5. Supplementary feeding (if needed) (Timing/ frequency: dry season)

Establishment inputs and costs

Specify input	Unit	Quantity	Cost per unit (Pulla BWP)	Total cost per input (Pulla BWP)	% of costs borne by land users
Plant material					
Supplementary feed	bale	1	9.00	9.00	
			Total costs for establishment of the Technology	**9.00**	**100**

Comment: Maintenance costs are difficult to quantify but mainly keeping the fences clear of brush and replacing poles. Most of labour costs are probably assigned to this over a year. Water reticulation also a cost. A cost of P5000/MTH would be a good estimate. Bales of hay cost 7-9 USD in Botswana depending on availability.

NATURAL ENVIRONMENT

Average annual rainfall
- < 250 mm
- ✓ 251-500 mm
- ✓ 501-750 mm
- 751-1,000 mm
- 1,001-1,500 mm
- 1,501-2,000 mm
- 2,001-3,000 mm
- 3,001-4,000 mm
- > 4,000 mm

Agro-climatic zone
- humid
- sub-humid
- ✓ semi-arid
- arid

Specifications on climate

Average annual rainfall in mm: 432.0

While Split Ranch Grazing is mainly applied in semi-arid climates with a long dry season, the relevance of SRG is likely to increase with increasing rainfall because of the greater decline in forage quality as grassland matures in higher rainfall areas; hence the greater need to concentrate grazing pressure to prevent grassland maturation.

Name of the meteorological station: Department of Meteorological Services, Botswana.

Can be operated in semi-arid, sub-humid or humid environments.

Slope
- ✓ flat (0-2%)
- gentle (3-5%)
- moderate (6-10%)
- rolling (11-15%)
- hilly (16-30%)
- steep (31-60%)
- very steep (>60%)

Landform
- ✓ plateau/ plains
- ridges
- mountain slopes
- hill slopes
- ✓ footslopes
- valley floors

Altitude
- ✓ 0-100 m a.s.l.
- ✓ 101-500 m a.s.l.
- 501-1,000 m a.s.l.
- 1,001-1,500 m a.s.l.
- 1,501-2,000 m a.s.l.
- 2,001-2,500 m a.s.l.
- 2,501-3,000 m a.s.l.
- 3,001-4,000 m a.s.l.
- > 4,000 m a.s.l.

Technology is applied in
- convex situations
- concave situations
- ✓ not relevant

Soil depth
- [x] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [x] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [x] medium (1-3%)
- [ ] low (<1%)

Comment: The ranch has deep Kalahari sands in some sections and shallow rocky soils on calcrete in other sections. Nevertheless the technology is appropriate for any soil type.

Groundwater table
- [ ] on surface
- [x] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [x] good
- [ ] medium
- [ ] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] fine/ heavy (clay)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Is salinity a problem?
- [ ] yes
- [x] no

Occurrence of flooding
- [ ] yes
- [x] no

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [x] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [ ] mixed (subsistence/ commercial
- [x] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanisation
- [ ] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] sedentary
- [x] semi-nomadic
- [ ] nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [x] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Comment: The technology can be applied under commercial ranching situations using fenced paddocks to control the spatial and temporal distribution of livestock or it can be applied by semi-nomadic pastoralists using planned herding to control the spatial and temporal distribution of livestock.

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [x] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [x] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Access to services and infrastructure

health	poor			✓	good
education	poor			✓	good
technical assistance	poor			✓	good
employment (e.g. off-farm)	poor		✓		good
markets	poor		✓		good
energy	poor			✓	good
roads and transport	poor			✓	good
drinking water and sanitation	poor			✓	good
financial services	poor			✓	good

IMPACTS – BENEFITS AND DISADVANTAGES

Socio-economic impacts

fodder production	decreased	☐☐☐☐☐✓☐	increased	**For details see:** *Fynn, R.W.S. Kirkman, K & Dames, R. (2017)***.**
fodder quality	decreased	☐☐☐☐☐✓☐	increased	**Comment:** Forage quality improved by keeping the grass in an immature state. **For details see:** Fynn, R.W.S. Kirkman, K & Dames, R. (2017).
animal production	decreased	☐☐☐☐☐✓☐	increased	**Comment:** Benefit from improved forage quality and larger spatial scales for adaptive foraging. **For detail see:** Fynn, R.W.S. Kirkman, K & Dames, R. (2017).

Ecological impacts

water quantity	decreased	☐☐☐☐☐✓☐	increased	
water quality	decreased	☐☐☐☐☐✓☐	increased	**Comment:** Better soil cover and protection.
surface runoff	increased	☐☐☐☐☐✓☐	decreased	**Comment:** Better soil cover and protection.
vegetation cover	decreased	☐☐☐☐☐✓☐	increased	**Comment:** Better soil cover and protection.
biomass/ above ground C	decreased	☐☐☐☐☐✓☐	increased	
habitat diversity	decreased	☐☐☐☐☐✓☐	increased	

Benefits compared with establishment costs

Short-term returns	very negative	☐☐☐☐☐✓☐	very positive
Long-term returns	very negative	☐☐☐☐☐✓☐	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	☐☐☐☐☐✓☐	very positive
Long-term returns	very negative	☐☐☐☐☐✓☐	very positive

Comment: This technology aims to reduce infrastructure and maintenance costs by reducing the amount of fencing. It also aims to reduce reliance on supplementary feeding.

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ☐ single cases/ experimental
- ✓ 1-10%
- ☐ 10-50%
- ☐ more than 50%

Of all those who have adopted the Technology, how many have did so without receiving material incentives?

- ☐ 0-10%
- ☐ 10-50%
- ☐ 50-90%
- ✓ 90-100%

Comment: They have adopted the technology because of seeing the results of those using the technology and from farmers day talks.

Number of households and/ or area covered

In Ghanzi region of Botswana probably about five ranchers have adopted the technology.

Has the Technology been modified recently to adapt to changing conditions?

- ☐ yes
- ✓ no

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Strengths

Land user's view

- Management complexity is reduced – fewer paddocks and less frequent movement between paddocks.
- Establishment and maintenance costs are lower than complex rotational grazing systems owing to less fencing required. Livestock production increased relative to costs.
- Need for supplementary feed and mineral licks reduced owing to livestock having greater adaptive foraging options. Rangeland condition improved.
- Rangeland condition improved.
- Rangeland condition improved – better grass cover and greater abundance of high-quality perennial grasses.

Key resource person's view

- Conceptually the most robust grazing management technology: Extremely long recovery periods promotes sustainability.
- Low establishment and maintenance costs relative to production.
- Concentration of livestock on half the available area enables sufficient grazing pressure to prevent grassland maturation and loss of forage quality.
- Development of a large reserve of forage for the dry season through season long resting promotes stability and reduces needs for supplementary feeding (increased profits).
- Very large paddocks combined with minimal forced movement of livestock promotes adaptive foraging options for livestock thereby reducing need for supplementary feeding and licks (increased profits).

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view

- Less intensive management increases predation events on livestock. → Herding of livestock.

Key resource person's view

- Potential over/under use of certain habitat type. Less control of timing and intensity of grazing distribution could result in damage to sensitive habitat types. → Monitoring by the rancher of impacts on vegetation and use of water point reticulation/ lick placement/herding to move animals to underutilized areas.

REFERENCES

Compiler: Richard Fynn (richardwsfynn@gmail.com)
Resource persons: Richard Fynn (richardwsfynn@gmail.com) - SLM specialist
Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/technologies/view/technologies_3217
Documentation was facilitated by: Institution: University of Botswana (University of Botswana) - Botswana
Date of documentation: Oct. 16, 2017; **Last update:** May 23, 2018

Key references

Optimal grazing management strategies: Evaluating key concepts Fynn, R.W.S., Kirkman, K.P. and Dames, R. 2017. African Journal of Range and Forage Science 34 (2): 87-98: Taylor and Francis Publishers
Towards optimal rangeland management. Fynn, R.W.S. 2015. Farmers Weekly 18: 56-59: Farmers weekly magazine

Links to relevant information which is available online

Grazing Strategy of Riaan Dames: https://www.youtube.com/watch?v=9lOAr1RT69M

A combined herd under planned grazing (Colin Nott).

Combined herding for planned grazing (Namibia)

Omarisiro wovinamuinjo motjimbumba

DESCRIPTION

Daily combining of livestock from all households into a single herd to be driven to different designated portions of the communal grazing area. Grass can then recover by replenishing its reserves before being re-grazed some months later.

This technology is currently being applied in communal areas as well as commercial farms of Namibia. It is particularly effective in areas with no fences, and areas with high incidence of stock theft and predator losses. The technology aims to replace continuous, open grazing with a planned system. This gives grass a chance to recover in the growing season, and prepares the soil and grass for the forthcoming rainy season. In addition, fixed stocking rates based on carrying capacities are replaced by flexible stocking rates which track availability of forage. Two grazing plans are developed for one year; one when perennial grasses are growing and the other when they are dormant. Grazing plans may change, depending on the season and unanticipated events such as fire. A grazing plan is put in place for the growing season, that ensures plants are not re-grazed before they have recovered their root reserves. It is targeted at good animal performance. In the non-growing season, animal numbers are adjusted to ensure that there is sufficient grass to last until the next rains.

The grazing plans must take into account all factors that affect livestock performance as well as capacity of the livestock owner. These factors include occurrence of the first rains, presence of natural water pans, current and projected animal performance, availability of good quality forage for cows prior to bulling, avoiding poisonous plants, and timing of vaccinations, etc. Once the plan has been developed, the animals are moved by herders using low stress handling techniques to various parts of the farm or communal grazing area, according to the plan. Strategic moving of livestock by herding enables fire breaks to be created by deliberate over trampling. Each night the livestock are brought back to a kraal (Afrikaans for corral) where they are kept overnight. Watering of livestock can take place in the kraal at night, in the morning, or alternatively in the field depending on water availability. This process is repeated day after day by the herders.

At the end of each growing season, the amount of forage available to the current herd is estimated. Animal numbers are adjusted to make sure that there is still sufficient forage to support them before the rains – and to leave enough ground cover to feed the soil organisms and protect the soil from erosion. Deciding when the forage produced will run out needs to be done using a method that livestock owners relate to. Livestock owners may decide to meet and reach consensus on this based on their knowledge and past experience of the effectiveness of rainfall. If it is decided that there is sufficient food to see the animals through until the next rains, then livestock owners will be satisfied; if there is excess forage they may be able to re-stock. If, however, a forage shortage is expected then de-stocking is required: the severity of the forage shortage determines how many livestock can be carried on the land during the off-season. Again, livestock owners can reach consensus on this. Deciding whose animals to sell and how many is always a thorny issue, so livestock owners will always move excess livestock to other areas if possible, or alternatively sell unproductive animals.

LOCATION

Location: Communal grazing areas of Erora, Outokotorua and Nsindi, Kunene Region, Namibia

No. of Technology sites analysed: 2-10 sites

Geo-reference of selected sites
- 14.05915, -18.32659
- 14.17937, -19.36578
- 19.28976, -17.92738

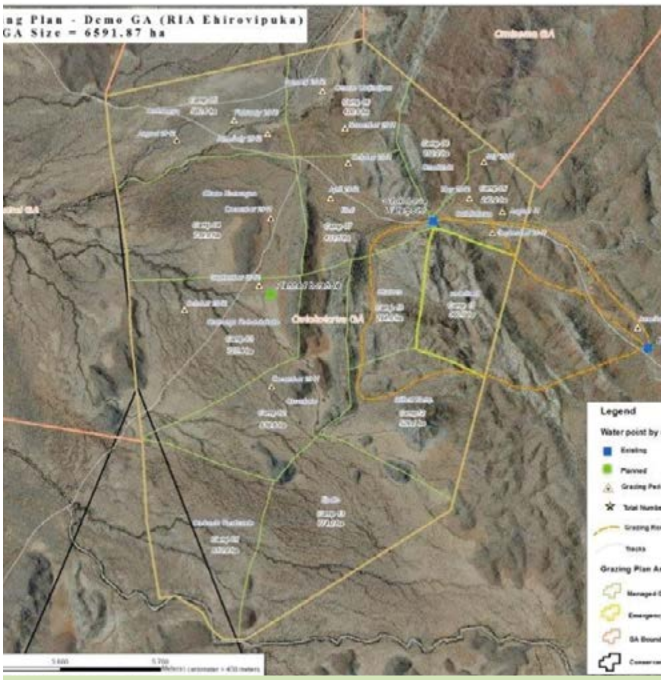
Spread of the Technology: evenly spread over an area (approx. 100-1,000 km²)

Comment: Animals are herded over the entire area – except areas that are too steep for livestock to walk up.

Date of implementation: 2004

Type of introduction
- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ✓ through projects/ external interventions

Comment: Community projects facilitated by NGO 'Conservation Agriculture Namibia'.



Map used for developing the grazing plan for Outokotorua communal grazing area (Colin Nott).

Grazing chart used for developing the grazing plan for Outokotorua communal grazing area (Collin Nott).

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- ✓ improve production
- ✓ reduce, prevent, restore land degradation
- ✓ conserve ecosystem
- ✓ protect a watershed/ downstream areas – in combination with other Technologies
- ✓ preserve/ improve biodiversity
- ✓ reduce risk of disasters
- ✓ adapt to climate change/ extremes and its impacts
- ✓ mitigate climate change and its impacts
- ✓ create beneficial economic impact
- ✓ create beneficial social impact

Land use

Grazing land – Extensive grazing land: Semi-nomadism/ pastoralism
Main animal species and products: Livestock, increased forage production, improved animal performance

Water supply

- ✓ rainfed
- ☐ mixed rainfed-irrigated
- ☐ full irrigation

Number of growing seasons per year: 1
Livestock density: Livestock density is high as a result of herding, but stocking rate varies.

Purpose related to land degradation

- ☐ prevent land degradation
- ☐ reduce land degradation
- ✓ restore/ rehabilitate severely degraded land
- ☐ adapt to land degradation
- ☐ not applicable

Comment: Land is severely degraded but can be restored by changing the management.

Degradation addressed

soil erosion by water – Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying, Wo: offsite degradation effects

soil erosion by wind – Et: loss of topsoil

physical soil deterioration – Pk: slaking and crusting

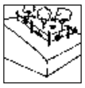
biological degradation – Bc: reduction of vegetation cover, Bq: quantity/ biomass decline, Bs: quality and species composition/ diversity decline, Bl: loss of soil life

water degradation – Ha: aridification, Hs: change in quantity of surface water, Hg: change in groundwater/ aquifer level

Comment: The control of over-trampling which otherwise leads to rill and gully erosion.

SLM group
- pastoralism and grazing land management

SLM measures

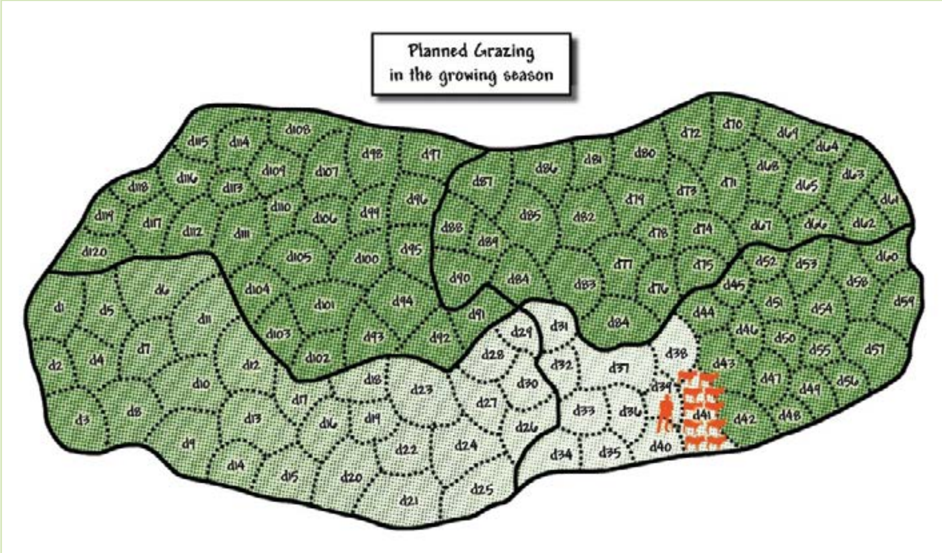

management measures – M4: Major change in timing of activities

Comment: The technology does not involve a change in land use. The grazing plan means that livestock will only be on a particular piece of land twice in any given year (once in the growing season and once in the non growing season). The animal density is however high, leading to increased impact for a very short period.

TECHNICAL DRAWING

Technical specifications

Schematic of planned growing season grazing. In this diagram grazing started in the bottom left hand camp (plot), marked d1, and the livestock were grazed in this area for one day. The next day the herd of livestock were taken to the area marked d2 and grazed there. This continued until day 41 where the livestock are currently. If deviations from the plan occur then the grazing map is marked according to what actually happened. This is the map that helps inform next year's grazing plan – to avoid using certain camps at the same time of year. The degree of greenness in the diagram indicates the recovery of grass. It is lightest in the area just grazed, marked d40. By the time the herd reaches day 120, which has the darkest green indicating readiness to be re-grazed, then the grass in the area marked d1 was calculated to have recovered sufficiently to be re-grazed. This plan has a built-in recovery period of 120 days. It is possible that growth rates are slower than expected and it may be necessary to reduce numbers of cattle in the herd to slow down movement to ensure an adequate recovery period.



Author: Colin Nott.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs
- Costs are calculated: per Technology area (size and area unit: **5,000 ha**)
- Currency used for cost calculation: **US Dollars**
- Average wage cost of hired labour per day: USD 4

Most important factors affecting the costs

Appreciation by land users that investment in herders will pay back, especially from the second year onwards.

Establishment activities
1. Three meetings for mobilization of communities (Timing/ frequency: Month 1)
2. Exchange visit to local livestock owners using this practise (Timing/ frequency: Month 4)
3. Assess water infrastructure, site and drill and install additional water point (Timing/ frequency: Month 6)
4. Grazing planning meeting with stakeholders (Timing/ frequency: After adequate grass growth to enable planned grazing)
5. Appoint, equip and train herders (Timing/ frequency: After 4)
6. Planning meeting and determination of starting date (Timing/ frequency: After 5)
7. Build overnight kraals at new water points (Timing/ frequency: When needed)
8. Build temporary kraals for improved grass growth (Timing/ frequency: When needed)

Establishment inputs and costs (per 5,000 ha)

Specify input	Unit	Quantity	Cost per unit (US Dollars)	Total cost per input (US Dollars)	% of costs borne by land users
Labour					
Six herders (four on duty per day) for 400 cattle	Month	6	77.00	462.00	100
One manager	Month	1	115.00	115.00	100
Equipment					
Overalls, boots and hat that may need replacement after one year	Set	7	100.00	700.00	100
Construction material					
Housing for herders built from mud and dung	Shelter	3	100.00	300.00	100
Other					
Laminated grazing chart and map per year	Documents	2	10.00	20.00	
			Total costs for establishment of the Technology	**1,597.00**	

Comment: Grazing maps and charts produced by CAN (support NGO), but will be taken over soon by farmers.

Maintenance activities

1. Daily herding, watering of livestock and health checks and treatment (Timing/ frequency: Daily)
2. Maintenance of kraals and water points (Timing/ frequency: Quartery)

Establishment inputs and costs (per 5,000 ha)

Specify input	Unit	Quantity	Cost per unit (US Dollars)	Total cost per input (US Dollars)	% of costs borne by land users
Labour					
Six herders (four on duty per day) for 400 cattle	Month	6	77.00	462.00	100
One manager	Month	1	115.00	115.00	100
Equipment					
Overalls, boots and hat, replacement annually	Set	7	100.00	700.00	100
Construction material					
Maintenance of clay and dung housing for herders	Shelter	3	100.00	300.00	100
Other					
Diesel for pumping water per month	Diesel	100	1.00	100.00	100
Laminated grazing chart and map per year	Documents	2	10.0	20.00	100
			Total costs for establishment of the Technology	**1,697.00**	

NATURAL ENVIRONMENT

Average annual rainfall
- ✓ < 250 mm
- 251-500 mm
- 501-750 mm
- 751-1,000 mm
- 1,001-1,500 mm
- 1,501-2,000 mm
- 2,001-3,000 mm
- 3,001-4,000 mm
- > 4,000 mm

Agro-climatic zone
- humid
- sub-humid
- semi-arid
- ✓ arid

Specifications on climate

Summer rainfall December-March

Name of the meteorological station: Opuwo

Slope
- flat (0-2%)
- gentle (3-5%)
- moderate (6-10%)
- rolling (11-15%)
- ✓ hilly (16-30%)
- steep (31-60%)
- very steep (>60%)

Landform
- plateau/ plains
- ridges
- ✓ mountain slopes
- hill slopes
- footslopes
- ✓ valley floors

Altitude
- 0-100 m a.s.l.
- ✓ 101-500 m a.s.l.
- 501-1,000 m a.s.l.
- 1,001-1,500 m a.s.l.
- 1,501-2,000 m a.s.l.
- 2,001-2,500 m a.s.l.
- 2,501-3,000 m a.s.l.
- 3,001-4,000 m a.s.l.
- > 4,000 m a.s.l.

Technology is applied in
- convex situations
- concave situations
- ✓ not relevant

Soil depth
- very shallow (0-20 cm)
- shallow (21-50 cm)
- ✓ moderately deep (51-80 cm)
- deep (81-120 cm)
- very deep (> 120 cm)

Soil texture (topsoil)
- ✓ coarse/ light (sandy)
- medium (loamy, silty)
- fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- coarse/ light (sandy)
- ✓ medium (loamy, silty)
- fine/ heavy (clay)

Topsoil organic matter content
- high (>3%)
- medium (1-3%)
- ✓ low (<1%)

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [x] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial
- [ ] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [x] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechaniSation
- [x] manual work
- [ ] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [x] sedentary
- [x] semi-nomadic
- [ ] nomadic

Individuals or groups
- [ ] individual/ household
- [x] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Comment: In dry years all livestock may move to another cattle post. But they return to the sedentary site as their main grazing area. A significant number of land users take up employment in the nearest town.

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [x] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [x] medium-scale
- [ ] large-scale

Comment: Communal land is not owned or leased, but the community has rights to use it for agricultural purposes.

Land ownership
- [x] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled

Land use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [x] individual

Comment: Land is communal and organized but no rights to enforce management are yet in place through formal structures.

Access to services and infrastructure

health	poor		✓		good
education	poor		✓		good
technical assistance	poor			✓	good
employment (e.g. off-farm)	poor		✓		good
markets	poor	✓			good
energy	poor		✓		good
roads and transport	poor		✓		good
drinking water and sanitation	poor		✓		good
financial services	poor	✓			good

IMPACTS – BENEFITS AND DISADVANTAGES

Socio-economic impacts

fodder production	decreased						✓		increased
animal production	decreased						✓		increased
risk of production failure	increased							✓	decreased
land management	hindered							✓	simplified
water availability for livestock	decreased							✓	increased
expenses on agricultural inputs	decreased		✓						increased
farm income	decreased						✓		increased
economic disparities	decreased						✓		increased
workload	increased		✓						decreased

Socio-cultural impacts

		1	2	3	4	5	6	7	
food security/ self-sufficiency	reduced						✓		improved
land use/ water rights	worsened						✓		improved
community institutions	weakened							✓	strengthened
SLM/ land degradation knowledge	reduced							✓	improved
conflict mitigation	worsened						✓		improved

Ecological impacts

		1	2	3	4	5	6	7	
surface runoff	increased						✓		decreased
evaporation	increased					✓			decreased
soil moisture	decreased						✓		increased
soil cover	reduced						✓		improved
soil loss	increased						✓		decreased
soil crusting/ sealing	increased						✓		reduced
nutrient cycling/ recharge	decreased						✓		increased
vegetation cover	decreased						✓		increased
plant diversity	decreased					✓			increased
animal diversity	decreased					✓			increased
drought impacts	increased						✓		decreased
fire risk	increased						✓		decreased
micro-climate	worsened						✓		improved

Off-site impacts

		1	2	3	4	5	6	7	
Community's cattle no longer graze on land of neighbouring communities	none					✓			improved

Benefits compared with establishment costs

		1	2	3	4	5	6	7	
Short-term returns	very negative						✓		very positive
Long-term returns	very negative							✓	very positive

Benefits compared with maintenance costs

		1	2	3	4	5	6	7	
Short-term returns	very negative							✓	very positive
Long-term returns	very negative							✓	very positive

Comment: The ability to bring back perennial grasses into the system allows higher stocking rates, less drought risk and better quality animals, therefore higher income over time and consequently a better cost-benefit analysis.

CLIMATE CHANGE

Climate change/ extreme to which the Technology is exposed — **How the Technology copes with these changes/ extremes**

Gradual climate change

		1	2	3	4	5	
annual temperature increase	not well at all			✓			very well
annual rainfall	not well at all			✓			very well

Climate-related extremes (disasters)

		1	2	3	4	5	
local thunderstorm	not well at all				✓		very well
drought	not well at all			✓			very well
land fire	not well at all				✓		very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ☐ single cases/ experimental
- ✓ 1-10%
- ☐ 10-50%
- ☐ more than 50%

Number of households and/ or area covered

20,000 ha

Of all those who have adopted the Technology, how many have did so without receiving material incentives?

- ✓ 0-10%
- ☐ 10-50%
- ☐ 50-90%
- ☐ 90-100%

Comment: This is a key issue undergoing lobbying of government and the communal farmers union to establish through a consultative process legislation that enables grazing plans to be enforced from within and from outside. This is lacking at the moment.

Has the Technology been modified recently to adapt to changing conditions?

- ✓ yes
- ☐ no

To which changing conditions?

- ☐ climatic change/ extremes
- ☐ changing markets
- ☐ labour availability (e.g. due to migration)
- ✓ adaptive management

Comment: Addition of erosion control and overnight kraaling to assist with gully control. Refining re-planning in response to monitored results that deviate from aims.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Strengths

Land user's view
- It is cost-effective; genuine improvement is seen in grass production, while livestock losses to predators are significantly reduced.
- For absentee owners they can leave a manager and herders in place to get on with the work and this can be easily evaluated after time since animals wondering around leave evidence.
- Livestock are better cared for than they used to be, and a sense of community has been restored.

Key resource person's view
- This is a viable and upscaleable technology for both communal and commercial farmland in Namibia and beyond.
- It addresses the root cause of livestock related degradation and on a larger scale could have a significant impact on mitigating climate change if all the degraded rangelands of the dry climates of the world were restored by using the principles embodied in this approach – one which has been adopted in the National Rangeland Management Policy and Strategy. Moreover it can improve the quality of lives of millions of people who live in areas where livestock is the only viable land use.
- This is a true 'triple bottom line' technology that improves the resource base whilst increasing profits and enables improved quality of life for residents.

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view
- Herders are difficult to find, train and keep. → National level vocational training of herders is required.
- Water infrastructure tends to result in overtrampling of the same routes. → The Directorate of Rural Water Supply should change its water specifications to include the provision of water for livestock – which can be cheap and effective.
- Grass poaching takes place by neighbours and the majority will of people in an area is sometimes overrun by a small minority. → Farmers Unions must address these issues and get enforceable mechanisms in place for improved rangeland management.

Key resource person's view
- There is insufficient national buy-in from line ministries in terms of implementation to address many of the issues that have been raised. → Line ministries should support implementation to address these problems. Joint implementation, joint review and adaptation by government, unions, livestock owners and support providers will assist in solving many issues for resource-base improvement.

REFERENCES

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Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/technologies/view/technologies_3326/

Linked SLM data: SLM Approach: Community grazing management https://qcat.wocat.net/en/wocat/approaches/view/approaches_3050/

Documentation was facilitated by: Conservation Agriculture Namibia (Conservation Agriculture Namibia) - Namibia; Namibia University of Science and Technology (NUST) - Namibia; Southern African Science Service Centre for climate change and Adaptive Land management (SASSCAL)

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Key references

Holistic mangement, Savory, A. & Butterfield, J., 1991: Island Press

Links to relevant information which is available online

Volkmann, W. (2011). Community based rangeland and livestock management. Windhoek: GOPA-CBRLM.: https://rmportal.net/groups/cbrlm/cbrlm-forreview/namibia-community-based-rangeland-livestock-management-cbrlm-2nd-edition/view

RANGE IMPROVEMENT (TG3)

Plateau with Nardi/ Vallerani pits, planted with grass and trees, Niger (GIZ).

In a nutshell

Short description
Range improvement including soil improvement involves management of fire/ prescribed burning, firebreaks, enrichment planting, seeding of leguminous species, control of bush encroachment and alien invasive species, natural regeneration, soil fertility amendments (manure), erosion control, soil moisture (water harvesting by micro-catchments) and reducing evaporation losses.

Principles
- Develop and implement a grazing management plan.
- Improve range health by managing soil health and improving forage quantity and quality.
- Improve range through restoring grass cover e.g. reseeding, clearing of invasive and unproductive species, and fire management.
- Improve plant water availability and water use efficiency, by in-situ water conservation and rainwater harvesting.
- Improve soil health by increasing organic matter and hence improving soil aggregate structure, soil's ability to store water and nutrients, and soil microorganism content.
- Secure rights over the land and water.

Most common technologies
Reseeding and planting: can be an effective and inexpensive method to improve the quality and quantity of forage (pasture and hay) including right species selection to reduce competition and avoid spread of invasive species. After reseeding a management change is needed to favour the continued growth of the seeded grasses.

Fertility improvement: through livestock manure collection and spreading (adding organic matter and nutrients) or by incorporating nitrogen-fixing leguminous species in the range.

Control of bush encroachment and alien invasive species: often associated with high grazing pressures. Unpalatable shrubs increase when the more palatable ones are overgrazed. Several control mechanisms are involved: fire, mixed grazing use by grazers and browsers, mechanical uprooting, pesticide or biological control.

Fire management (natural and prescribed burning): enables regrowth and access to palatable and nutritious regrowth especially of perennial grasses. Fire is also used to control invasive woody vegetation (indigenous and alien). Effect of fires depends on intensity, seasonality, frequency and type. Herbaceous biomass is the key determinant of fire activity. Trees promote fires at low densities but suppress fires at higher densities. Firebreaks are strips of land from which the trees and vegetation have been removed to prevent fire from spreading.

Land user managed natural regeneration: woodlands are restocked by trees that develop from seeds that fall, germinate in-situ and are protected from browsing in early stages – until they are out of the reach of animals.

Health of land resources addressed	
rangeland vegetation	+++
invasive alien species	++
soil loss	+++
soil resources (OM, nutrients)	+++
water resources	++
biodiversity	++
ESS addressed	
fodder production	+++
fodder quality	+++
water availability	++
stream flow	+++
food security/ self-sufficiency	++
SRM knowledge	++
conflict mitigation	++
equity (gender, disadv. group)	+
governance	+++
DRR (drought, floods, fire)	++
CC adaptation	++
C and GHG emissions	++

Benefit-cost ratio		
Inputs	short-term	long-term
Establishment	+	+++
Maintenance	+	++

Importance: +++ high, ++ medium, + low, +/– neutral, na: not available

Enclosures: rehabilitate and restore the natural resource bases (soil, vegetation and soil water) by prohibiting grazing and allowing resting and recovery.

Erosion control: prevent loss of soil due to water runoff and wind (e.g. gully stabilisation, dune stabilisation). It involves mainly vegetative and structural measures.

Soil water management: protect soil moisture by reducing evaporation losses and improving rainwater infiltration. Water harvesting by microcatchments such as planting pits and half moons.

Rangeland use system (RUS)

Reseeding and microcatchments found in 'agropastoral' and 'bounded' systems and 'small-scale settled pastures'.

Fertility improvement and enclosures are applied in 'small-scale settled pastures'.

Control of bush encroachment and invasive species is often done under 'bounded' (trees and bushes) or 'pastures' (herbaceous species) systems, where land rights are firmly regulated.

Firebreaks: 'pastoral' and 'agropastoral' systems.

Managed natural regeneration and dune fixation: in systems where crop production is integrated – 'agropastoral' and 'pastures'.

Main benefits

- Improves rangeland health. Soil and water conservation improves soil and vegetation health as a basis for improved fodder/ forage productivity.
- Increases vegetative cover and fodder production.
- Improves pasture quality (regeneration of perennial grasses, control of invasive species).
- Protects grazing lands from erosion and sand encroachment.

Main disadvantages

- High cost input of implementation.
- Susceptible to conflicts as improved green land attracts neighbours and invasion.

Applicability and adoption

Pasture and soil improvement practices are scattered throughout Sub-Saharan Africa. These systems are most common around settlements and urban centres in the Sahel and in many agricultural areas in in East and West Africa. This group of technologies is mainly applicable in more intensively managed systems. Seeding of degraded rangeland is more costly than resting for recovery and natural regeneration.

There is a strong trend towards spontaneous adoption, thanks to high effectiveness regarding increasing productivity and soil and water conservation.

Pitting to restore degraded catchment, South Africa

Rehabilitation of eroded land in the Mount Fletcher dam catchment, South Africa (Jacob Buckle).

The catchment of the Mount Fletcher dam in the Eastern Cape is affected by severe sheet and rill erosion due to overgrazing and veld (grassland) fires on the highly erodible soils resulting in severe siltation of the dam. The main purpose of pitting is to enhance infiltration of runoff water by capturing and ponding it on capped/ crusted bare soils. It is combined with brush packing (laying cut bush on the soil's surface) or mulching, and the construction of silt fences (low barriers across the slope) to further improve sediment trapping. Re-seeding in pits with commercially available grass seed mixes can enhance vegetation cover.

https://qcat.wocat.net/en/summary/3659/

Restoration of grazing land invaded by *Sida cordifolia*, Niger

The grazing areas are communal lands set aside for the animals in the rainy season, enabling the reduction of conflicts between farmers and livestock keepers. For more than two decades these areas have been invaded by *Sida cordifolia*, a species disliked by animals. A method was successfully tested that combines tillage and weeding with seeding of *Hibiscus sabdariffa*, or roselle – a plant normally used to make tea or eaten as a vegetable, but also valuable as a fodder. Because of its rapid germination, the hibiscus invades the area very quickly, and suppresses the first seedlings of the *Sida cordifolia*.

https://qcat.wocat.net/en/summary/3442/

Grazing land invaded by *Sida cordifolia* (Issaka Dan Dano).

Night corralling, Niger

The most common way of manure concentration is by corralling or tethering livestock during the night. During the day the animals are allowed to graze rangelands, fallows or crop residue fields. Corrals are moved to a new spot every 4-5 nights in order to spread manure evenly. While a 250 kg cow produces about 1 kg of manure (dry matter) per night, 7 sheep or 7 goats are needed to produce this same amount. To cover 1 hectare of land with 2.5 tons of manure, a herd of 15 cattle would need to be corralled for 3.5 months. Thus, it is recommended to organise corralling within a community of farmers and especially to revitalize the traditional corralling contracts *contrats de parcage* with transhumant herders.

https://qcat.wocat.net/en/summary/3608/

Cattle corralled on a crop field to improve soil fertility, Niger (ILRI/Stevie Mann).

Delfino plow digging micro bassins (Lindo Grandi).

Vallerani System (Burkina Faso)

DESCRIPTION

A special tractor-pulled plow that constructs micro-catchments. It combines the traditional techniques of rainwater harvesting with mechanization for large scale land rehabilitation.

The Technology mechanizes the traditional technique of zai and semi circular bunds for water harvesting using a modified plow named Delfino3s pulled by a 180hp tractor. A normal plow on flat land excavates a symmetrical, continuous furrow, and earth piles up equally on both sides of the furrow. The Delfino3s plow has a single reversible plowshare that creates an angled furrow and piles up the excavated soil in half moon shaped ridges only on the downhill side. The plowing must be done along the contour to collect and slows down run-off water as it flows downhill. The plow's blade moves in and out of the soil creating micro basins about 5 meters long, 50 cm deep, 50 cm wide and spaced 2-3 m. The ripper placed before the plow cracks up the soil to a depth of 70 cm facilitating the infiltration of water into the soil profile and the growth of deep roots. After plowing, the local population sows seeds of plants of indigenous species. They are sown along the ridges of the basins and in the furrow of the ripper. While for most species seeds are collected by the local population, for species rarely present in the region, seeds are purchased from tree nurseries. Sowing the manure of goat containing seeds has also been very successful with about 95% of all micro basin having at least one tree growing.

The intervention on a big scale, the effects of water infiltration in depth, erosion reduction and vegetation growth, boost a long lasting rehabilitation process. Each day the Delfino plow can plow up to 20 ha, digging 6.000-7.000 micro basins. The speed, the capability to plow hard, abandoned land, the effectiveness of the Delfino3s plow are its major advantages for the ecosystem rehabilitation process but require a big commitment. To make the best out of it, a great motivation and organisational work is necessary to: find great availability of land; train accurately the technicians; have well-rooted Subjects in the region. The technological aspect is just part of the recovery process, an important work with the Communities is required upstream and downstream. Communities are involved in the management process – in identifying the areas to be restored, clarifying the land uses of the affected areas, planning and implementing e.g. gathering and keeping seeds of local ecotypes, sowing, in the management of plantations and in the monitoring and evaluation of the results.

Rules for SLM are adopted and respected by all. The Technology is applied in a degraded agro-sylvo-pastoral area of the Sahel Region, in the north east of Burkina Faso with 200-500 mm of annual rainfall. The soil is sandy-loam, strongly degraded with surface crust. The population is mainly composed of semi-nomadic herders. At the beginning of the project, the NGO Reach Italia was promoting schooling; they soon realized that during the dry season most kids left school and that to avoid it they should face food security and pasture improvement. So they started applying the Vallerani System and developed the participatory approach. The vegetation growth reduces the need for fodder search and long-range transhumance which also allows children to go to school regularly. The

LOCATION

Location: Sahel Region, Burkina Faso

No. of Technology sites analysed: 10-100 sites

Comment: Since the project is going on since 2002, it is possible to see implemented sites in different stadium of rehabilitation. The plowing lines are clearly visible.

Geo-reference of selected sites
- -0.073, 14.61707
- -0.08643, 14.61319
- -0.15407, 14.52775
- -0.08555, 14.53118
- -0.13956, 14.52615
- -0.15697, 14.59569

Spread of the Technology: evenly spread over an area (approx. 100-1,000 km²)

Date of implementation: 10-50 years ago

Type of introduction

- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ✓ during experiments/ research
- ✓ through projects/ external interventions

Degraded field after plowing (Lindo Grandi).

Local people sowing indigenous trees and shrubs seeds in the tilled lines. Sowing days are important and joyful events for the communities (Lindo Grandi).

ecosystem rehabilitation effect of the technology help the communities to become more conscious and resilient to the effects of climate change and prepared to cope with the socio-economic-environmental changes they are faced with.

Comment: The Technology was introduced in the Region in an agro-sylvo-pastoral pilot project to fight against desertification by FAO in 1996-97.

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- ✓ improve production
- ✓ reduce, prevent, restore land degradation
- conserve ecosystem
- protect a watershed/ downstream areas – in combination with other Technologies
- ✓ preserve/ improve biodiversity
- ✓ reduce risk of disasters
- ✓ adapt to climate change/ extremes and its impacts
- ✓ mitigate climate change and its impacts
- ✓ create beneficial economic impact
- ✓ create beneficial social impact

Land use

Grazing land – Extensive grazing land: Semi-nomadism/ pastoralism
Intensive grazing/ fodder production: Improved pastures
Main animal species and products: Goats, cattle.

Unproductive land – Specify: Hard abandoned land.
Remarks: Especially at the beginning of the project, some communities agreed to try the system on their most unproductive land. After seeing the results, they started to request the intervention on less degraded soil and on fields that are closer to their villages.

Comment: Major land use problems (compiler's opinion): Land degradation-desertification with reduction of vegetation cover in terms of plant density and species diversity is the main problem: disappearance of grasses and trees, reduction of the size of the plants that are resistant and of the biological activity of the soil. Runoff, water and wind erosion increase. Drought and irregular precipitation have heavy consequences on soil fertility, availability of water for humans and livestock, and recharging groundwater.

Water supply

- ✓ rainfed
- mixed rainfed-irrigated
- full irrigation

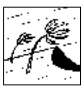
Number of growing seasons per year: 1

Purpose related to land degradation

- prevent land degradation
- ✓ reduce land degradation
- ✓ restore/ rehabilitate severely degraded land
- adapt to land degradation
- not applicable

Degradation addressed

soil erosion by water – Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying, Wo: offsite degradation effects



soil erosion by wind – Et: loss of topsoil, Eo: offsite degradation effects

Degradation addressed

chemical soil deterioration – Cn: fertility decline and reduced organic matter content (not caused by erosion)

physical soil deterioration – Pc: compaction, Pk: slaking and crusting, Pu: loss of bio-productive function due to other activities

biological degradation – Bc: reduction of vegetation cover, Bh: loss of habitats, Bq: quantity/ biomass decline, Bs: quality and species composition/ diversity decline, Bl: loss of soil life

water degradation – Ha: aridification, Hg: change in groundwater/aquifer level

Comment: Main causes of degradation: over-exploitation of vegetation for domestic use, such as wood cut for cooking, to feed livestock or as building material, overgrazing, low contribution of animal dejections that are used as cooking fuel, change of seasonal rainfall, droughts. Secondary causes of degradation: deforestation/ removal of natural vegetation (incl. forest fires), low environmental awareness and support services such as forestal or veterinary assistance.

SLM group

- agroforestry
- pastoralism and grazing land management
- water harvesting

SLM measures

agronomic measures – A1: Vegetation/ soil cover, A3: Soil surface treatment, A4: Subsurface treatment

vegetative measures – V1: Tree and shrub cover, V2: Grasses and perennial herbaceous plants

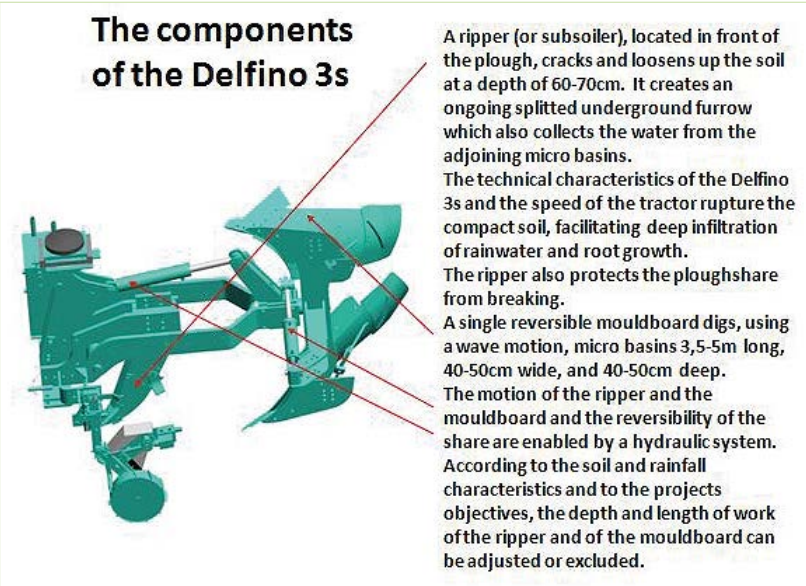
structural measures – S2: Bunds, banks, S4: Level ditches, pits

management measures – M1: Change of land use type, M2: Change of management/ intensity level, M3: Layout according to natural and human environment

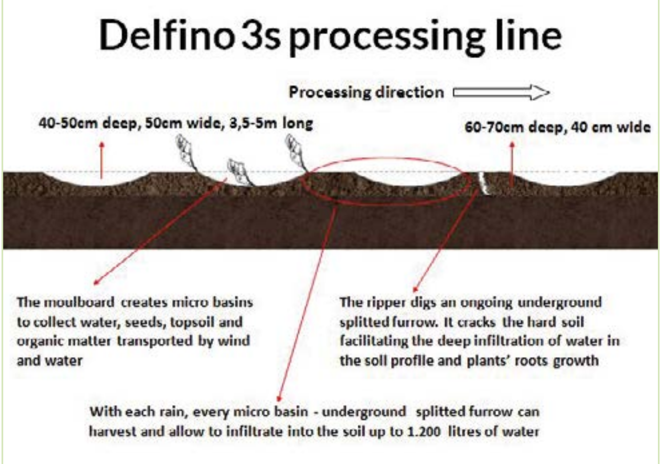
TECHNICAL DRAWING

Technical specifications

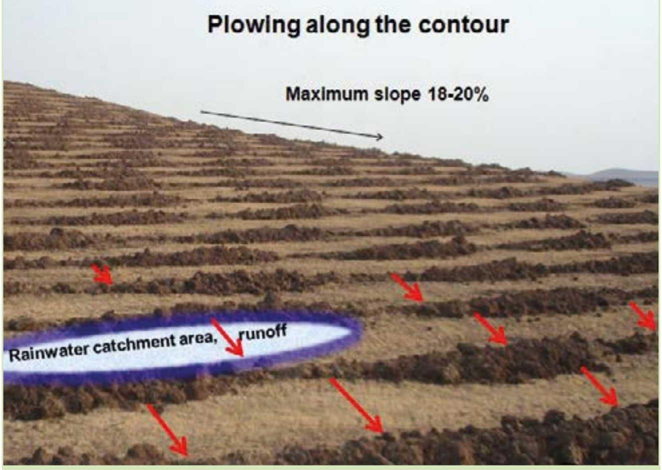
Drawing 1) A. The land chosen together with the local population is plowed with the special Delfino3s plow. The spacing between the plowed lines depend on: slope, soil and rain characteristics, purpose of the project. In average the inter-line is 4-6 m wide. B. Local people sow seeds (collected from local trees or bought if species are rare) or goat dung containing seeds (collected in the night enclosures after feeding the goats shaking trees with ripe seeds). C. The micro basins collect the rain that falls into the crescents and up to 90% of the runoff water. The water easily penetrates into the soil profile, remains available to plant roots without risk of evaporation and eventually infiltrates to the groundwater. Drawing 2) All plowing measures are adjustable. Total length of work: 4/8 m. Tractor required: 180 hp. Working speed: 4/7 km/h which correspond to 1,5/2.5 ha per hour. Weight of the plough: 1,800 kg. Drawing 3) To optimize run off harvesting and reduce water erosion, the ploughing must always be done along the contour. The bare soil between the tilled lines works as catchment area for the collection of runoff. To facilitate the execution of the plowing along the contour, nowadays there are new technologies such as laser guidance systems or GPS assistance.



Author: Patrizia Kolb.



Author: Sabina Vallerani.



Author: Sabina Vallerani.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **100 hectares**)
- Currency used for cost calculation: **US Dollars**
- Average wage cost of hired labour per day: 2.5

Most important factors affecting the costs

Upfront costs for the acquisition of the required implements are around 40,000 EUR for the plow and 75,000 EUR for the tractor. Depending on the maintenance activities, the spares and fuel costs can be reduced. Fuel, oil and spares also greatly depend from the characteristics of the soil and the purpose of the project.

Establishment activities

1. Project planning, consulting and training (Timing/ frequency: Before starting)
2. Plowing with the Delfino plow (Timing/ frequency: Dry season)
3. Seed harvesting and storage (Timing/ frequency: When seeds are ripe)
4. Missing seeds purchase in local markets or nurseries (Timing/ frequency: When seeds are ripe)
5. Direct sowing (Timing/ frequency: Dry season)

If land user bore less than 100% of costs, indicate who covered the remaining costs

The NGO REACH AFRICA which implements the project is also supported by REACH ITALIA which mainly works for fundraising. They have many different founders. After the first years, thanks to the collaboration and funding by the Swiss Association Deserto Verde Burkinabé and the good results achieved, founders are more likely to be found. The main are: different NGO's, some Italian Municipalities, a Swiss school, the Government of Burkina Faso, FAO, international cooperation agencies of Luxembourg and Belgium, a mining company and others.

Comment: The actual (2018) total cost of each implemented hectare is $170. This cost can be considerably reduced by around 22% in the case of an optimal use of the Technical Mechanization Unit, ie 800-1000 hours of work per year. This means that an operator who works with the plow Delfino has a gross investment cost which can vary according to its technical and organisational experience and by the amount of the plowed surface each year.

Maintenance activities

1. Pasture management to avoid overgrazing (Timing/ frequency: After the rain and in the dry season)
2. Vegetation growth management (Timing/ frequency: During the first 3-5 years)
3. Woodcut management (Timing/ frequency: After 4-7 years)
4. Equipment maintenance (plow, tractor) (Timing/ frequency: Daily, weekly, seasonal)

Comment: Maintenance costs of plow and tractor greatly depend from the attention and technical skills of tractor drivers and mechanics and from the diligence and frequency of the maintenance activities of the implements. No other maintenance costs are foreseen for the Technology.

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [x] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [ ] humid
- [ ] sub-humid
- [x] semi-arid
- [x] arid

Specifications on climate

Dry season from October to may, rainy season from June to September. There's a great climate variability with unexpected dry periods or areas in the rainy season. In the last years climate change effects are experienced in the region with raise in temperature, droughts and rain variability increase. Some Community claim that since the rehabilitation of big degraded areas it rains more regularly and abundant.

Name of the meteorological station: Dori, Burkina Faso.

Thermal climate class: subtropics. Average temperature 30°C.

Slope
- [x] flat (0-2%)
- [x] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landform
- [x] plateau/ plains
- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [x] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [x] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [x] very shallow (0-20 cm)
- [ ] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [ ] medium (1-3%)
- [x] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [x] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [x] medium
- [ ] poor/ none

Water quality (untreated)
- [ ] good drinking water
- [x] poor drinking water (treatment required)
- [ ] fine/ heavy (clay)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Is salinity a problem?
- [ ] yes
- [x] no

Occurrence of flooding
- [ ] yes
- [x] no

Comment: Generally the water table is lowering. Surface water is collected in ponds for livestock and household activities. Its quality deteriorates during the dry season and its quantity decreases fast.

Species diversity
- [ ] high
- [ ] medium
- [x] low

Habitat diversity
- [ ] high
- [ ] medium
- [x] low

Comment: Up to 30-50 years ago biodiversity was rich and soil coverage higher.

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [x] subsistence (self-supply)
- [ ] mixed (subsistence/ commercial
- [ ] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [x] very poor
- [x] poor
- [ ] average
- [ ] rich
- [ ] very rich

Level of mechanisation
- [x] manual work
- [ ] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [ ] sedentary
- [x] semi-nomadic
- [ ] nomadic

Individuals or groups
- [ ] individual/ household
- [x] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [x] youth
- [x] middle-aged
- [ ] elderly

Comment: During the dry season men often migrate(d) to the nearby mines or cities for off-site income. After the implementation of the Technology the need for seasonal migration reduced. Difference in gender involvement: the project involves reforestation and pasture improvement for the grazing of livestock which is a men dominated activity. Since 2010 women have sown and protected from grazing some special plants for medical and domestic use and as raw material for handcrafts. Population density: 10-50 persons/km^2. Annual population growth: 3%-4%. Off-farm income specification: The only activity people of the region are engaged in is goat and cattle breading. Crop production is practiced only for subsistence use.

Area used per household
- < 0.5 ha
- 0.5-1 ha
- 1-2 ha
- 2-5 ha
- 5-15 ha
- 15-50 ha
- ✓ 50-100 ha
- ✓ 100-500 ha
- 500-1,000 ha
- 1,000-10,000 ha
- > 10,000 ha

Scale
- ✓ small-scale
- medium-scale
- ✓ large-scale

Land ownership
- ✓ state
- company
- ✓ communal/ village
- group
- individual, not titled
- individual, titled

Land use rights
- ✓ open access (unorganized)
- ✓ communal (organized)
- leased
- individual

Water use rights
- ✓ open access (unorganized)
- ✓ communal (organized)
- leased
- individual

Comment: The Technology is applied on land that remains in use to the local population (it's mainly land owned by the State, the Region or the Municipality and given in use to the local Communities). The managed sites vary from 40 ha to 150 ha in each Village. Up to December 2017 a total of more than 25,600 ha have been managed.

Access to services and infrastructure

health	poor	✓			good
education	poor	✓			good
technical assistance	poor	✓			good
employment (e.g. off-farm)	poor	✓			good
markets	poor	✓			good
energy	poor	✓			good
roads and transport	poor	✓			good
drinking water and sanitation	poor	✓			good
financial services	poor	✓			good

IMPACTS – BENEFITS AND DISADVANTAGES

Socio-economic impacts

crop production — decreased ☐☐☐☐☐☐✓ increased

Before SLM: None
After SLM: 2-4 times
Comment: Crop production and biomass augmented 2-4 times compared with traditional cultural techniques.

fodder production — decreased ☐☐☐☐☐☐✓ increased

Before SLM: 90 kg/MS/ha
After SLM: 1,250 kg/MS/ha
Comment: Grass fodder production increased by a factor of 5–30 compared with unmanaged land. The production of herbaceous biomass varied from 420 kg to 2,090 kg (dry matter) per ha; thus, on average, 1,250 kg of herbaceous biomass (dry matter) per ha developed on sites where the Vallerani system was deployed, compared with an average of 90 kg (dry matter) per ha in control plots. Vegetation is mainly distributed inside and around the micro basins.

fodder quality — decreased ☐☐☐☐☐☐✓ increased

Before SLM: 12 floral species
After SLM: 44 floral species
Comment: The application of the Technology boosts a regeneration process increasing year by year. Compared to the surrounding control rangelands, fodder quality and biodiversity increased with a high proportion of grassland species of good forage value, such as *Panicum laetum* and *Schonefeldia gracilis*, and the return of legume species such as *Alysicarpus ovalifolius* and *Zornia glochidiata* also testify the improvement of the quality of the reconstituted pastures.

animal production — decreased ☐☐☐☐☐☐✓ increased

Comment: The increase of fodder quantity and quality represents a surplus of 22–106 grazing days per tropical cattle unit per hectare. This extra fodder supply reduces the need to make long-range transhumance or cut shrubs to meet livestock needs for fodder, even in years where pasture is low. Livestock is fed with more and better quality fodder so its productivity and market price increase.

wood production — decreased ☐☐☐☐☐✓☐ increased

forest/ woodland quality — decreased ☐☐☐☐☐☐✓ increased

Before SLM: 20 trees/ha of 6 species
After SLM: 700 trees/ha of 14 species
Comment: Significant improvement in forest cover (700 live trees and shrubbs per ha, on average) and biodiversity: trees are capable of spontaneous growth even with open access to grazing and in years of high water stress.

non-wood forest production	decreased ☐☐☐☐☐✓☐ increased	**Comment:** Berries, gum arabica, resins, fruits.
risk of production failure	increased ☐☐☐☐☐✓☐ decreased	**Comment:** The increased fodder quantity, quality and biodiversity, the deep root system of the sown plants, increase resilience of the ecosystem and reduce the risk of production failure. The increased biodiversity, soil moisture and fertility increase the resilience of plants to attacks by pests, diseases and drought. Even in the case of severe drought, there are some plants that can be used as 'emergency food' by humans and animals.
product diversity	decreased ☐☐☐☐✓☐☐ increased	**Comment:** The implementation of the Technology gives the opportunity to diversify the production. Next to animal breeding, agriculture has intensified and in some villages the production of handicrafts, food processing, hunting and tourism activities are developing. Berries, gum arabica, resins, fruits enrich the family diet or can be sold at markets. Wild animals, insects, reptiles and birds have returned after decades and greatly increased.
production area (new land under cultivation/ use)	decreased ☐☐☐☐☐☐✓ increased	**Before SLM:** None **After SLM:** 25,600 ha **Comment:** By the end of 2017 about 25,600 hectares of severely degraded, abandoned land has been rehabilitated.
drinking water availability	decreased ☐☐☐☐✓☐☐ increased	**Comment:** Local people attest that the rehabilitation of large areas of bare soil augmented the local rain amount and the water level in the wells.
water availability for livestock	decreased ☐☐☐☐☐✓☐ increased	**Comment:** The rain collected in the micro basins is available for livestock during the rainy season. The augmented rainfall also increases water availability in boulies (ponds).
demand for irrigation water	decreased ☐☐☐✓☐☐☐ increased	**Comment:** No water is needed for the Technology except for rain.
expenses on agricultural inputs	decreased ☐☐☐✓☐☐☐ increased	**Comment:** The implementation cost of the technology is not entirely sustainable by Communities. donors and founders sustain the project. Large-scale application reduces the cost per hectare and increases the impact of actions in reversing the degradation–desertification trend. The cost of each plowed hectare.
farm income	decreased ☐☐☐☐☐✓☐ increased	**Comment:** Fodder increase in quality and quantity, improve animal health and productivity as well as their market price.
diversity of income sources	increased ☐☐☐☐☐✓☐ decreased	**Comment:** The Technology increases income for herders and their families also thanks to diversification. More land is also used for agriculture. Selling or transformation of other products such as berries, fruits, gums, resins; hunting; new job opportunities in disadvantaged areas such as tractor drivers, social promoters, seed collectors. The community raises awareness and a potential for small business activities occurs, mainly among women.
economic disparities	decreased ☐☐☐☐☐✓☐ increased	**Comment:** Disadvantaged groups such as women start new economic activities such as mat production and sale at markets, medical plants and food production. They diversify their income and improve their status in the community.
workload	increased ☐☐☐☐☐☐✓ decreased	**Before SLM:** 5 micro basins/day **After SLM:** 6,000 micro basins/day **Comment:** Each man can dig 5 micro basins per day doing a heavy work. The plow can dig 6,000-7,000 micro basins per day. As most rangelands, the area of the project has a low human density (29 inhabitants/km^2) so people are responsible for seed collection and storage, sowing, the livestock management during the first growing phase, monitoring activities, a.s.o.
migration	reduced ☐✓☐☐☐☐☐ increased	**Comment:** Increased and improved fodder availability reduces the need for long-range transhumance and seasonal or definitive migration to areas with more work opportunities (e.g. mines), cities or other countries.

Socio-cultural impacts

food security/ self-sufficiency	reduced ☐☐☐☐☐✓☐ improved	**Comment:** Food security improves with increased and diversified productivity and income. The increased fodder and crop quantity, quality and biodiversity, the deep root system and soil fertility, increase the resilience of the whole ecosystem. Even in the case of severe drought, there are some plants that can be used as 'emergency food' by humans and animals.

health situation	worsened	□□□□□✓□	improved	**Comment:** Improved health especially due to better nutrition also for disadvantaged groups such as children and old people: bigger amounts, diversification, milk, vegetables. The reduction of dust storms also improves the health situation.
land use/ water rights	worsened	□□□□□✓□	improved	**Comment:** Awareness rising and discussion of the theme are essential. Due to the great productivity of former degraded and often abandoned land, land use rules and water rights are clearly discussed and defined at the beginning of the project. Rules for SLM are adopted and respected by all; for example, it is forbidden to install camps in or near restored areas, to cut trees, and to mow for commercial purposes.
recreational opportunities	reduced	□□□□✓□□	improved	**Comment:** Shadow, green areas near the villages increase recreational opportunities.
community institutions	weakened	□□□□□✓□	strengthened	**Comment:** It is essential to involve and give responsibility to local people in every step of the process. Comities and groups such as the women or seniors groups gain relevance and become essential for the sustainability of the project.
national institutions	weakened	□□□□✓□□	strengthened	**Comment:** Collaborations with national institutions such as forestry direction, ministry of environment and agriculture, research institutes, etc.
SLM/ land degradation knowledge	reduced	□□□□□✓□	improved	**Comment:** All communities are involved in the management process – identifying the areas and the use of the sites to be restored, planning, and implementing (e.g. gathering and keeping seeds of local ecotypes, manure and sowing). Local villages are involved in the care and defence of new plantations and in the monitoring and evaluation of the results of vegetation growth. Ultimately they become responsible for the sustainable management of the whole area.
conflict mitigation	worsened	□□□□✓□□	improved	**Comment:** If land use and water rights are clearly defined, the increased availability of fodder reduces conflicts with neighbours and farmers.
situation of socially and economically disadvantaged groups (gender, age, status, ethnicity etc.)	worsened	□□□□□✓□	improved	
community well being	worsened	□□□□□✓□	improved	**Comment:** People have more confidence in the future, dignity and hope. The Community cohesion and identity is strengthened and the community becomes more resilient to conflicts and disasters.

Ecological impacts

water quantity	decreased	□□□□□✓□	increased	**Before SLM:** None **After SLM:** 360,000 l/ha **Comment:** With each rain, each micro basin can collect up to 1,200 litre of water. Each hectare collects an average of 360,000 litre of rain, runoff included. Collected in the micro basin, the water has enough time to infiltrate in the soil profile and eventually in the water table. Local people assert that after the implementation of the Technology, the water level in the wells has raised.
harvesting/ collection of water (runoff, dew, snow, etc.)	reduced	□□□□□□✓	improved	**Comment:** The Technology allows to harvest 100% of the rain falling in the micro basin and on the ripped furrow as well as up to 90% of the rain falling between the tilled lines. The bare soil between the tilled lines is essential as catchment area, to receive rainfall and process runoff downstream. The micro basins collect up to 95% of rainfall.
surface runoff	increased	□□□□□□✓	decreased	**Before SLM:** 5-15% **After SLM:** 90% **Comment:** Plowing is done along the contour. This is essential to collect the runoff that flows between the tilled lines (catchment area). The distance between the lines can be between 4 m and 12 m depending from: slope, rain characteristics (quantity, intensity), soil type, surface roughness (runoff coefficient), the purpose of the project (type of plants desired). The technology allows to collect up to 90% of the runoff.

groundwater table/ aquifer	lowered	□□□□✓□□	recharged	**Comment:** Local people assert that after the implementation of the technology, the water level in the wells has raised.
evaporation	increased	□□□□□□✓	decreased	**Comment:** The rain collected in the micro basins infiltrates in the soil profile being accessible for seeds and roots without evaporating. After the first rains, the micro basins are quickly covered with high grasses that contribute to reduce evaporation.
soil moisture	decreased	□□□□□✓□	increased	**Comment:** Improved soil hydrodynamic properties: the relative size of capillaries by different soil levels increased and the soil water-retaining capability improved.
soil cover	reduced	□□□□□✓□	improved	
soil loss	increased	□□□□□✓□	decreased	**Comment:** Reduced soil loss through runoff reduction and wind erosion.
soil compaction	increased	□□□□□□✓	reduced	**Before SLM:** 423 **After SLM:** 70 **Comment:** At different depth soil compactness reduces from 6 (0 to 20 cm) to 1.3 times (40 to 60 cm)
nutrient cycling/ recharge	decreased	□□□□□✓□	increased	
soil organic matter/ below ground C	decreased	□□□□□✓□	increased	
vegetation cover	decreased	□□□□□✓□	increased	**Comment:** Vegetation cover increase 5 to 30 times. Vegetation grows mainly inside and around the micro basins.
biomass/ above ground C	decreased	□□□□□□✓	increased	**Before SLM:** 70 to 110 kg/MS/ha **After SLM:** 420 to 2,090 kg/MS/ha **Comment:** The biomass production increases 5 to 30 times compared to the nearby unplowed soil. On implemented sites, biomass varies from 420 to 2,090 kg/ DM/ ha, on average between 1,000 and 1,200 kg / ha against 70 to 110 kg / DM / ha on control plots.
plant diversity	decreased	□□□□□□✓	increased	**Before SLM:** 14 herbaceous, 6 woody species/ha **After SLM:** 44 herbaceous, 14 woody species/ha **Comment:** Floral diversity increases from 14 to 44 species. With a high proportion of graminaceous species of good forage value and the return of more leguminous species. Concerning the diversity of woody plants the results show an average per hectare of 14 species on implemented sites and an average of 6 species on control plots.
animal diversity	decreased	□□□□□✓□	increased	**Comment:** A great increase of animal biodiversity: insects, birds, reptiles and mammals (such as squirrel, jackals, gazelle...) are observed in the implemented sites.
pest/ disease control	decreased	□□□□□✓□	increased	**Comment:** The increased vegetal and animal biodiversity, deep root system, soil fertility and water availability, increase the health and resilience capacity of the whole ecosystem.
flood impacts	increased	□□□□□✓□	decreased	**Comment:** Through water harvesting the rain is retained in the precipitation area and flood risk decreases. If flood occurs in the plowed area before the vegetation is well established, the micro basins can be washed out.
drought impacts	increased	□□□□□✓□	decreased	**Comment:** Increased biodiversity, vegetation cover and soil fertility, deep root system and water storage in the soil profile, increase the resilience to drought of the whole ecosystem. During the project, in years of extreme drought, plants have reduced their growth but most of them survived, were used to feed animals and started growing again in the following rainy season.
emission of carbon and greenhouse gases	increased	□□□□✓□□	decreased	**Comment:** Minimal production of carbon dioxide compared with the potential gain.
fire risk	increased	□□□□✓□□	decreased	**Comment:** The implementing area remains open to lifestock (regulated pasture) to reduce the high production of grass that could favour the spread of a fire, herders also monitor the territory. There is a high level of community involvement and a growing ecological awareness.
wind velocity	increased	□□□□✓□□	decreased	**Comment:** The great number of growing trees reduce the wind speed.
micro-climate	worsened	□□□□□✓□	improved	**Comment:** Local people attest that the Technology locally increased the amount of rain and reduced dust storms in number and intensity.

Off-site impacts

water availability (groundwater, springs)	decreased						✓		decreased	**Comment:** Local people tell that the rehabilitation of large areas of bare soil augmented the local rain amount and the water level in the wells.
wind transported sediments	increased						✓		reduced	**Comment:** Wind intensity and dust storms reduction thanks to soil coverage and wind brake effect by trees and shrubs.

Benefits compared with establishment costs

Short-term returns	very negative						✓		very positive
Long-term returns	very negative							✓	very positive

Benefits compared with maintenance costs

Short-term returns	very negative						✓		very positive
Long-term returns	very negative							✓	very positive

Comment: The system includes the use of a heavy duty tractor and a special plow whose costs are high though difficult to sustain by the local population. Most financial costs are covered by founders and donors, the land user's participate to the project with their work so even if the benefits in the short term are fewer than in the mid and long-term, for them it is still very positive.

CLIMATE CHANGE

Climate change/ extreme to which the Technology is exposed

How the Technology copes with these changes/ extremes

Gradual climate change

annual temperature increase	not well at all					✓	very well	
seasonal temperature increase	not well at all					✓	very well	Season: dry season
annual rainfall decrease	not well at all				✓		very well	
seasonal rainfall decrease	not well at all				✓		very well	Season: wet/ rainy season

Climate-related extremes (disasters)

local rainstorm	not well at all			✓			very well
local sandstorm/ duststorm	not well at all					✓	very well
local windstorm	not well at all					✓	very well
flash flood	not well at all		✓				very well
insect/ worm infestation	not well at all				✓		very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ☐ single cases/ experimental
- ☐ 1-10%
- ✓ 10-50%
- ☐ more than 50%

Number of households and/ or area covered

330 villages and around 33,000 beneficiaries.

Of all those who have adopted the Technology, how many have did so without receiving material incentives?

- ☐ 0-10%
- ☐ 10-50%
- ✓ 50-90%
- ☐ 90-100%

Comment: Except for plowing, the other activities part of the Technology are practicable by the population under an initial guidance of a promoter with specific training. These are done without any material incentives/payments. The technology is well known in the Region and there is an active participation of the local people and a strong demand for new interventions.

Has the Technology been modified recently to adapt to changing conditions?

- ✓ yes
- ☐ no

To which changing conditions?

- ☐ climatic change/ extremes
- ☐ changing markets
- ☐ labour availability (e.g. due to migration)
- ✓ technical

Comment: The design of the plow has been adapted to increase the performance of the implement and reduce the running costs of plowing. The reversibility of the plowshare reduces the need for empty rides. The different parts of the plow are adjustable to adapt it to the needs of the project and the soil characteristics.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Strengths

Land user's view

- Highly degraded, abandoned land becomes fertile and rentable again. Fodder increases in quantity and improves in quality and lasts all year round. Food security also in drought years. Herds are healthier and more productive. Fodder and water availability for animals is closer to the villages. Some plants can be sown for different uses: crops, medicine or for the production of mats or other handcrafts products that can be sold.
- Better life conditions, more income opportunities and diversification. Food is diversified and more nutritious. Less hunger and diseases.
- Greater community cohesion and less migration, better environmental consciousness and commitment, education and security. People gain back dignity, confidence in the future and hope.

Key resource person's view

- The Technology allows the rehabilitation of rangeland and highly degraded areas in a fast and natural way on a large scale. This can boost a longlasting effect and the shift of the whole ecosystem. The Technology confers drought resilience and reduces the effects of climate change. It allows the sequestration of CO_2 and can contribute to achieve the Land Degradation Neutrality Goals.
- The participatory approach is essential for the sustainability of the project. The local Communities improve their life quality, awareness, cohesion and resilience. The need for migration is reduced and people has the chance to stay in their Lands.
- The sown tree and shrub species are mainly indigenous and locally adapted species. Each specie can follow it's own growing laws and adaptation strategies. Through the tillage process the technology offers the highest degree of efficiency in the first years from processing. Its effects last for a long time so it does not need to be repeated on the same site.
- The VS does not use any water (except rain) in countries where water is rare and precious.
- The use of a mechanized implement allows to rehabilitate very hard, degraded and abandoned land on large areas with reduced population. As the Delfino3s can plow strongly degraded land, the local people often ask to work their worse land which they would never be able to use.

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view

- Land that was unproductive and nobody claimed becomes productive: it can lead to misunderstandings and conflicts. → Land use and production exploitation rules must be cleared and accepted by all Subjects at the beginning of the project.
- Good pasture attracts animals and herders from the nearby Region (also from far away and abroad). → Rules must be clear.

Key resource person's view

- The investment and running costs for the machinery are high and cannot be covered by single land users or small Communities. → The projects must be financed by donors or founders. The Community can participate to some extent to cover the running costs.
- The speed and effectiveness of the Delfino3s plow are its major advantages in the ecosystem rehabilitation process but can also be its major limitation. To make the best out of it, it is necessary to have a great availability of land (1,000-1,800 ha) every year. → A big organisational capacity is needed. The spreading 'like wildfire' that has characterized the case study was possible by the presence on the territory of an NGO already active and rooted in the territory for many years and by perseverance, respect and competence of all involved subjects.
- Since great extensions will be processed, a big organisation is needed for all connected activities (awareness raising, seed collection and stockage, training, logistics, etc.), → Must be well organized and should operate already before starting with plowing.
- The professional level of the tractor drivers and the mechanics as well as the lack of a well-organized mechanical workshop and spares stock can lead to long interruptions of the work and high extra costs. → Professional technical trainings and monitoring are very important. The organisation of a well managed mechanical workshop and spares stock are essential. This can also be a great development opportunity for the Region.
- The increased amount of fodder can induce the shepherds to increase the number of animals. → An important work with the Communities is essential to achieve shared and sustainable management goals.

REFERENCES

Compiler: Sabina Galli Vallerani (valleranisystem@gmail.com)

Resource persons: Sabina Galli Vallerani - SLM specialist; Allain Long - land user; Grandi Lindo - SLM specialist; Amadou Boureima - land user

Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/technologies/view/technologies_1528/

Linked SLM data: SLM Approach: Video: https://player.vimeo.com/video/95412178

Video: https://player.vimeo.com/video/95412178

Documentation was facilitated by: Institution: Reach Africa (Reach Africa); Reach Italia (Reach Italia) - Italy. Book project: Water Harvesting – Guidelines to Good Practice (Water Harvesting)

Date of documentation: May 3, 2012; **Last update:** July 16, 2018

Key references

Un 'delfino' rinverdisce i deserti, Venanzio Vallerani, ISBN 978-88-95858-05-0: info@vallerani.com

Links to relevant information which is available online

Récupération des sols fortement dégradés à des fins sylvo-pastorales, CILSS 2009: http://www.vallerani.com/wp/wp-content/uploads/2013/06/Rapport-Reach-Cills-2009.pdf

GIZ, Good practices in soil and water conservation, pag. 22 seg.: https://www.giz.de/fachexpertise/downloads/giz2012-en-soil-water-conservation.pdf

Using Mechanized Water Harvesting System (The Vallerani System) for Rehabilitation of Degraded ASALs in Kenya: http://www.vallerani.com/wp/wpcontent/uploads/2015/06/Meshack-Muga-Paper-25-Final.pdf

Report for the Sino-Italian cooperation project, SFA, China: http://www.vallerani.com/wp/wp-content/uploads/2013/06/Report_in_English-10.pdf

Global guidelines for the restoration of degraded forests and landscapes in drylands FAO, pag. 104 seg.: http://www.fao.org/3/a-i5036e.pdf

Improved rainwater harvesting for fodder shrub production and livestock grazing: the Vallerani micro-catchment system in the Badia of Jordan: http://www.fao.org/family-farming/detail/en/c/1040697/

Conedera, M., N. Bomio-Pacciorini, et al. 2010. Reconstitution des écosystèmes dégradés sahéliens. Bois et Forêts des Tropiques 304(2). Bois et Forêts des Tropiques 304(2). Bois et Forêts des Tropiques: http://www.vallerani.com/images/Reconstitution.pdf

Operational firebreak (Abdoulahi Ousseini, Journal Sahel Dimanche, February 2015).

Firebreaks (Niger)

DESCRIPTION

Firebreaks are strips from which dry vegetation – straw – is removed in order to stop the progression of fire into the large areas of grazing land. They are of paramount importance for protecting and securing available grazing.

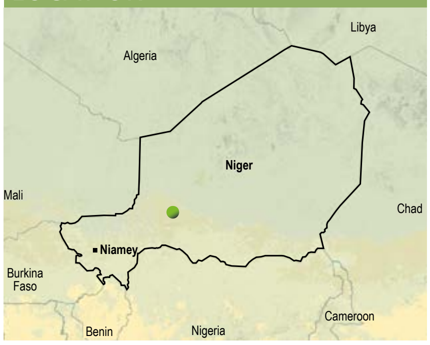
In Niger, firebreaks are constructed in pastoral and agropastoral zones, which are characterized by abundant grazing after the rainy season – but also by a high risk of bush fires. Every year, at the end of the rainy season, thousands of hectares of grazing land go up in smoke due to bush-fires. This causes enormous losses of fodder, which is essential for the survival of livestock in this Sahelian region which has lacked adequate grazing over the last decades.

Firebreaks, as their name indicates, are strips of land set-up perpendicular to the dominant wind direction. They are between 20 and 30 m in width and spaced 3 to 4 km apart – according to the national standards in Niger. Along these strips, which can exceed 10 km in length in the pastoral zones, dried vegetation is removed. This creates firebreaks which stop the progression of fires into the large areas of grazing, thereby protecting and securing fodder supplies. In general, firebreaks are implemented according to a 'cash for work' approach, with the aim of supporting the local economy and strengthening the resilience of the population, and of the livestock, during the lean season. Three specific objectives are set for this technology in Niger: (i) the clearance of the firebreaks is part of the annual plan for preliminary support to the populations experiencing food insecurity. These plans are implemented by the National Mechanism for the Prevention and Management of Disasters and Food Crises (DNPGCCA).

The main activity in the implementation and maintenance of the firebreaks is weeding with local tools (Hilaire, daba, machete) and the collection and storage of the cut straw. These activities require a large number of laborers (men and women). The main advantages of the technology are low implementation costs, ease of scaling-up, contribution to efficient management of the fodder resources, and a contribution to the training/ mobilization/ organisation of the pastoralist populations. Finally, it fosters efficient spatial planning of the grazing areas. The direct impacts are reduction of bushfires, improved protection of grazing areas, and an increase in the income of the local people. The indirect impacts consist of the increased financial resources of the land users, and the impacts of the measures for the prevention, and management, of disasters and food crises.

This technology, while combating bushfires and fostering the increase of incomes, contributes to improved livelihoods of livestock keepers and to sustainable land management. However, the systematic commercialization of the cut straw may reduce the potential for regeneration of the vegetation cover in the grazing areas, and may cause conflicts between the traders of straw and the land users. This technology, while combating bushfires and fostering the increase of incomes, contributes to improved livelihoods of livestock keepers and to sustainable land management. However, the systematic commercialization of the cut straw may reduce the potential for regeneration of the vegetation cover in the grazing areas, and may cause conflicts between the traders of straw and the land users.

LOCATION



Location: Grazing area of Ameidida (40 km southwest of Abalak), Urban municipality of Abalak, Department of Abalak, Region of Tahoua, Niger

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 6.0886, 15.4679

Spread of the Technology: evenly spread over an area (approx. 1-10 km²)

Date of implementation: 2016

Type of introduction
- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ☑ through projects/ external interventions

Comment: The project concerned is a micro-project, financed by the Food Crisis Unit (CCA/the Prime Minister's Office), in the framework of the Annual Plan to Support Vulnerable Populations. The CCA/ Prime Minister's Office is an institution of the DNPGCCA.

Firebreak in Ameidida (Abalak, Tahoua, Niger) (Abdoulaye Mahamane).

Young men and women clearing a firebreak. The straw that is removed is piled up on the sides of the firebreak (PAAPSSP).

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- ☐ improve production
- ✓ reduce, prevent, restore land degradation
- ✓ conserve ecosystem
- ☐ protect a watershed/ downstream areas – in combination with other Technologies
- ✓ preserve/ improve biodiversity
- ✓ reduce risk of disasters
- ☐ adapt to climate change/ extremes and its impacts
- ☐ mitigate climate change and its impacts
- ✓ create beneficial economic impact
- ✓ create beneficial social impact

Comment: The clearance of the firebreaks is part of the annual plan for preliminary support to the populations experiencing food insecurity. It is an instrument to distribute income and food supplies to people through the work accomplished under the "High-Intensity Labour" (HIMO) initiative through the approach of "work for food supplies and/or cash". (ii) Selling of the straw was developed to enable people on the one hand to increase their financial resources, and on the other hand to implement strategies for storage and optimal use of the fodder resources. (iii) The firebreaks provide the opportunity to ensure information and awareness-raising of the people about sustainable land management. This includes the training of fire guards and livestock keepers in sustainable management of fodder resources, and spatial planning of the grazing areas, with the aim of securing the movement of transhumant herds.

Land use

Grazing land – Extensive grazing land: Nomadism, Semi-nomadism/ pastoralism
Main animal species and products: In the pastoral zone of Abalak, the main animal breeds are cattle, camels, sheep, goats, mules and horses. The latter (horses) are becoming increasingly rare. Mules are mainly kept by Peulh (Bororo) and by some Tuareg.

Mixed (crops/ grazing/ trees), incl. agroforestry -Agro-silvopastoralism
Main products/ services: A small number of livestock keepers practice rainfed agriculture by producing sorghum and millet. In the lower parts of the landscape, several livestock keepers practice horticulture by producing vegetables (tomatoes, lettuce), potatoes and various fruits (mango, lemon, etc.). Over the past twenty years, irrigated agriculture has seen a spectacular development due to the implementation of adaptation strategies for climate change.

Water supply

- ☐ rainfed
- ✓ mixed rainfed-irrigated
- ☐ full irrigation

Number of growing seasons per year: 1
Land use before implementation of the Technology: The land use has not changed due to the implementation of the technology.
Livestock density: The livestock numbers (in tropical livestock units) are between 200,000 and 300,000 over the five last years, which is high considering the overall area and the human population dependent on them.

Purpose related to land degradation

- ☑ prevent land degradation
- ☐ reduce land degradation
- ☐ restore/ rehabilitate severely degraded land
- ☐ adapt to land degradation
- ☐ not applicable

Comment: The firebreaks contribute firstly to preventing effects from bush fires on the available grazing land, by mobilizing the local populations in regular activities of surveillance, monitoring and control of the bush fires in the grazing areas, and in imposing penalties to those responsible for the bush fires. Secondly, in case of bush fires, the effects for grazing are limited; the firebreaks therefore reduce the land degradation which would result from these bush fires.

Degradation addressed

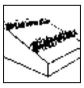
biological degradation – Bc: reduction of vegetation cover, Bq: quantity/ biomass decline, Bf: detrimental effects of fires

Comment: The firebreaks contribute to limit the effects of bush fires on the vegetation cover and the biomass.

SLM group

- pastoralism and grazing land management
- protection and securing grazing land

SLM measures

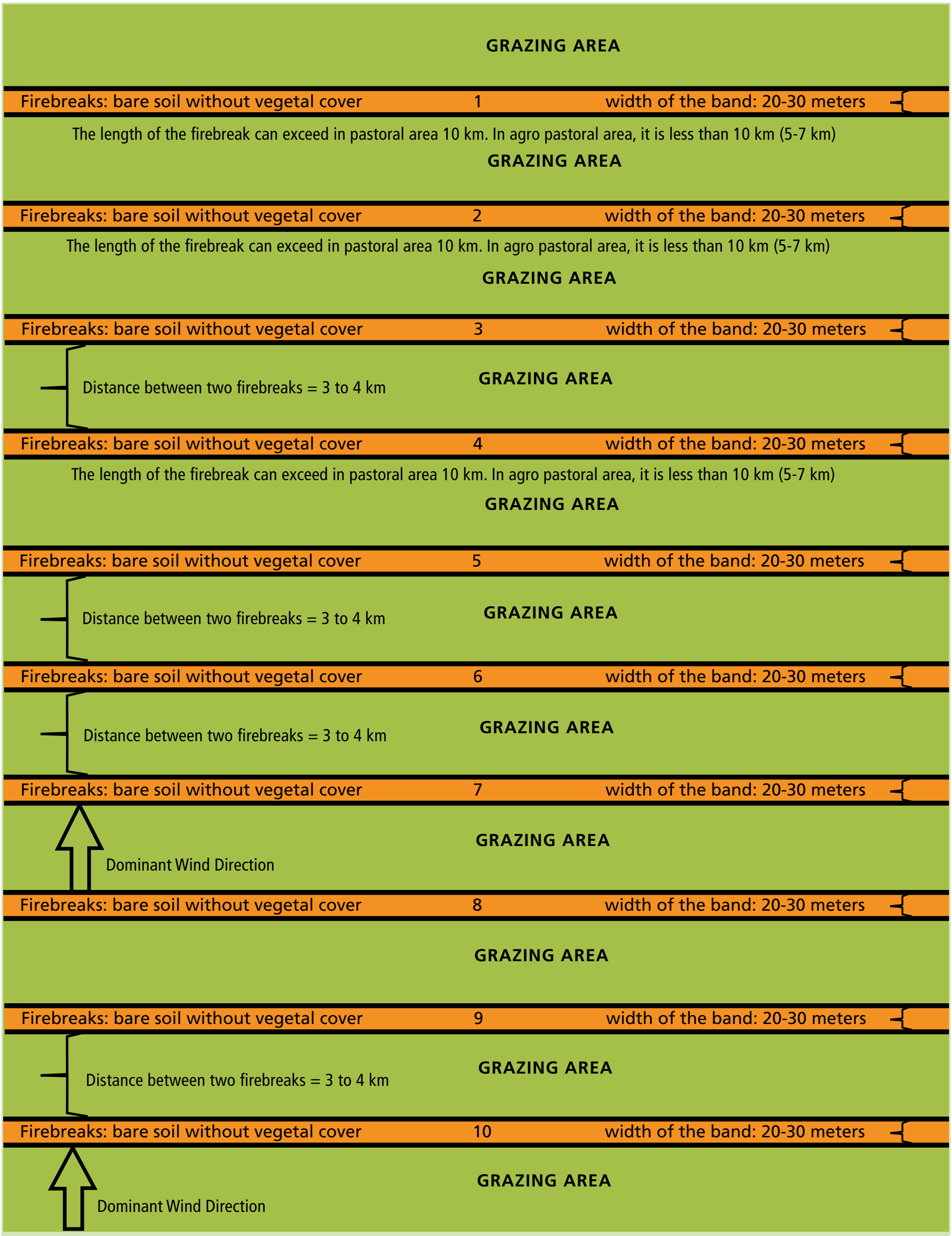


vegetative measures – V3: Clearing of vegetation

TECHNICAL DRAWING

Technical specifications

Each firebreak has a width of between 20 m and 30 m, a length of 10 km (in this case for the pastoral zone), and a spacing of 3 km to 4 km between them. The firebreaks are perpendicular to the dominant wind direction, which is from east to west in Niger. In the agro-pastoral zones, the length of the firebreaks is below 10 km.



Author: Abdoulaye Sambo Soumaila.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **3 km²**)
- Currency used for cost calculation: **West African CFA franc**
- Exchange rate (to USD): 1 USD = 500.00 West African CFA franc
- Average wage cost of hired labour per day: 1,300 CFA francs

Most important factors affecting the costs

The most important factor affecting the costs of the technology is unskilled labour; this technology requires a large amount of labour, both for the implementation and for the maintenance.

Establishment activities

1. Information/ awareness-raising/ mobilization of the local populations (Timing/ frequency: At the start of the project, after the harvest and the clearing of the fields in the agro-pastoral zone. In the pastoral zone, this activity is after the end of the rainy season.)
2. Planning workshop to identify the direct beneficiaries (Timing/ frequency: After the campaign of information/ awareness- raising/ mobilization of the local populations, during one day.)
3. Training of fire guards (Timing/ frequency: After the identification of direct beneficiaries, over three days.)
4. Laying-out of the firebreaks (Timing/ frequency: After the rainy season and following the training of fire guards.)
5. Weeding (Timing/ frequency: After the laying-out the firebreaks.)
6. Collection, transport and storage of the straw (Timing/ frequency: At the same time as weeding of the outlined strips.)
7. Selling of the straw on the markets (Timing/ frequency: During the lean season (March-June).)
8. Monitoring and evaluation (Timing/ frequency: During the period of implementation of the technology, and after the end of the project.)

Comment: The main activities in the implementation of the firebreaks are the weeding, the collection and the storage of the straw. In some cases, the straw is distributed between the livestock keepers (direct beneficiaries), who use it for their livestock. Monitoring and evaluation are carried out by the local contracting NGO, the technical departmental services, and by members of the sub-regional committee for the prevention and management of food crises (agriculture, livestock keeping, environment).

Establishment inputs and costs (per 3 km²)

Specify input	Unit	Quantity	Costs per Unit (West African CFA franc)	Total costs per input (West African CFA franc	% of costs borne by land users
Labour					
Labour provided by direct beneficiaries of 'cash for work'	person days	100	50,000.00	5,000,000.00	
Technical trainers	person days	2	50,000.00	100,000.00	
Technical surveyors	person days	180	13,000.00	234,000.00	
Supervision-monitoring	person days	24	10,000.00	240,000.00	
Equipment					
Information/awareness-raising	person days	6	10,000.00	6,000.00	
Drivers	person days	16	7,000.00	112,000.00	
Supervisors	person days	4	5,000.00	200,000.00	
Monitoring by the Chairman/Sub-regional Committee/ Programme for the Management of Disasters and Food crises, and by the municipality	person days	4	25,000.00	100,000.00	
Tools for weeding (scythes, rakes, machetes, 'daba', shovels)	km	100	13,475.00	1,347,500.00	
Mule/ oxen carts	number	10	20,000.00	200,000.00	100
Other					
Fuel	litre	1350	540.00	729,000.00	
Support for trainees	person-days	15	6,500.00	97,500.00	
Administrative costs	fixed price (5%)	1	411,000.00	411,000.00	
Total costs for establishment of the Technology				**8,831,000.00**	

Comment: The mule and oxen carts for the transport of the straw were provided by the local populations. In the cost assessment, the 20,000 CFA francs represent the rental cost for each cart. The firebreaks are implemented in the framework of the annual plans to support vulnerable populations in all regions of Niger. They are realized with the approach 'cash for work' after the rainy season. In a few cases, the firebreaks are cleared during the rainy season. This is not according to the national standards and does not fit in the framework of sustainable land management. Ultimately, all costs are covered by the Food Crisis Unit, except for the costs for the use of mule and oxen carts, which are owned by the direct beneficiaries.

Maintenance activities

1. Weeding (Timing/ frequency: Once a year after the rainy season)
2. Collection and storage of the straw (Timing/ frequency: Once a year after the rainy season)
3. Selling of the straw (Timing/ frequency: Continuously during the lean season)

Comment: The maintenance activities consist of weeding the strips after each rainy season. This activity should be continuously performed during the entire period of high fire risk in the agro-pastoral and pastoral zones (October-February).

Specify input	Unit	Quantity	Cost per unit	Total cost per input FCFA	% of costs borne by land users
Labour					
Unskilled labour	meeting	100	5,000.00	500,000.00	100
Fire guards	harrowing	150	1,300.00	195,000.00	100
Other					
Small equipment (rakes, scythes, pitchforks, etc.)	km	100	1,347.50	134,750.00	100
Mule/oxen carts	number	10	20,000.00	200,000.00	100
Total costs for establishment of the Technology				**1,029,750.00**	

Comment: The maintenance costs are covered by the local populations, who ensure their own compensation by selling the straw. The success of the maintenance is highly dependent on the income that is generated with the sale of the straw. Therefore, the livestock keepers organize themselves to maintain the firebreaks, which are used as corridors and rest areas in the majority of cases. These costs are calculated for each unit of 3 km^2.

NATURAL ENVIRONMENT

Average annual rainfall

- ✓ < 250 mm
- ✓ 251-500 mm
- 501-750 mm
- 751-1,000 mm
- 1,001-1,500 mm
- 1,501-2,000 mm
- 2,001-3,000 mm
- 3,001-4,000 mm
- > 4,000 mm

Agro-climatic zone

- humid
- sub-humid
- ✓ semi-arid
- arid

Specifications on climate

Average annual rainfall in mm: 299.0

This region has a Sahelo-Saharan climate, and is experiencing the effects of climate change.

Name of the meteorological station: Abalak prefecture

The site of Ameidida is located in the macro-agro-ecological zone of Azouagh.

Slope

- ✓ flat (0-2%)
- gentle (3-5%)
- moderate (6-10%)
- rolling (11-15%)
- hilly (16-30%)
- steep (31-60%)
- very steep (>60%)

Landform

- ✓ plateau/ plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

Altitude

- ✓ 0-100 m a.s.l.
- 101-500 m a.s.l.
- 501-1,000 m a.s.l.
- 1,001-1,500 m a.s.l.
- 1,501-2,000 m a.s.l.
- 2,001-2,500 m a.s.l.
- 2,501-3,000 m a.s.l.
- 3,001-4,000 m a.s.l.
- > 4,000 m a.s.l.

Technology is applied in

- convex situations
- concave situations
- ✓ not relevant

Comment: The firebreaks are constructed in the grazing areas, generally on flat or gently sloping terrain. These regions consist of plateaus/glacis, plains and valleys. Several sand dunes have formed over the last four decades.

Soil depth

- very shallow (0-20 cm)
- ✓ shallow (21-50 cm)
- moderately deep (51-80 cm)
- deep (81-120 cm)
- very deep (> 120 cm)

Soil texture (topsoil)

- ✓ coarse/ light (sandy)
- ✓ medium (loamy, silty)
- fine/ heavy (clay)

Soil texture (> 20 cm below surface)

- ✓ coarse/ light (sandy)
- ✓ medium (loamy, silty)
- fine/ heavy (clay)

Topsoil organic matter content

- high (>3%)
- ✓ medium (1-3%)
- low (<1%)

Comment: There are two main soil types: (i) sandy soils and sandy-loam soils in the dune formations, and (ii) clay soils and loamy clay soils in the valleys and depressions. On the hillslopes glacis and stony soils are found.

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [x] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [x] medium
- [ ] poor/ none

Water quality (untreated)
- [ ] good drinking water
- [x] poor drinking water (treatment required)
- [ ] fine/ heavy (clay)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Is salinity a problem?
- [ ] yes
- [x] no

Occurrence of flooding
- [ ] yes
- [x] no

Comment: The populations generally use water from the ponds and from the wells of the pastoralists. Despite the low quality of the water in the ponds, the pastoralist populations (transhumants and nomads) use the water for their daily consumption.

Species diversity
- [ ] high
- [ ] medium
- [x] low

Habitat diversity
- [ ] high
- [ ] medium
- [x] low

Comment: The vegetation consists of the herbaceous and shrub layers. The herbaceous layer is dominated by the species *Cenchrus biflorus*, *Eragrostis atrovirens*, et *Tribulus terrestris*. Also found are species like *Blepharis linarifolia*, *Cyperus conglomeratus*, and *Cymbopogon schoenantus*, which are disappearing. The tree layer consists mainly of thorny plants: *Acacia raddiana*, *Acacia ehrenbergiana*, *Balanites aegyptiaca* and *Maerua crassifolia*.
The wildlife used to be abundant and varied. Nowadays, it is reduced to several species of bustards, jackals, foxes, hares and guinea fowls. Birds are the most varied and numerous species. They comprise aquatic and terrestrial species. Reptiles and rodents are also numerous.

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [x] subsistence (self-supply)
- [x] mixed (subsistence/ commercial
- [ ] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [x] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [x] very poor
- [x] poor
- [ ] average
- [ ] rich
- [ ] very rich

Level of mechanisation
- [x] manual work
- [x] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [ ] sedentary
- [x] semi-nomadic
- [x] nomadic

Individuals or groups
- [x] individual/ household
- [x] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [x] youth
- [x] middle-aged
- [ ] elderly

Comment: The majority of the population are Tuareg. The Bororo Peulh are the second most important ethnical group. Tuareg and Bororo Peulh are nomadic or semi-nomadic livestock keepers which own most of the herds in the region.

Area used per household
- [ ] < 0.5 ha
- [x] 0.5-1 ha
- [x] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [x] small-scale
- [x] medium-scale
- [ ] large-scale

Comment: In the pastoral zone, private land ownership does not exist according to the law. The livestock keepers install themselves on the lands and cultivate these. However, private ranches increasingly appear in this zone, challenging the socio-economic and environmental equilibrium.

Land ownership
- [x] state
- [ ] company
- [x] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled

Land use rights
- [x] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Water use rights
- [x] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Comment: In the pastoral zone, the grazing land was declared communal by the scheme on pastoralism of 2010. Private land ownership in this zone does not exist according to the law. The scheme of 2010 regulates the access to resources (water and grazing land). It should be noted that private land ownership only exists in agglomerations and urban centres.

Access to services and infrastructure

health	poor	✓			good
education	poor	✓			good
technical assistance	poor	✓			good
employment (e.g. off-farm)	poor	✓			good
markets	poor		✓		good
energy	poor	✓			good
roads and transport	poor	✓			good
drinking water and sanitation	poor	✓			good
financial services	poor	✓			good

IMPACTS – BENEFITS AND DISADVANTAGES

Socio-economic impacts

fodder production — decreased □ □ □ □ ✓ □ □ increased

Before SLM: 0
After SLM: 100%
Comment: The production of fodder intended for marketing has significantly increased, by more than 100%.

fodder quality — decreased □ □ □ ✓ □ □ □ increased

Before SLM: 100%
After SLM: uncertain
Comment: The quality of the fodder could be reduced due to the weeding and storage of the straw (bad conditions of transport and storage). Therefore, the quality could be increased by conservation measures around the firebreaks (on-site fodder quality).

animal production — decreased □ □ □ ✓ □ □ □ increased

Before SLM: 0
After SLM: uncertain
Comment: The availability of straw throughout the year is an important factor in increasing the animal production in this Niger livestock breeding system.

diversity of income sources — increased □ □ □ □ □ □ ✓ decreased

Before SLM: 0
After SLM: 200.000 CFA francs to 1.000.000 francs CFA per site and per year
Comment: The implementation of the technology enables a significant increase of income, in particular resulting from the sale of straw.

Socio-cultural impacts

community institutions — weakened □ □ □ □ □ □ ✓ strengthened

Before SLM: 0
After SLM: A committee of fire guards is installed in each site.

national institutions — weakened □ □ □ □ □ □ ✓ strengthened

Before SLM: 0
Comment: The member institutions of the National Mechanism for the Prevention and Management of Disasters and Food Crises (at the level of the departments and the municipalities) are involved in the monitoring and evaluation of the vulnerability of the populations, and especially in monitoring progress. The land commissions attend to the compliance with the legislation of the rural code.

conflict mitigation — worsened □ □ □ □ ✓ □ □ improved

Before SLM: none
After SLM: depending on the zones.
Comment: The deployment of fire guards mobilizes all stakeholders for natural resource management. This increases dialogue and improves the peaceful co-existence in the zone. However, in the agro-pastoral zone, the pressure on resources leads to conflicts between the agro-pastoralists and the young traders of straw.

situation of socially and economically disadvantaged groups (gender, age, status, ethnicity etc.) — worsened □ □ □ □ □ □ ✓ improved

Before SLM: 0
After SLM: 100%
Comment: The approach of 'cash for work' for vulnerable people contributes to improving the situation of socially and economically disadvantaged groups.

Ecological impacts

surface runoff — increased □ ✓ □ □ □ □ □ decreased

Before SLM: 0
After SLM: 20%
Comment: The firebreaks are bare areas, on which surface runoff could be increased. It is estimated that surface runoff could increase to at least 20% after the clearing of a firebreak.

soil cover	reduced	☐ ✓ ☐ ☐ ☐ ☐ ☐	improved	**Before SLM:** None **After SLM:** 5% **Comment:** The technology consists of clearing the soil in the firebreaks, which reduces the vegetation cover on the site. This could promote some forms of erosion (mainly water erosion).
fire risk	increased	☐ ☐ ☐ ☐ ☐ ☐ ✓	decreased	**Before SLM:** 11 fires **After SLM:** 0

Off-site impacts

water and wind erosion	increased	☐ ☐ ☐ ☐ ✓ ☐ ☐	reduced	**Before SLM:** 0 **After SLM:** 10% **Comment:** The weeding of the firebreaks could increase the risk of water erosion due to surface runoff in the weeded part. The loss of vegetation cover in some parts of the grazing areas could also promote wind erosion, with sand from outside the sites being transported to the treated zones. The firebreaks have small off-site impacts. It should be noted that the transport of the straw leads to the movement of some forage seeds to other zones, where they could become invasive plants.

Benefits compared with establishment costs

Short-term returns	very negative	☐ ☐ ☐ ☐ ☐ ✓ ☐	very positive
Long-term returns	very negative	☐ ☐ ☐ ☐ ☐ ✓ ☐	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	☐ ☐ ☐ ☐ ☐ ✓ ☐	very positive
Long-term returns	very negative	☐ ☐ ☐ ☐ ☐ ✓ ☐	very positive

Comment: From the perspective of the livestock keepers and the agro-pastoralists, there is no doubt about the economic and financial viability of the firebreaks. They enhance rational management of the available grazing land, by establishing a dynamic of conservation and protection. The costs of implementation and maintenance are much lower than the income generated and received from the DNPGCCA (National Mechanism for the Prevention and Management of Disasters and Food Crises), and especially lower than the opportunity costs (of the grazing land saved from bush fires) in the short/medium and long term.

CLIMATE CHANGE

Climate change/ extreme to which the Technology is exposed — **How the Technology copes with these changes/ extremes**

Gradual climate change

annual temperature increase	not well at all	☐ ☐ ☐ ☐ ✓	very well	
seasonal temperature increase	not well at all	☐ ☐ ☐ ☐ ✓	very well	Season: dry season
seasonal rainfall decrease	not well at all	☐ ☐ ☐ ☐ ✓	very well	Season: wet/ rainy season

Climate-related extremes (disasters)

local rainstorm	not well at all	☐ ☐ ☐ ☐ ✓	very well	
local sandstorm/ duststorm	not well at all	☐ ☐ ☐ ☐ ✓	very well	
local windstorm	not well at all	☐ ☐ ☐ ☐ ✓	very well	
tornado	not well at all	☐ ☐ ☐ ✓ ☐	very well	
drought	not well at all	☐ ☐ ☐ ☐ ✓	very well	
land fire	not well at all	☐ ☐ ☐ ☐ ✓	very well	
epidemic diseases	not well at all	☐ ☐ ☐ ☐ ✓	very well	
insect/ worm infestation	not well at all	☐ ☐ ☐ ☐ ✓	very well	**Comment:** The nature of the technology enhances its resilience to disasters and other climatic extremes.

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ☐ single cases/ experimental
- ✓ 1-10%
- ☐ 10-50%
- ☐ more than 50%

Of all those who have adopted the Technology, how many have did so without receiving material incentives?

- ☐ 0-10%
- ☐ 10-50%
- ☐ 50-90%
- ✓ 90-100%

Number of households and/ or area covered

Almost 10% of the livestock keepers in the zone have adopted the technology, focusing on the collection and storage of the straw.

Comment: These livestock keepers have adopted the technology spontaneously on small surfaces. They understood the need to stockpile straw for the lean season.

Has the Technology been modified recently to adapt to changing conditions?

- ✓ yes
- no

To which changing conditions?

- climatic change/ extremes
- ✓ changing markets
- labour availability (e.g. due to migration)

Comment: The adaptation consisted of developing markets for the straw, and especially for forage seeds, which are collected during the weeding of the firebreaks. This adaptation led to increased marketing of the straw, and in this way transformed the management of the natural resources. According to the organisations of livestock keepers, like the 'Association to Revitalize Livestock keeping in Niger' (AREN), the effect of sale of the straw is negative: it puts an additional pressure on this resource, which cannot effectively recover due to climate change.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Strengths

Land user's view

- The protection of the grazing land. In this region, where bush fires are common, a significant reduction of the impacts of these fires on the grazing land decreases the vulnerability of the local populations.
- The marketing of the straw. Significant income was generated following the implementation of the firebreaks.
- The ease of implementation and maintenance of the technology, and its low costs, apart from labour.

Key resource person's view

- The protection of the grazing areas from the impacts of bush fires, which have become a disaster for the transhumant livestock keepers in the last decades.
- The approach of 'cash for work', which was implemented during the construction of the firebreaks, enables on the one hand support of the vulnerable populations during the lean season, and on the other hand the creation of positive momentum for the conservation and protection of the grazing land. The combination of measures for sustainable land management and food security is, without doubt, an effective strategic instrument for this pastoralist zone, which is in an almost chronic state of crisis.

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view

- The implementation of the technology could threaten the extensive management of the grazing land through the marketing of the straw. → The regulations for the marketing of straw should be strengthened, and especially the rural markets should be regulated.
- The transport of the straw carries along certain forage seeds to other zones, where they could become invasive plants. → An effective transport system for the straw should be put in place.

Key resource person's view

- The systematic marketing of the straw is a major weakness. This may reduce the potential of the vegetation cover to regenerate in the grazing areas, and cause conflicts between the traders of straw and the land users (livestock keepers, agro-pastoralists). → Conservation measures for herbaceous species and measures to control soil degradation should be put in place in the firebreaks.

REFERENCES

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Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/technologies/view/technologies_2323

Documentation was facilitated by: Institution: GREAD (GREAD) - Niger. Project: Projet de cash for work pour l'ouverture de bandes pare-feux à Ameidida (Abalak, Tahoua), Niger

Date of documentation: May 21, 2017; **Last update:** March 13, 2018

Key references

Rapport du projet d'ouverture de bandes pare-feux à Ameidida (Abalak, Tahoua): NGO ADR, CCA/Prime Minister's Office

Links to relevant information which is available online

Les bandes pare-feux du PAAPSSP: une action trois résultats!: http://www.reca-niger.org/spip.php?article929

Réflexions: protéger et valoriser les ressources fourragères: http://www.reca-niger.org/spip.php?article929

Dispositif National de Prévention et de Gestion des catastrophes et des Crises Alimentaires: un vaste programme de bandes pare-feux: http://www.dnpgcca.ne/images/Programme%20de%20bandes%20pare%20feu%20-%20Copie.pdf

Herd of cattle and shepherds on a pasture area treated with Assisted Natural Regeneration (selection of herbaceous plants, maintenance of trees and grasses). (Abdoulaye Sambo Soumaila).

Assisted Natural Regeneration on agro-pastoral, sylvo-pastoral and pastoral land (Niger)

DESCRIPTION

Assisted Natural Regeneration (ANR) in pastoral zones is a simple and low-cost agroforestry technique. It involves locating and preserving shoots from stumps of woody and herbaceous vegetation on communal land used for agro-pastoralism, sylvo-pastoralism or pastoralism. The aim is to accelerate the process of natural regeneration resulting from natural seedlings or from sprouting stumps inherently present in the area.

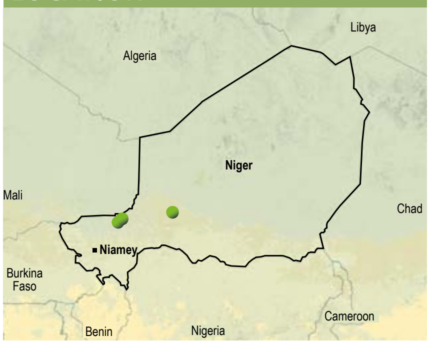
Assisted Natural Regeneration (ANR) is an agroforestry technique applied in areas affected by water and wind erosion on cropped fields as well as agro-pastoral and sylvo-pastoral land. Local populations in the pastoral zone of Niger include mainly transhumant livestock keepers and/or pastoralists who derive their income from the use of natural resources. People in the Sahelo-Saharan region have developed local know-how about sustainable land management, notably the practice of assisted natural regeneration on land that is exclusively set aside for grazing.

The significant growth of the population is dramatically increasing pressure on natural resources. In combination with the impacts of climate change and desertification, the process of land degradation has accelerated, resulting in chronic deficits in food and forage throughout the country. Facing these multiple environmental and ecological challenges, the state and its development partners have been testing and refining the technology of ANR since the 1990s. Assisted Natural Regeneration involves accelerating the process of natural regeneration of vegetation resulting from natural seedlings or from stumps inherently present in the area. Shoots from tree stumps with living root systems grow faster than seedlings derived from seeds. In the agricultural zone, ANR is a technique suited to improved land clearing, which involves locating and preserving shoots from stumps of desirable species of woody and herbaceous vegetation during the process of opening of land for cultivation. On sylvo-pastoral communal land this results in an increase of desirable vegetation species with the best potential for ANR. These include those with a strong ability to sprout from roots or those that can be propagated by layering.

In the pastoral zone the practice was developed by livestock keepers to optimize the length of the grazing period during transhumance. Techniques employed are tree trimming, selection of the livestock routes for transhumance to enhance ANR through the movement of animals, monitoring and protection of palatable species, seeding of local forage crops in areas with low vegetative cover, and protection of particular species that enhance the development of understory vegetation.

An increasing number of development projects are trying to develop local practices of ANR, especially in the northern part of the region of Tahoua and in the southern part of the region of Agadez. The main objectives of ANR are: (i) protection of cropland through erosion control (water and wind erosion), (ii) improvement of soil fertility, (iii) production

LOCATION



Location: Urban municipality of Abala, Department of Abala, Region of Tillabéri, Urban municipality of Abalak, Department of Abalak, Region of Tahoua, Niger

No. of Technology sites analysed: 2-10 sites

Geo-reference of selected sites
- 6.0886, 15.4679
- 3.33424, 15.25866
- 3.10044, 15.00621

Spread of the Technology: evenly spread over an area (approx. 10,000 km²)

Date of implementation: 2010; less than 10 years ago (recently)

Type of introduction
- ✓ through land users' innovation
- as part of a traditional system (> 50 years)
- during experiments/ research
- ✓ through projects/ external interventions

Herd and a shepherd girl on a grazing area and transhumance during treatment with Assisted Natural Regeneration (Abdoulaye Soumaila).

Agro-pastoral producer applying RNA on an agro-sylvo-pastoral land (Amadou Adamou Kalilou, GREAD).

of firewood or timber, (iv) production of forage for livestock, (v) reduction of evapotranspiration, and (vi) restoration and preservation of forage resources in the pastoral zone.

The following results are expected for the agricultural and agro-sylvo-pastoral zones: (i) a significant increase of woody biomass for energy provision, forage and timber, (ii) an increase in agricultural yields, and (iii) new sources of income enabling farmers to improve their living standards. Results expected for the pastoral zone include: (i) conservation and preservation of palatable vegetation species for livestock in the grazing areas, (ii) an increase in forage resources and woody biomass, and (iii) restoration of the vegetation cover on degraded pastoral land.

ANR requires labour and hand tools (hoes and machetes). The low costs of implementation and maintenance are the major advantage of this technology; these explain the ease of adoption and the broad dissemination among agro-pastoralists and livestock keepers. However, due to the lack of regular monitoring of achievements and the weak enforcement of laws that regulate the management of forest resources, the ecological and socio-economic impacts of ANR in Niger are limited, especially in the pastoral zone.

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- ✓ improve production
- ✓ reduce, prevent, restore land degradation
- ✓ conserve ecosystem
- ☐ protect a watershed/ downstream areas – in combination with other Technologies
- ✓ preserve/ improve biodiversity
- ☐ reduce risk of disasters
- ✓ adapt to climate change/ extremes and its impacts
- ✓ mitigate climate change and its impacts
- ✓ create beneficial economic impact
- ✓ create beneficial social impact

Land use

Grazing land – Extensive grazing land: Nomadism, Seminomadism/ pastoralism
Main animal species and products: cattle, dromedaries, sheep, goats and donkeys. In this zone, the implementation of ANR is part of the management framework for herds and forage resources.

Mixed (crops/ grazing/ trees), incl. agroforestry – Agroforestry, Agro-pastoralism, Agro-silvopastoralism, Silvo-pastoralism
Main products/ services: production of millet, sorghum, cowpea, and cash crops;
it is applied on land in use for agro-sylvo-pastoralism, sylvo-pastoralism and agro-pastoralism. In these areas, agriculture, livestock and the trade of agropastoral products (livestock, cereals) are the main activities of local populations.

Water supply

- ☐ rainfed
- ✓ mixed rainfed-irrigated
- ☐ full irrigation

Number of growing seasons per year: 1
Land use before implementation of the Technology: Implementation of ANR on communal land requires secure land tenure
Livestock density: In the pastoral zone of the urban municipality of Abalak, the livestock density was estimated at 50 TLU/km^2 in 2016.

Purpose related to land degradation

- ✓ prevent land degradation
- ✓ reduce land degradation
- restore/ rehabilitate severely degraded land
- adapt to land degradation
- not applicable

Comment: Apart from preventing and reducing land degradation, ANR also contributes to the restoration and rehabilitation of degraded land, that otherwise would have required considerable investments. In that case ANR is linked to the closure of certain areas for grazing to enable a full recovery of the land.

Degradation addressed

soil erosion by water – Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying

soil erosion by wind – Et: loss of topsoil, Ed: deflation and deposition

chemical soil deterioration – Cn: fertility decline and reduced organic matter content (not caused by erosion)

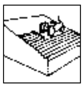
Bc: reduction of vegetation cover, Bh: loss of habitats, Bq: quantity/ biomass decline, Bs: quality and species composition/ diversity decline

Comment: ANR addresses several types of land degradation which threaten the soil fertility and the production of forage. The practice integrates an enhanced support to the regeneration of plants and vegetation cover with the aim to control the most frequently occurring types of soil erosion in the countries of the Sahel.

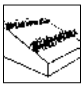
SLM group

- agroforestry
- pastoralism and grazing land management
- improved ground/ vegetation cover

SLM measures



agronomic measures – A6: Others



vegetative measures – V1: Tree and shrub cover, V2: Grasses and perennial herbaceous plants, V5: Others

Comment: On agricultural fields, ANR is used as an agronomic practice to improve the system of land clearing. It is also a vegetative measure to improve the cover of trees and shrubs. In the pastoral zone, the technology fulfills all these functions, especially the functions to improve the vegetation cover and to produce forage.

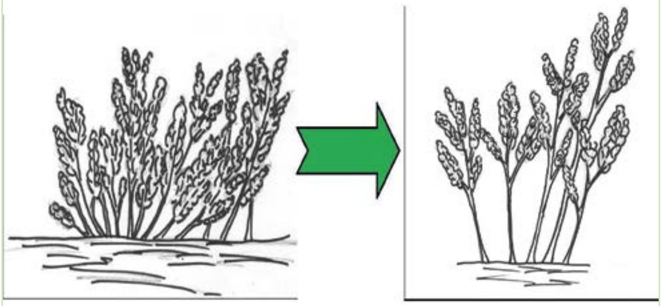
TECHNICAL DRAWING

Technical specifications

Sketch 1 shows tree seedlings which are pruned to fewer stems to enhancedevelopment.

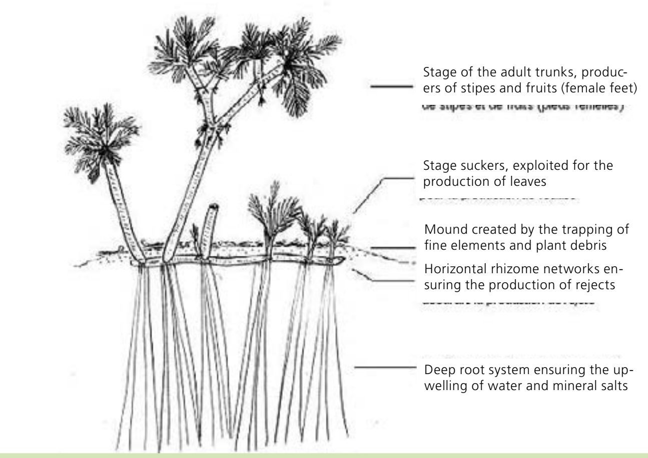
Sketch 2 presents the structure of a patchof doum palm seedlings, showing theinterdependence between the differentsprouts.

Sketch 3 presents a scheme for a doumpalm plantation in the agricultural zone, inan arrangement of cells with trees invarious stages of regeneration over aperiod of 30 years.



Sketch of PASADEM, Maradi, Niger

Author: PASADEM, Maradi, Niger.



Author: Peltier Régis, Claudine Serre Duhem and Aboubacar Ichaou.

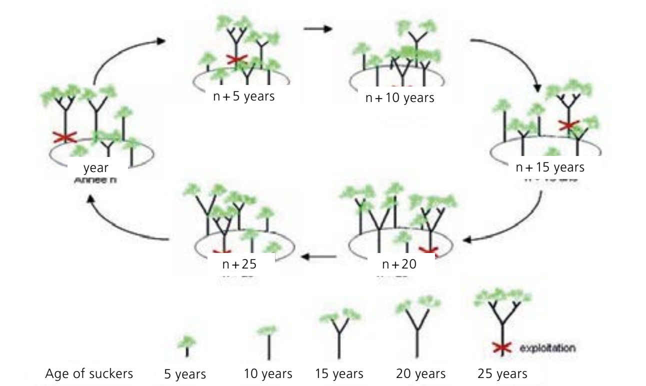


Figure 4: Silviculture scheme of the Doum by regeneration cells, over a period of 30 years, in agricultural zone.

Author: Peltier Régis, Claudine Serre Duhem and Aboubacar Ichaou.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **1 hectare**)
- Currency used for cost calculation: **West African CFA francs**
- Exchange rate (to USD): 1 USD = 500.0 West African CFA francs
- Average wage cost of hired labour per day: 1,500 CFA francs

Most important factors affecting the costs

Labour is the key determinant of the costs for establishment and maintenance of the technology, representing almost 90% of the total costs.

Establishment activities

1. Awareness-raising among the population and demonstrations of ANR techniques in villages (Timing/ frequency: In the dry season, at the start of the project (preferably in January-February))
2. Set-up of an organisational structure to promote ANR (Timing/ frequency: Immediately after the awareness-raising and before the start of the rainy season)
3. Early intervention to enhance the regeneration and treatment of seedlings (Timing/ frequency: At the start of the rainy season, after the establishment of the supervisory committees)
4. Develop vegetative propagation of species with potential for ANR (Timing/ frequency: During the rainy season)

Comment: These activities are part of the implementation of a development project. If ANR is implemented spontaneously, the agropastoralist or livestock keeper directly initiates ANR without an awareness campaign or supervisory committee in place.

Establishment inputs and costs (per 1 hectare)

Specify input	Unit	Quantity	Cost per unit	Total cost per input FCFA	% of costs borne by land users
Labour					
skilled labour	person-days	1	21,000.00	21,000.00	
unskilled labour	person-days	14	1,500.00	21,000.00	100
Equipment					
Small equipment (machete, hoe, short-handled hoe, etc.)	set	1	3,000.00	3,000.00	100
Total costs for establishment of the Technology				**45,000.00**	

If land user bore less than 100% of costs, indicate who covered the remaining costs
In case the implementation of the technology was conducted in the context a development project, only the costs of training are not borne by the land user, but covered by the project. In some cases the project also provides technical support, such as the installation of a tree nursery or food distribution.

Comment: The total costs are indicated for the establishment of ANR through a development project. When the land user accomplishes ANR himself, the costs are 24,000 CFA francs/hectare, that is the costs for labour and depreciation of equipment. Labour costs represent almost 90% of the total costs for establishment of the technology. The costs for installation of a nursery are not included in the cost calculations. In the strict sense, ANR is not combined with the production of nursery plants.

Maintenance activities
1. Base pruning: meaning cutting a tree close to the soil surface to encourage sprouts to shoot. (Timing/ frequency: Before the start of the rainy season, during the period from March to May.)
2. Pruning trees: comprising cutting off excess and weak branches. (Timing/ frequency: Tree pruning must be performed right after the establishment of crops.)
3. Trellising: involving driving one or more posts into the ground to support the selected shoot. (Timing/ frequency: During the rainy season.)
4. In agricultural areas, protecting species which are palatable, and species which are not resistant to grazing. (Timing/ frequency: Throughout the rainy season until the crop harvesting.)

Comment: Maintenance work is generally performed by the land users. On sylvo-pastoral land maintenance is carried out by the community and continues throughout the year, but it is most important in the period with precipitation. In the pastoral zone transhumant livestock keepers and nomadic people maintain the technology on an individual basis. In this region, maintenance involves optimizing the use of available forage resources, livestock rotation, and monitoring of the grazing land to enhance the natural regeneration of palatable vegetation species.

Establishment inputs and costs (per 1 hectare)

Specify input	Unit	Quantity	Cost per unit	Total cost per input FCFA	% of costs borne by land users
Labour					
unskilled labour	person-days	34	1,500.00	51,000.00	100
Equipment					
Small equipment (machete, hoe, short-handled hoe)	set	1	3,000.00	3,000.00	100
Total costs for establishment of the Technology				**54,000.00**	

Comment: The maintenance costs exceed the costs for establishment of the technology due to the efforts to secure the ownership of treated land throughout the year. Labour accounts for the major share of the costs. Operations are more intensive during maintenance compared to establishment of the technology. The production of nursery plants is not included in the cost estimation.

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [x] 251-500 mm
- [x] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [ ] humid
- [ ] sub-humid
- [x] semi-arid
- [ ] arid

Specifications on climate
The mean annual precipitation in the pastoral zone does not exceed 300 mm. In the southern regions of Niger (the Sahelian zone), annual precipitation is between 500 and 600 mm. Recent decades have been marked by a large variability in rainfall in space and time across Niger.

Name of the meteorological station: meteorological stations of Abalak and Tillabéry.

The pastoral zone of Niger has a Sahelian-Saharan climate. The agro-pastoral regions of Niger are characterized by a Sahelian climate.

Slope
- [x] flat (0-2%)
- [ ] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landform
- [x] plateau/ plains
- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [x] 0-100 m a.s.l.
- [x] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [x] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [x] medium (1-3%)
- [x] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [x] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [ ] medium
- [x] poor/ none

Water quality (untreated)
- [ ] good drinking water
- [x] poor drinking water (treatment required)
- [ ] fine/ heavy (clay)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Occurrence of flooding
- [ ] yes
- [x] no

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [x] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial
- [ ] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [x] very poor
- [x] poor
- [ ] average
- [ ] rich
- [ ] very rich

Level of mechanisation
- [x] manual work
- [x] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [x] sedentary
- [x] semi-nomadic
- [ ] nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [x] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [x] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [x] 0.5-1 ha
- [ ] 1-2 ha
- [x] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [x] small-scale
- [ ] medium-scale
- [ ] large-scale

Land ownership
- [x] state
- [ ] company
- [x] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled

Land use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [x] individual

Access to services and infrastructure

health	poor	✓			good
education	poor	✓			good
technical assistance	poor	✓			good
employment (e.g. off-farm)	poor	✓			good
markets	poor			✓	good
energy	poor	✓			good
roads and transport	poor	✓			good
drinking water and sanitation	poor	✓			good
financial services	poor	✓			good

IMPACTS – BENEFITS AND DISADVANTAGES

Socio-economic impacts

crop production — decreased ☐☐☐☐☐☐✓ increased

Before SLM: 50 kg/ha
After SLM: 100 kg/ha
Comment: In the agro-pastoral zone, the application of ANR in fields has increased the cereal production (millet, sorghum) by almost 50%. On less fertile land the production increased by more than 100%.

fodder production — decreased ☐☐☐☐☐☐✓ increased

Before SLM: None
After SLM: 50%
Comment: The vegetation cover on sylvo-pastoral land has increased by more than 100%. The fodder production is esti-mated to have increased by at least 50%. In the pastoral zone the application of ANR has increased the fodder production by nearly 50%.

fodder quality — decreased □□□□□✓□ increased

Before SLM: None
After SLM: 25%
Comment: On sylvo-pastoral land in the south, the application of ANR to enhance selected species, in particular the doum palm, is thought to have improved the fodder quality through the development of palatable vegetation species. In the pastoral zone in the north, the technology enabled to maintain the fodder quality in the areas of transhumance.

animal production — decreased □□□□□✓□ increased

Before SLM: None
After SLM: 50%
Comment: The application of ANR contributes to the increase of the livestock production in pastoral and sylvo-pastoral land in the south by nearly 20%. In the pastoral zone ANR has increased livestock production by at least 20%.

wood production — decreased □□□□□□✓ increased

Before SLM: None
After SLM: 50%
Comment: In the south of the country an increase in the production of wood by at least 50% was observed following the implementation of ANR. It should be noted that this production increase was promoted by the planting of woody species in the sites where ANR was applied.

diversity of income sources — increased □□□□□□✓ decreased

Before SLM: None
After SLM: 100%
Comment: The application of ANR promotes trade in timber, other forest products and hay/straw in the agro-pastoral zone. In several cases the trade is combined with the production of seedlings in nurseries, which are sold to land users. In the pastoral zone ANR has led to the marketing of forest products (e.g. gum arabic from acacia trees) and hay/straw in some regions. In addition ANR enhances dairy production and the production of cheese.

economic disparities — decreased □□□✓□□□ increased

Before SLM: None
After SLM: In the short term there is no evident impact.
Comment: ANR contributes to reducing economic disparities between vulnerable and wealthy land users in the medium and long term. In the pastoral zone, ANR benefits the entire population. This applies especially to the poorest livestock keepers, who lack the financial resources to buy imported animal feed.

Socio-cultural impacts

food security/ self-sufficiency — reduced □□□□□□✓ improved

Before SLM: None
After SLM: 20%
Comment: ANR contributes to food security and food self-sufficiency in the southern regions of the country. The impact is estimated at 20% at least. In the pastoral zone in the north, ANR can reduce forage deficits. In this way, the technology reduces hardship to livestock keepers in the lean season, and prevents them from being forced to sell their animals.

community institutions — weakened □□□□□□✓ strengthened

Before SLM: None
After SLM: 100%
Comment: In the agro-pastoral zone in the south the implementation of ANR has led to the creation of community-based organisations, for example the committees for management and supervision. Organisations of livestock keepers in the pastoral zone have been strengthened by the establishment of committees. Similarly, traditional associations strengthen their capacities by diversifying their activities relating to the implementation of ANR.

SLM/ land degradation knowledge — reduced □□□□□□✓ improved

Before SLM: None
After SLM: 100%
Comment: Project interventions entail the setting up of training programmes, both in the north and the south of the country, to enable land users to increase their knowledge of SLM. In the pastoral zone existing local knowledge is used and innovations by livestock keepers are promoted.

conflict mitigation	worsened ☐☐☐☐☐☐✓ improved	**Before SLM:** None **After SLM:** 100% **Comment:** ANR mitigates conflicts about timber management in the southern regions by establishing community arrangements. In the pastoral zone the technology contributes to conflict mitigation on forage resources by creating an environment for knowledge sharing and compliance with the regulations in force.
situation of socially and economically disadvantaged groups (gender, age, status, ethnicity etc.)	worsened ☐☐☐☐☐✓☐ improved	**Before SLM:** None **After SLM:** 50% **Comment:** ANR improves the situation of vulnerable producers by ensuring the increase of farm and livestock production, and also off-farm income. The technology allows smallholder farmers to increase their yields and to access expanding forest resources.

Ecological impacts

soil cover	reduced ☐☐☐☐☐☐✓ improved	**Before SLM:** None **After SLM:** 100% **Comment:** ANR leads to a substantial increase of the vegetation cover. It promotes the return of some herbaceous species on unproductive land, and especially the suppression of invasive plants which are unsuitable for livestock.
soil organic matter/ below ground C	decreased ☐☐☐☐☐☐✓ increased	**Before SLM:** None **After SLM:** 100% **Comment:** A rapid and significant increase of soil organic matter was observed in the short term. Practices of livestock rotation in the grazing areas of the pastoral zone increase the soil organic matter significantly, and maintain soil fertility on a sustainable basis.
vegetation cover	decreased ☐☐☐☐☐☐✓ increased	**Before SLM:** None **After SLM:** 100% **Comment:** The main impact of ANR in the regions where it is applied is the increase of the vegetation cover. On pastoral and sylvo-pastoral land the increase is rapid and particularly strong.
biomass/ above ground C	decreased ☐☐☐☐☐☐✓ increased	**Before SLM:** None **After SLM:** 100% **Comment:** Above-ground biomass increases especially on pastoral and sylvo-pastoral land. An increase is also observed in agricultural fields, mainly due to the high density of woody vegetation.
plant diversity	decreased ☐☐☐☐☐☐✓ increased	**Before SLM:** None **After SLM:** 100% **Comment:** The application of ANR in combination with the planting of selected tree species in the agro-pastoral region enhances plant diversity, particularly when herbaceous species are reintroduced which had disappeared from the area.
invasive alien species	increased ☐☐☐☐☐☐✓ reduced	**Before SLM:** None **After SLM:** 100% **Comment:** The PASADEM project has joined the implementation of ANR with the control of Sida cordifolia, an invasive species which is undermining the grazing land in the region of Maradi.
drought impacts	increased ☐☐☐☐☐✓☐ decreased	**Before SLM:** None **After SLM:** 100% **Comment:** By improving the vegetation cover and increasing the production of woody vegetation, ANR helps to reduce the impacts of long droughts during the rainy season.

Off-site impacts

buffering/ filtering capacity (by soil, vegetation, wetlands)	reduced ☐☐☐☐☐✓☐ improved	**Before SLM:** 100% **After SLM:** None **Comment:** By increasing the vegetation cover, ANR significantly improves the buffer and filtering capacities of the soil, especially through the development of woody species. In this way the technology helps to control water erosion (rills and gullies), which is typical of these regions.

Benefits compared with establishment costs

Short-term returns	very negative					✓			very positive
Long-term returns	very negative							✓	very positive

Benefits compared with maintenance costs

Short-term returns	very negative					✓			very positive
Long-term returns	very negative							✓	very positive

Comment: The establishment and maintenance costs of ANR are very low. Therefore the short-term returns are still slightly positive. In the pastoral zone observations show positive returns of the technology, even in the short term. The impacts are clearer in the medium and long term, and the cost-effectiveness is highest at these time scales.

CLIMATE CHANGE

Climate change/ extreme to which the Technology is exposed / **How the Technology copes with these changes/ extremes**

Gradual climate change

annual temperature increase	not well at all		✓				very well	
seasonal temperature increase	not well at all		✓				very well	Season: dry season
annual rainfall decrease	not well at all		✓				very well	
seasonal rainfall decrease	not well at all		✓				very well	Season: wet/ rainy season

Climate-related extremes (disasters)

local sandstorm/ duststorm	not well at all			✓			very well
local windstorm	not well at all			✓			very well
tornado	not well at all			✓			very well
drought	not well at all		✓				very well

Other climate-related consequences

reduced growing period	not well at all			✓			very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ☐ single cases/ experimental
- ☐ 1-10%
- ✓ 10-50%
- ☐ more than 50%

Of all those who have adopted the Technology, how many have did so without receiving material incentives?

- ☐ 0-10%
- ☐ 10-50%
- ☐ 50-90%
- ✓ 90-100%

Number of households and/ or area covered

The majority of transhumant livestock keepers in the pastoral zone (60%) have adopted ANR over an area of approximately 2,000 km² of grazing land. In the agro-pastoral zone within the regions of Tillabéri, Maradi and Tahoua the area treated with ANR exceeds 10,000 km².

Has the Technology been modified recently to adapt to changing conditions?

- ✓ yes
- ☐ no

To which changing conditions?

- ✓ climatic change/ extremes
- ☐ changing markets
- ☐ labour availability (e.g. due to migration)

Comment: Several projects have adapted ANR by complementing the implementation with tree planting and seeding local or external forage species in sylvo-pastoral land. Some projects have combined the technology with the control of invasive plant species and plants that are harmful to livestock. ANR is based on the selection of species that have high potential for the production and marketing of forage and timber.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Strengths

Land user's view
- The strength of ANR is that the technology is easy to implement and maintain, and therefore entails very low costs. This has led to the widespread adoption of the technology in all regions.
- The second strength is the improvement of soil fertility and the increase of crop and fodder yields. The improved soil fertility leads to an increase in production and improved food security, both for humans and livestock.
- The third strength is that resources are being renewed, and that needs for timber and forage are met. According to land users, these supplementary resources enable them to improve their living standards.

Key resource person's view
- The ease of adoption, which has enabled the dissemination of the technology across the country. The technology is a local innovation, which was disseminated and scaled-up by development projects. The implementation and maintenance are in line with the project cycle.
- The effect of ANR in reducing the evaporation of soil moisture is a major strength in a Sahelian country like Niger. The ANR technology has positive impacts on the vegetation cover, the soil biodiversity and the density of woody vegetation. These constitute a major advantage in a region subject to accelerated desertification and to the effects of almost chronic droughts.
- Conservation and restoration of the environment through ANR are a major advantage in this region of the Sahel, which faces accelerated environmental degradation due to human activities and climate change.

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view
- The impacts of investments in the technology are only significant in the medium and long term. A long period is required to benefit from the results. → Land users should be supported by implementing the technology in the first year in which ANR is adopted, in the form of cash or food for work.
- The technology requires that tenure of fields and sylvo-pastoral land are secure. → Establishing community-based brigades to supervise the land under treatment.

Key resource person's view
- Illegal logging both in the fields and in the grazing areas. → Establish a communal system to supervise treated areas in partnership with all stakeholders.
- Lack of a monitoring mechanism and of guidelines for the rational use of resources. → The land commissions at the local level and at the level of villages or tribes should be supported to establish community-based mechanisms to supervise and monitor the implementation of laws on pastoralism, and of the rural code in general.
- Lack of legislation on forestry incorporating the status of regenerating trees in fields and in the pastoral zone. → The legislation in force should be adapted to the context resulting from the implementation of ANR in fields and in the pastoral zone.

REFERENCES

Compiler: Soumaila Abdoulaye (leffnig@yahoo.fr)
Resource persons: Soumaila Abdoulaye - SLM specialist
Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/technologies/view/technologies_2325/
Linked SLM data: SLM Approach: Pastoralism in Niger: monitoring system for movements and spatial adaptation strategies of transhumant livestock keepers https://qcat.wocat.net/en/wocat/approaches/view/approaches_2328/
Documentation was facilitated by: Institution: GREAD (GREAD) - Niger. Project: Projet Améliorer la résilience aux changements climatiques par la diffusion de technologies de gestion intégrée Eau-Sol-Agro-Sylvo-Pastoralisme, Niger (PARC/YANA-YI); Projet d'appui à la Sécurité Alimentaire et au Développement de Maradi (PASADEM); Projet de surveillance pastorale en Afrique subsaharienne (Départements d'Abala, de Banibangou et de Filingué), Niger (ACF / AREN
Date of documentation: May 21, 2017; **Last update:** June 6, 2018

Key references
Valoriser les produits du palmier doum pour gérer durablement le système agroforestier d'une vallée sahélienne du Niger et éviter sa désertification, Peltier Régis, Claudine Serre Duhem and Aboubacar Ichaou, 2008: document available for download on the Internet
Note de capitalisation « Expérience du Programme Niger FIDA dans la mise á l'échelle de la Régénération Naturelle Assistée (RNA) », PASADEM, 2015: PASADEM, GREAD
Etude de Cas: Régénération Naturelle Assistée (RNA) dans la région de Maradi (Niger), Abdoulaye Sambo Soumaila, 2015 : GREAD

Grass seedling to rehabilitate degraded natural pastures (Kevin Mganga).

Grass reseeding (Kenya)

Reseeding

DESCRIPTION

Grass reseeding is a sustainable land management practice aimed at rehabilitating degraded pastures and providing livestock feed. This is mainly carried out with indigenous perennial grass species.

Grass reseeding is a sustainable land management practice especially appropriate for pastoral and agro-pastoral communities inhabiting the arid and semi-arid rangelands of the world. Seedbed preparation involves clearing of invasive bush patches and creation of furrows across the slope using an ox-plough (traditional) or shallow and light ploughing using a tractor (modern). Grass seeds are sown along the furrows which are created directly in the degraded grazing land. The seeds are lightly covered with soil because the indigenous grass seeds are very small. This encourages faster emergence of grass seedlings. The slope should be generally flat or very gentle (<5%) to reduce the speed of runoff, thus prevent soil erosion and consequently the washing away of the grass seeds. Eroded and deposited seeds will eventually lead to uneven establishment of pasture, mainly concentrated downslope. Minimal soil disturbance by ox-plough or tractor facilitates root penetration of the seedlings and also helps breaking the soil surface hardpan formed by continuous hoof action.

Furrows constitute a form of in-situ moisture conservation, capturing rainwater where it falls, thus increasing availability of water for emerging seedlings. The main purpose of this technology is to rehabilitate degraded natural pastures and provide a continuous source of livestock feed especially during lean periods. Use of indigenous grass species e.g. *Eragrostis superba*, *Cenchrus ciliaris*, *Enteropogon macrostachyus* and *Chloris roxburghiana* is advocated for better establishment and subsequent development. Ecological impacts of this technology include improved soil cover and reduced soil erosion. In addition to rehabilitating degraded natural pastures and improving quality and quantity for livestock production, grass reseeding has additional socio-economic impacts, thus benefiting rural livelihoods. This is through the sale of hay and grass seed and surplus milk in the local market, which provide supplementary sources of income.

LOCATION

Location: Kibwezi, Eastern, Kenya

No. of Technology sites analysed: 10-100 sites

Geo-reference of selected sites
- 38.0127, -1.39055
- 37.97768, -2.39661

Spread of the Technology: applied at specific points/ concentrated on a small area
Comment: Practiced among several agropastoral and pastoral households in the arid and semi-arid lands.

Date of implementation: 10-50 years ago

Type of introduction
- [ ] through land users' innovation
- [ ] as part of a traditional system (> 50 years)
- [x] during experiments/ research
- [ ] through projects/ external interventions

Seedbed preparation using ox-driven plough – creating microcatchment (Kevin Mganga).

Grass seedlings emerging along the furrows (Kevin Mganga).

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- ✓ improve production
- ✓ reduce, prevent, restore land degradation
- conserve ecosystem
- protect a watershed/ downstream areas – in combination with other Technologies
- preserve/ improve biodiversity
- ✓ reduce risk of disasters
- adapt to climate change/ extremes and its impacts
- ✓ mitigate climate change and its impacts
- create beneficial economic impact
- create beneficial social impact

Land use

Grazing land – Extensive grazing land: Nomadism, Semi-nomadism/ pastoralism, Ranching

Water supply

- ✓ rainfed
- mixed rainfed-irrigated
- full irrigation

Number of growing seasons per year: 2
Livestock density: On average 2-3 cattle, 7-8 goats, 2 sheep per household.

Purpose related to land degradation

- prevent land degradation
- ✓ reduce land degradation
- ✓ restore/ rehabilitate severely degraded land
- adapt to land degradation
- not applicable

Degradation addressed

soil erosion by water – Wt: loss of topsoil/ surface erosion

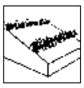
physical soil deterioration – Pc: compaction, Pi: soil sealing

biological degradation – Bc: reduction of vegetation cover, Bh: loss of habitats, Bq: quantity/ biomass decline, Bs: quality and species composition/ diversity decline

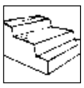
SLM group

- pastoralism and grazing land management
- minimal soil disturbance
- water harvesting

SLM measures



vegetative measures – V2: Grasses and perennial herbaceous plants



structural measures – S4: Level ditches, pits

TECHNICAL DRAWING

Technical specifications

15-20 cm deep and 10-15 cm wide furrows across the slope. Spacing between furrows is 15-20 cm and depends mostly on plant species. Seeds are sown along the furrows intentionally built to capture and hold rainwater. Flat or very gentle (<5%) slope to reduce runoff.

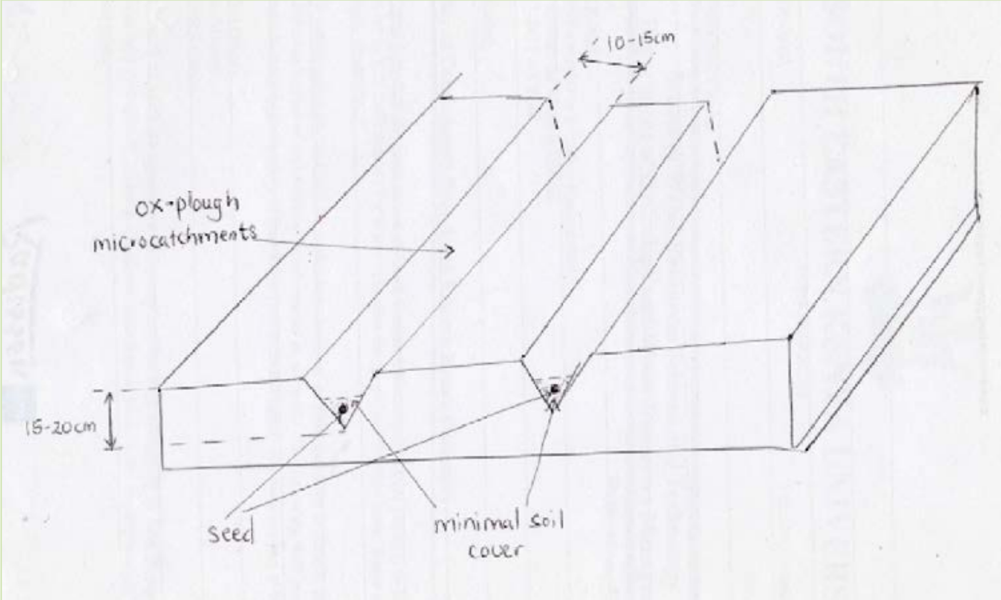


Figure: Ousmane Oumarou Bako.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **Hectare**)
- Currency used for cost calculation: **US Dollars**
- Average wage cost of hired labour per day: 5

Most important factors affecting the costs

Seed availability in the 'informal markets' i.e. between farmers and farmer groups, research organisation, influences the cost of grass seed. This is mainly determined by the preceding rainy season.

1. Creation of furrow micro-catchments with ox-plough (Timing/ frequency: Before onset of the rains).
2. Sowing (seed placement and covering with soil) (Timing/ frequency: Before onset of the rains).
3. Gapping (reseeding gaps with poor establishment and cover) (Timing/ frequency: After establishment).

Establishment inputs and costs

Specify input	Unit	Quantity	Cost per unit	Total cost per input FCFA	% of costs borne by land users
Labour					
Casual and Household labour	person-days	4	5.00	20.00	100
Equipment					
Hiring ox-driven plough	person-days	4	100.00	400.00	100
Plant material					
Seeds	kgs	5	10.00	50.00	100
Total costs for establishment of the Technology				**470.00**	

Maintenance activities

1. Gapping (i.e. reseeding bare areas (patches) with poor germination and cover) (Timing/ frequency: Seasonal).

Comment: Gapping is done to ensure uniform plant cover.

Maintenance inputs and costs (per Hectare)

Specify input	Unit	Quantity	Cost per unit	Total cost per input FCFA	% of costs borne by land users
Labour					
Casual and Household labour	person-days	1	5.00	5.00	100
Equipment					
Ox-driven plough	person-days	1	100.00	100.00	100
Plant material					
Seed	kg	1	10.00	10.00	100
Total costs for establishment of the Technology				**115.00**	

NATURAL ENVIRONMENT

Average annual rainfall
- ☐ < 250 mm
- ✓ 251-500 mm
- ✓ 501-750 mm
- ☐ 751-1,000 mm
- ☐ 1,001-1,500 mm
- ☐ 1,501-2,000 mm
- ☐ 2,001-3,000 mm
- ☐ 3,001-4,000 mm
- ☐ > 4,000 mm

Agro-climatic zone
- ☐ humid
- ☐ sub-humid
- ✓ semi-arid
- ☐ arid

Specifications on climate

Average annual rainfall in mm: 700.0

Highly variable in space, time and season.

Name of the meteorological station: Meteorological Station South Eastern Kenya University.

Slope
- ✓ flat (0-2%)
- ✓ gentle (3-5%)
- ☐ moderate (6-10%)
- ☐ rolling (11-15%)
- ☐ hilly (16-30%)
- ☐ steep (31-60%)
- ☐ very steep (>60%)

Landform
- ✓ plateau/ plains
- ☐ ridges
- ☐ mountain slopes
- ☐ hill slopes
- ☐ footslopes
- ☐ valley floors

Altitude
- ☐ 0-100 m a.s.l.
- ☐ 101-500 m a.s.l.
- ✓ 501-1,000 m a.s.l.
- ✓ 1,001-1,500 m a.s.l.
- ☐ 1,501-2,000 m a.s.l.
- ☐ 2,001-2,500 m a.s.l.
- ☐ 2,501-3,000 m a.s.l.
- ☐ 3,001-4,000 m a.s.l.
- ☐ > 4,000 m a.s.l.

Technology is applied in
- ✓ convex situations
- ☐ concave situations
- ☐ not relevant

Comments and further specifications on topography:
Altitude 900 m above sea level
Slope angle – flat 0-2% and gentle 3-5% slopes.

Soil depth
- ✓ very shallow (0-20 cm)
- ✓ shallow (21-50 cm)
- ☐ moderately deep (51-80 cm)
- ☐ deep (81-120 cm)
- ☐ very deep (> 120 cm)

Soil texture (topsoil)
- ✓ coarse/ light (sandy)
- ✓ medium (loamy, silty)
- ☐ fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- ✓ coarse/ light (sandy)
- ✓ medium (loamy, silty)
- ☐ fine/ heavy (clay)

Topsoil organic matter content
- ☐ high (>3%)
- ☐ medium (1-3%)
- ✓ low (<1%)

Groundwater table
- ☐ on surface
- ☐ < 5 m
- ✓ 5-50 m
- ☐ > 50 m

Availability of surface water
- ☐ excess
- ☐ good
- ✓ medium
- ☐ poor/ none

Water quality (untreated)
- ☐ good drinking water
- ✓ poor drinking water (treatment required)
- ☐ fine/ heavy (clay)
- ☐ for agricultural use only (irrigation)
- ☐ unusable

Is salinity a problem?
- ☐ yes
- ✓ no

Occurrence of flooding
- ☐ yes
- ✓ no

Species diversity
- ☐ high
- ✓ medium
- ☐ low

Habitat diversity
- ☐ high
- ✓ medium
- ☐ low

Comment: Due to intensive utilisation of natural pastures, notably due to overgrazing, indigenous pasture species are depleted and replaced by less preferred invasive plant species. However, reseeded pastures reverses this trend by re-introducing various species the indigenous pastures which can naturally co-exist and reduce competition with other herbaceaous plant species, thereby increases biodiversity.

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- ✓ subsistence (self-supply)
- ✓ mixed (subsistence/ commercial
- ☐ commercial/ market

Off-farm income
- ☐ less than 10% of all income
- ✓ 10-50% of all income
- ☐ > 50% of all income

Relative level of wealth
- ☐ very poor
- ✓ poor
- ✓ average
- ☐ rich
- ☐ very rich

Level of mechanisation
- ✓ manual work
- ✓ animal traction
- ☐ mechanized/ motorized

Sedentary or nomadic
- ✓ sedentary
- ✓ semi-nomadic
- ☐ nomadic

Individuals or groups
- ✓ individual/ household
- ✓ groups/ community
- ☐ cooperative
- ☐ employee (company, government)

Gender
- ✓ women
- ✓ men

Age
- ☐ children
- ✓ youth
- ✓ middle-aged
- ☐ elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [x] 2-5 ha
- [x] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [x] small-scale
- [x] medium-scale
- [ ] large-scale

Land ownership
- [ ] state
- [ ] company
- [x] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [x] individual

Comment: Communal land use right – e.g. common grazing land, reserved and seasonal grazing areas (large scale).
Individual land use right – e.g. individual pasture establishment within individual owned land.
Communal water use rights – e.g. watering point, river, lake, stream, community water reservoir, boreholes.
Individual water use rights – e.g. individual tap water, roof water catchment.

Access to services and infrastructure

health	poor		✓		good
education	poor		✓		good
technical assistance	poor		✓		good
employment (e.g. off-farm)	poor		✓		good
markets	poor		✓		good
energy	poor		✓		good
roads and transport	poor		✓		good
drinking water and sanitation	poor		✓		good
financial services	poor		✓		good

IMPACTS – BENEFITS AND DISADVANTAGES

Socio-economic impacts

fodder production	decreased						✓		increased
fodder quality	decreased						✓		increased
farm income	decreased						✓		increased
diversity of income sources	increased						✓		decreased

Ecological impacts

soil cover	reduced						✓		improved
soil loss	increased						✓		decreased

Off-site impacts

buffering/ filtering capacity (by soil, vegetation, wetlands)	reduced						✓		improved

Comment: Reseeded areas improve the soil hydrological properties by reducing the impact of raindrops thus reducing soil disturbance and increasing water infiltration capacity. Consequently, runoff, and sediment production – an index of soil erosion, are greatly reduced.

Benefits compared with establishment costs

Short-term returns	very negative					✓			very positive
Long-term returns	very negative						✓		very positive

Benefits compared with maintenance costs

Short-term returns	very negative					✓			very positive
Long-term returns	very negative						✓		very positive

CLIMATE CHANGE

Climate change/ extreme to which the Technology exposed

How the Technology copes with these changes/ extremes is

Gradual climate change

annual rainfall decrease	not well at all				✓		very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- single cases/ experimental
- 1-10%
- ✓ 10-50%
- more than 50%

Of all those who have adopted the Technology, how many have did so without receiving material incentives?

- 0-10%
- 10-50%
- ✓ 50-90%
- 90-100%

Has the Technology been modified recently to adapt to changing conditions?

- yes
- ✓ no

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Strengths

Land user's view

- Increased quantities of livestock forage especially during the dry season (fodder reserves).
- Diversification of source of income through sale of grass hay and seeds.
- Improving the environment i.e. rehabilitating degraded grazing land.

Key resource person's view

- Reliable source of livestock forage especially during periods of drought.
- Diversification of source of income through sale of grass hay and seeds.
- Improving the environment i.e. rehabilitating degraded grazing land.
- Climate change mitigation through carbon (C) sequestration.

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view

- Successful establishment is dependent on amount, distribution and duration (rainy days) of rainfall in the area. → Improved rainwater capture and storage technologies.
- Seed availability – quantity and quality. → Large-scale production of good quality indigenous seed to supply the pastoral and agropastoral communities at a subsidized price.

Key resource person's view

- Rainfed and climatic (rainfall dependent). → Improved rainwater harvesting and storage technologies.
- Low uptake/interest among the youth, students. → Sensitization of the youth as a source of income (business).

REFERENCES

Compiler: Kevin Mganga (kmganga@seku.ac.ke)
Resource persons: Kevin Mganga (kmganga@seku.ac.ke) - SLM specialist
Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/technologies/view/technologies_2288/
Linked SLM data: SLM Approach: Combating erosion, recovery and enhancement of degraded land and climate change adaptation (EKF Project) https://qcat.wocat.net/en/wocat/approaches/view/approaches_608/; SLM Approach: On-farm pasture establishment demonstrations https://qcat.wocat.net/en/wocat/approaches/view/approaches_3285/
Documentation was facilitated by: Institution: Department of Range and Wildlife Sciences, South Eastern Kenya University (SEKU) - Kenya
Date of documentation: May 18, 2017; **Last update:** Feb. 21, 2018

Key references

KZ Mganga, NKR Musimba, DM Nyariki. 2015. Competition indices of three perennial grasses used to rehabilitate degraded semi-arid rangelands in Kenya. The Rangelands Journal 37: 489-495: The Rangeland Journal website, US Dollars $25

KZ Mganga, NKR Musimba, DM Nyariki. 2015. Combining sustainable land management technologies to combat land degradation and improve rural livelihoods in semi-arid lands in Kenya. Environmental Management 56: 1538-1548: Environmental Management Journal website, US Dollars $38

KZ Mganga, NKR Musimba, MM Nyangito, DM Nyariki, AW Mwang'ombe. 2015. The choice of grass species to combat desertification in semi-arid Kenyan rangelands is greatly influenced by their forage value for livestock. Grass and Forage Science 70: 161-167.: Grass and Forage Science Journal website, US Dollars $38

Links to relevant information which is available online

Competition indices of three perennial grasses used to rehabilitate degraded semi-arid rangelands in Kenya: http://www.publish.csiro.au/rj/RJ15023 Combining sustainable land management technologies to combat land degradation and improve rural livelihoods in semi-arid lands in Kenya: https://link.springer.com/article/10.1007/s00267-015-0579-9

The choice of grass species to combat desertification in semi-arid Kenyan rangelands is greatly influenced by their forage value for livestock: http://onlinelibrary.wiley.com/doi/10.1111/gfs.12089/abstract

Kalama Community Wildlife Conservancy site treated with restoration technology (right) bordering untreated area (left) (Hanspeter Liniger).

Rangeland restoration by cutting invasive species and grass reseeding and managing grazing (Kenya)

DESCRIPTION

This 'Rangeland Restoration' technology is part of a 'Holistic Rangeland Management' approach. It involves clearing of invasive vegetation (predominantly Acacia reficiens) and reseeding with grass (*Cenchrus ciliaris*) and allowing resting and reduced grazing pressure to rehabilitate degraded communal grazing land.

The 'Rangeland Restoration' technology is applied in degraded sites within the 3,100 ha 'core conservation area' (an central area with minimised grazing pressure designated for tourism) and 'buffer zone' (an area surrounding the 'core conservation area' with reduced grazing pressure) of the Kalama Community Wildlife Conservancy (total area: 9,500 ha). The main characteristics are clearing of invasive woody vegetation (predominantly Acacia reficiens) and reseeding with grass (*Cenchrus ciliaris*). Acacia reficiens (commonly known as red-bark acacia, red thorn or false umbrella tree or thorn) is a native tree or shrub but is considered an invasive species as it can encroach degraded areas with bare and disturbed soil. It is very opportunistic and hardy and can subsequently take over large areas of native vegetation. The invasion can reach a closed or nearly closed canopy with A. eficiens thickets, which are hindering animals to enter and access fodder thus making the area inaccessible for grazing and browsing. Additionally it can be observed that the soil underneath the canopy remains bare and the grass growth seems to be suppressed. As a result the top soil is compacted or forms crusts, which hinder infiltration. During the erratic but heavy rains most of the water flows away as runoff (research in close by areas show that runoff is between 60-80% of the rainfall) and increases soil erosion and further degradation of the land despite a rather good tree cover. Rangeland grass and fodder productivity in these areas are reduced to a fraction of their potential.

The main activity is the cutting of the trees and shrubs at a height of ~1 m. The main trunks and branches can be used for fencing, temporary house constructions, firewood and charcoal. Most of the cut trees and the remaining branches are used to spread on the bare land where the trees and shrubs are cut. Underneath this dead material the bare soil receives some cover, which creates favourable conditions and microclimate for termites and other fauna in the soil to brake the hard top soil and crust and enable infiltration of the water during the next rains. This allows regrowth of grasses, particularly in the areas protected by the branches. In the following seasons the spread of the grasses can increase also the the area not protected by the branches. Additionally, seeding with *Cenchrus ciliaris* (buffel-grass or African foxtail grass), a grass species which is native to most of Africa, enhances the growth of a highly valuable fodder grass. Seeds are hand-broadcasted in the treated areas and germinate during the next rainy season. The first greening is visible in the places where the branches and the wood pieces cover the soil. From there the local annual and perennial grasses start colonising and expanding in the following seasons until, ideally, the whole area that has been bare is covered by valuable perennial grasses. Parallel to the cutting and reseeding is reduced grazing pressure and a resting period over

LOCATION

Location: Samburu County, Kenya

No. of Technology sites analysed: 2-10 sites

Geo-reference of selected sites

- 37.52845, 0.69574
- 37.58098, 0.70432
- 37.56415, 0.69437

Spread of the Technology: applied at specific points/ concentrated on a small area

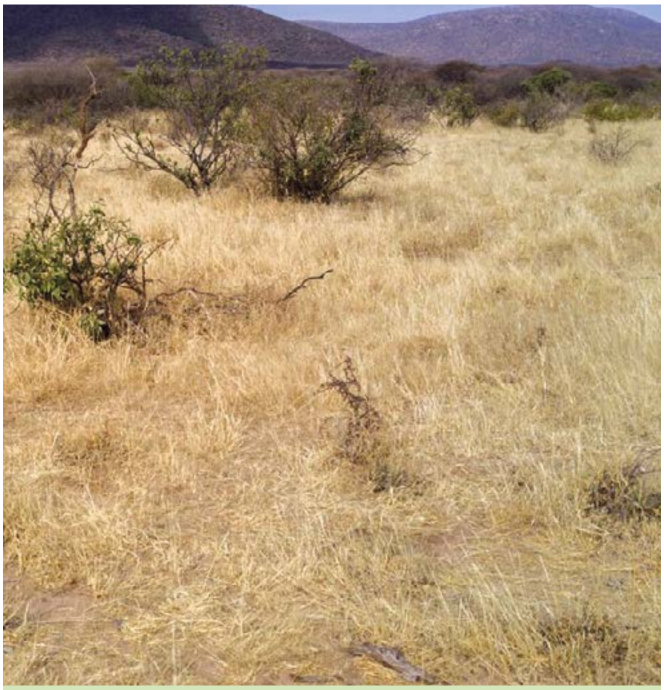
Date of implementation: 2006

Type of introduction

- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ✓ through projects/ external interventions

Comment: Acacia reficiens was already selectively cleared traditionally when constructing livestock corrals ('bomas'), but the introduction of more extensive clearing and grass-reseeding to rehabilitate specific areas was facilitated by Northern Rangeland Trust and Grevy's Zebra Trust.

Recently treated site with cut Acacia reficies branches laid on bare ground and in erosion gully (Hanspeter Liniger).



Site treated approximately 10 years previously (Hanspeter Liniger).

at least one dry season, which is facilitated by the fact that treated areas are situated in the core conservation area or in the buffer zone. This involves the cooperation of the members of Kalama Conservancy, who agree to restrict grazing in the buffer zone and more so in the core conservation area. The exact duration that grazing is allowed in each of these two areas varies year to year depending on drought severity and forage availability. Whereas the grazing pressure by livestock can be regulated, there remains uncontrolled grazing by wildlife. The major herbivores are zebra, elephants and a number of different gazelle and antelope species the grazing pressure by wildlife varies but can be substantial at certain times.

Rehabilitating degraded grazing land is the primary purpose of the technology. Other benefits of the technology include: 1) augmented forage availability for the community; 2) increased livestock production; 3) reduced soil erosion and flooding. Land users enjoy these benefits but would like larger areas to be similarly restored. However, the limiting factor is the funding required to pay for labour, which is the major input required for the clearing and reseeding activities. Establishing a market for removing the main stems and producing and selling charcoal is still an opportunity to further explore immediate benefits and cash income in order to pay for the investment into the clearing.

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [ ] improve production
- [x] reduce, prevent, restore land degradation
- [x] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [x] preserve/ improve biodiversity
- [ ] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [ ] create beneficial economic impact
- [ ] create beneficial social impact

Land use

Grazing land – Extensive grazing land: Semi-nomadism/ pastoralism, Ranching
Main animal species and products: Cattle (milk, beef), Sheep/Goats (milk, meat), Camels (milk, meat), Donkeys

Unproductive land – Specify: Bare and/or degraded land
Remarks: The area has been overused and continuously grazed for a long period of time without given the land and vegetation a break to recover. Thus a vicious spiral developed: the reduced grass cover lead to degradation of the soil to compaction and crusting, reduced infiltration thus reduced runoff and reduced vegetation growth, which in turn increased the pressure on the remaining vegetation and thus more base soil etc.

Water supply

- [x] rainfed
- [ ] mixed rainfed-irrigated
- [ ] full irrigation

Number of growing seasons per year: 2
Livestock density: likely continuously growing till technology was introduced.

Purpose related to land degradation

- ☐ prevent land degradation
- ☑ reduce land degradation
- ☑ restore/ rehabilitate severely degraded land
- ☐ adapt to land degradation
- ☐ not applicable

Degradation addressed


soil erosion by water – Wt: loss of topsoil/ surface erosion, Wg: gully erosion/ gullying


physical soil deterioration – Pc: compaction, Pk: slaking and crusting

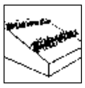

biological degradation – Bc: reduction of vegetation cover, Bs: quality and species composition/ diversity decline, Bl: loss of soil life

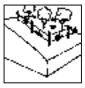

water degradation – Ha: aridification

SLM group

- pastoralism and grazing land management
- improved ground/ vegetation cover
- improved plant varieties/ animal breeds

SLM measures


vegetative measures – V2: Grasses and perennial herbaceous plants, V4: Replacement or removal of alien/ invasive species


management measures – M2: Change of management/ intensity level

TECHNICAL DRAWING

Technical specifications

A total of 279 hectares were treated with this rangeland restoration technology (clearing invasive Acacia reficiens and reseeding with *Cenchrus ciliaris*). Treated areas were relatively flat (slope < 5%). A. reficiens were cut ~1 m above the ground and well before the onset of the rains to discourage regeneration. C. ciliaris seeds were hand-broadcast at a rate of ~45 kg/ ha.

Holding membership of multiple community conservancies facilitates the movement between wet season and dry season grazing areas. For example, many of the local communities move their livestock to Losesia, in Sera Conservancy, for dry season grazing. These porous boundaries relieve pressure from Kalama Conservancy during some parts of the year, potentially facilitating recovery of treated areas, but also allows neighbouring communities to access treated areas rendering their grazing management challenging.

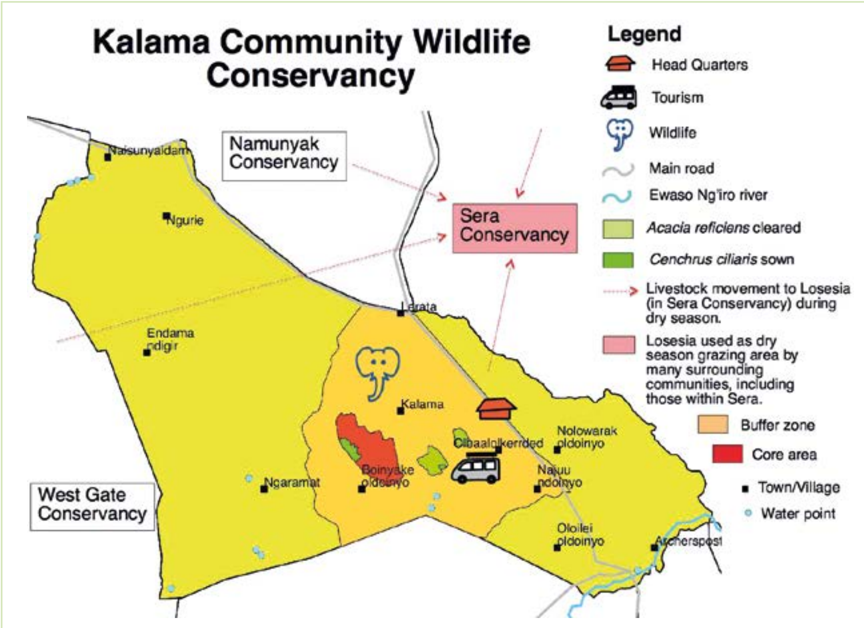


Figure: Ousmane Oumarou Bako.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **279 hectares (total over 6 sites)**)
- Currency used for cost calculation: Kenya Shillings
- Exchange rate (to USD): 1 USD = 101.00 Kenya Shillings
- Average wage cost of hired labour per day: 450 Kenya

Most important factors affecting the costs

Hiring labour, as it was the most costly component.

Establishment activities

1. Clearing Acacia reficiens (cutting and spreading) (Timing/ frequency: During dry season, well before the onset of rains to prevent Acacia reficiens regrowth from stump.)
2. Reseeding with *Cenchrus ciliaris* grass seed (Timing/ frequency: Prior to the onset of rainy season to maximise germination and establishment of *Cenhrus ciliaris*.)

Establishment inputs and costs

Specify input	Unit	Quantity	Cost per unit (Kenya Shillings)	Total cost per input (Kenya Shillings)
Labour				
Clearing Acacia reficiens	person-days	1,200	450.00	540,000.00
Hand-broadcasting *Cenchrus ciliaris* seeds	person-days	1,200	450.00	540,000.00
Equipment				
Machettes	units	40	500.00	20,000.00
Plant material				
Cenchrus ciliaris seeds	kg	2,520	50.00	126,000.00
Other				
Transport of workers to and from site	litre	600	100.00	60,000.00
			Total costs for establishment of the Technology	**1,286,000.00**

If land user bore less than 100% of costs, indicate who covered the remaining costs
Funding raised by Northern Rangelands Trust and Grezy's Zebra Trust (including USAID and FAO funding).

Comment: These are the costs associated a 55 ha treated area. Six sites of a similar size were treated with similar budgets totalling 279 ha.

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [x] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [ ] humid
- [ ] sub-humid
- [x] semi-arid
- [ ] arid

Specifications on climate
Average annual rainfall in mm: 351
Name of the meteorological station: Archer's Post

Slope
- [x] flat (0-2%)
- [x] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landform
- [x] plateau/ plains
- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [x] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [x] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [ ] medium (1-3%)
- [x] low (<1%)

Available information: pH ~7-8.5; SOC 4.7 g/ kg of soil; Na ~0.1-0.4 cmolc/ kg.

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [x] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [ ] medium
- [x] poor/ none

Water quality (untreated)
- [ ] good drinking water
- [x] poor drinking water (treatment required)
- [ ] fine/ heavy (clay)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Is salinity a problem?
- [ ] yes
- [x] no

Occurrence of flooding
- [ ] yes
- [x] no

Species diversity
- [x] high
- [ ] medium
- [ ] low

Habitat diversity
- [ ] high
- [x] medium
- [ ] low

Comment: Rangelands in Kenya are generally characterized by high bio-diversity. The particular sites have been degraded in terms of vegetation ans soils. After the restoration diversity increases but has not reached its full potential.

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial
- [ ] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [ ] 10-50% of all income
- [x] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanisation
- [x] manual work
- [ ] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [ ] sedentary
- [x] semi-nomadic
- [ ] nomadic

Individuals or groups
- [ ] individual/ household
- [x] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [x] men

Age
- [ ] children
- [x] youth
- [x] middle-aged
- [ ] elderly

Comment: Kalama Conservancy receives considerable income from the high end tourism (~60% of total income) and donations (~25% of total income).

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [x] > 10,000 ha

Scale
- [ ] small-scale
- [ ] medium-scale
- [x] large-scale

Land ownership
- [ ] state
- [ ] company
- [x] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled

Land use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor		✓		good
education	poor			✓	good
technical assistance	poor			✓	good
employment (e.g. off-farm)	poor			✓	good
markets	poor	✓			good
energy	poor		✓		good
roads and transport	poor		✓		good
drinking water and sanitation	poor			✓	good
financial services	poor		✓		good

IMPACTS – BENEFITS AND DISADVANTAGES

Socio-economic impacts

fodder production	decreased							✓	increased	**Comment:** Due to degradation fodder production before was minimal both for grasses (hardly that survived the grazing pressure) as well as accessible browse material.
fodder quality	decreased						✓		increased	**Comment:** Perennial grasses were brought back.
animal production	decreased						✓		increased	
wood production	decreased					✓			increased	**Comment:** Cut wood of the invasive species can be used for charcoal production, and construction material. The amount is high but the marketing is still weak, so most of it is left to be spread on the ground.
forest/ woodland quality	decreased						✓		increased	**Comment:** One dominate invasive wood species was removed to give way for other native species to repopulate the area.

Socio-cultural impacts

food security/ self-sufficiency	reduced						✓		improved
SLM/ land degradation knowledge	reduced						✓		improved
conflict mitigation	worsened						✓		improved

Ecological impacts

surface runoff	increased						✓		decreased	**Comment:** There is still potential to decrease runoff further a the system is still recovering and improving.
soil moisture	decreased						✓		increased	

		1	2	3	4	5	6	7	
soil cover	reduced							✓	improved
soil loss	increased						✓		decreased
soil crusting/ sealing	increased						✓		reduced
soil compaction	increased						✓		reduced
nutrient cycling/ recharge	decreased					✓			increased
soil organic matter/ below ground C	decreased						✓		increased
vegetation cover	decreased						✓		increased
biomass/ above ground C	decreased						✓		increased
plant diversity	decreased							✓	increased

Off-site impacts

		1	2	3	4	5	6	7	
downstream flooding (undesired)	increased					✓			reduced
downstream siltation	increased						✓		decreased
damage on public/ private infrastructure	increased					✓			reduced

Comment: Damage on major bridges but also on smaller within the conservancy.

Benefits compared with establishment costs

		1	2	3	4	5	6	7	
Short-term returns	very negative						✓		very positive
Long-term returns	very negative							✓	very positive

CLIMATE CHANGE

Climate change/ extreme to which the Technology is exposed

How the Technology copes with these changes/ extremes

Gradual climate change

		1	2	3	4	5	
annual temperature increase	not well at all			✓			very well

Climate-related extremes (disasters)

		1	2	3	4	5	
local rainstorm	not well at all					✓	very well
drought	not well at all				✓		very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ✓ single cases/ experimental
- 1-10%
- 10-50%
- more than 50%

Of all those who have adopted the Technology, how many have did so without receiving material incentives?

- ✓ 0-10%
- 10-50%
- 50-90%
- 90-100%

Has the Technology been modified recently to adapt to changing conditions?

- yes
- ✓ no

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Strengths

Land user's view
- Land that was previously considered unproductive is now considered grazing land.
- Increased infiltration and decreased runoff and water erosion.
- Recolonisation by local grasses and forbs to replace reseeded *Cenchrus ciliaris* after 1-2 years provides nutritious forage (particularly the forbs) for livestock.

Key resource person's view
- Decreased impact of the invasive *Acacia reficiens* on vegetation and soil within treated areas.
- Increased biomass of herbaceous vegetation for livestock and wildlife forage.
- Augmented biodiversity after reseeded *Cenchrus ciliaris* replaced by local grasses and forbs.

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view
- Creates overly high expectations from the community regarding the potential to restore larger areas. → Raise awareness among community members regarding the limitations of large-scale restoration.
- Lack of funds to pay labourers. Paying community members to undertake restoration activities rather than these activities being voluntary is now, in hindsight, perceived to have been a mistake. → There will never be enough funding as labourers will continue to expect ever-increasing wages. However, over time, community members may decide to restore land voluntarily. Explore the potential for marketing the main trunks for charcoal production of firewood to pay for the labourers.
- Controlling grazing in recovering areas. → Raise awareness about the restoration projects within immediate and neighbouring communities. Also, ensure grazing by-laws are implemented and offenders fined.
- Land users unwilling to voluntarily take part in restoration activities. → Increase ownership by conducting restoration projects at more local zonal-levels rather than at the conservancy-level. Create additional incentives by using and marketing of some of the wood material (for legal charcoal production).

Key resource person's view
- Inability to provide adequate rest to treated areas (i.e. by controlling grazing pressure) leading to unsuccessful establishment of *Cenchrus ciliaris* or other herbaceous vegetation in treated areas, particularly in 'buffer zone'. → Implement grazing rules more stringently.
- Lack of capacity regarding how to reseed *Cenchrus ciliaris* in some treated areas. In one case, seeds were buried (as farmers do with maize seeds), which is reported to have contributed to low establishment success of *Cenchrus ciliaris* seeds. → Capacity building.
- Germination and establishment of *Cenchrus ciliaris* depends on timing in relation to the onset of rains, which are unpredictable and led to unsuccessful rehabilitation of some treated areas. → Provide most accurate weather forecasts available.

REFERENCES

Compiler: Harry Wells (harrybmwells@gmail.com)
Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/technologies/view/technologies_3381/
Linked SLM data: SLM Approach: Holistic Rangeland Management combined with high end tourism https://qcat.wocat.net/en/wocat/approaches/view/approaches_3399/
Date of documentation: Feb. 5, 2018; **Last update:** March 23, 2018

Key references
'Northern Rangeland Trust: Baseline assessment of rangeland health - Kalama and Namunyak conservancies', Tor-G. Vågen & Leigh A. Winowiecki, 2014: https://cgspace.cgiar.org/bitstream/handle/10568/65671/nrtReport_march2014.pdf?sequence=1
Links to relevant information which is available online
Northern Rangeland Trust: Baseline assessment of rangeland health - Kalama and Namunyak conservancies: https://cgspace.cgiar.org/bitstream/handle/10568/65671/nrtReport_march2014.pdf?sequence=1

Manual bush harvesting with axes and mechanised processing into wood chips, Otjozondjupa Region Namibia (Cheetah Conservation Fund).

Bush thinning and biomass processing by manual or mechanised means (Namibia)

Bush Thinning

DESCRIPTION

In Namibia, excess bush is harvested to reduce competition with other plants, especially grasses. Bush can be thinned manually (e.g. with axes), semi-mechanised (e.g. chainsaws) or fully mechanised (e.g. customised equipment). After cutting, the bush is left to dry and then processed into chips or other products.

Bush thinning is carried out in Namibia to restore degraded rangeland by stimulating the re-growth of grasses – which are suppressed by excess bush. About 30-45 million hectares are affected by bush encroachment, and this affects biodiversity, groundwater recharge and the carrying capacity of rangeland. There are many causes of bush encroachment, including overgrazing and reduced frequency of wildfires. Most bush encroachment involves indigenous, rather than invasive, species.

While natural transitions in the ecosystems may lead to reductions in bush encroachment, active rehabilitation measures are required for the short-term improvements. This is an absolute necessity for many farmers, who experience severe economic difficulties due to the reduced productivity of their rangeland.

Bush control comprises responsive measures (bush thinning), follow-up measures (aftercare) as well as preventative measures (good rangeland management). Since vast areas of Namibian rangeland are heavily encroached by bush, the focus is currently on bush thinning. This entails selective harvesting of bush. To determine the density of bush remaining after thinning, a formula based on tree equivalent (TE) and average annual rainfall is used. One TE is defined as a woody tree or bush of 1.5 metres in height.

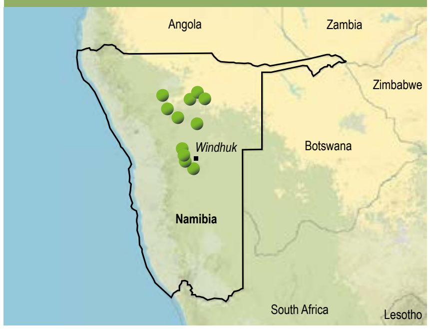
As rule of thumb for attaining optimal bush density, about 30-35% of encroacher biomass should be removed. This is based on research carried out mainly in South Africa, measuring and comparing the re-growth after bush removal. Where too much bush was removed, this often resulted in even heavier encroachment.

Bush thinning follows strict environmental guidelines set by the Directorate of Forestry (DoF) through the Forestry Act and the Directorate of Environmental Affairs (DEA) through the Environmental Management Act. This governs the equipment used (to avoid soil disturbance) and the amount of bushes harvested (to achieve a healthy number of the desired bush species). The amount of bushes to be harvested is determined by an expert and depends on various factors.

While there is a lack of precise knowledge on the long-term effect of bush thinning, there is no doubt that control has an overall positive effect on the savannah ecosystem in Namibia. The need is widely recognised among land owners and acknowledged on the national political agenda.

To render bush thinning economically feasible, value chains have been developed. Through processing and utilisation of the woody biomass, income can be generated. Processed bush biomass can, for example in the form of chips, can be used for thermal and electrical energy applications (e.g. local biomass power plants or biomass boilers for

LOCATION



Location: Bush control is applied across Namibia on many privately owned farms. Activities are most concentrated in the regions Khomas, Omaheke, Namibia

No. of Technology sites analysed: 100-1,000 sites

Geo-reference of selected sites
- 16.15492, -20.10128
- 17.33093, -19.63741
- 15.91322, -19.39298
- 17.71545, -19.25411

Spread of the Technology: evenly spread over an area (approx. 1,000-10,000 km²)

Date of implementation: 2015

Type of introduction
- ☑ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☑ during experiments/ research
- ☑ through projects/ external interventions

Comment: Since the 1950s the phenomenon of bush encroachment has been recognized by farmers in Namibia and counter measures have been implemented over the decades.

Mechanised bush harvesting using a customised excavator with hydraulic shear (Ohlthaver & List).


Manual bush cutting with axes (Cheetah Conservation Fund).

industry). Currently two such energy installations exist in Namibia, one at a local brewery and one at a local cement factory. In addition, the national power utility NamPower currently considers the construction of a 20-40 MW biomass power plant.

Other existing value chains include the production of charcoal, firewood, poles, as well as bush -based animal feed. Further value chains under consideration include composite materials, such as wood-plastic, as well as biochar.

Scientific observations have shown, that bush thinning requires regular follow-up. These measures ('aftercare') include the prevention of coppicing and re-growth. This can be achieved by applying aboricides selectively to the cut stems, stem fires or the introduction of browsers (e.g. goats). Research on the effectiveness and possible side effects of each of these methods is limited.

A major challenge is the limited suitability of available machines. The process leads to high wear and tear on the equipment (both harvesting and processing technology, (like chippers and pelletisers), often rendering operations unprofitable. Research into, and development of, more suitable machinery is necessary. Other requirements are improved skills training and continuous monitoring of the long-term effects on rangeland.

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- ✓ improve production
- ✓ reduce, prevent, restore land degradation
- ✓ conserve ecosystem
- protect a watershed/ downstream areas – in combination with other Technologies
- ✓ preserve/ improve biodiversity
- reduce risk of disasters
- adapt to climate change/ extremes and its impacts
- mitigate climate change and its impacts
- ✓ create beneficial economic impact
- create beneficial social impact

Land use


Grazing land – Extensive grazing land: Ranching Main animal species and products: Cattle, goats, game

Water supply

- ✓ rainfed
- mixed rainfed-irrigated
- full irrigation

Number of growing seasons per year: 1
Land use before implementation of the Technology: The implementation of bush thinning allows to maintain the land use (e.g. cattle ranching) and is typically applied to increase productivity in the long-term.
Livestock density: 284,000 in targeted area (105,460 km^2) of bush thinning (Otjozondjupa region).

Purpose related to land degradation

- ✓ prevent land degradation
- reduce land degradation
- ✓ restore/ rehabilitate severely degraded land
- adapt to land degradation
- not applicable

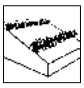
Degradation addressed

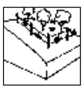

biological degradation – Bh: loss of habitats; Bq: quantity/ biomass decline; Bs: quality and species composition/ diversity decline

SLM group

- pastoralism and grazing land management
- improved ground/ vegetation cover

SLM measures

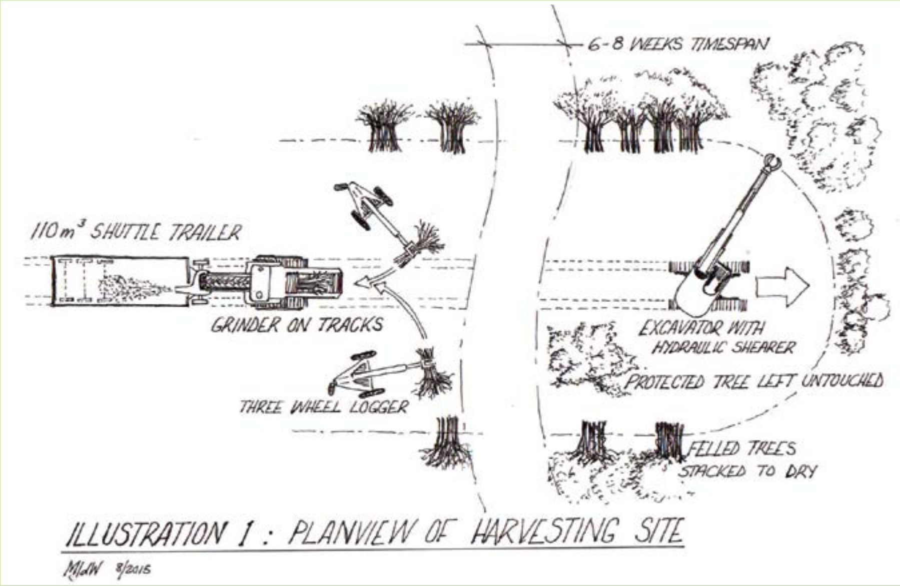

vegetative measures – V4: Replacement or removal of alien/ invasive species


management measures – M2: Change of management/intensity level, M5: Control/ change of species composition

TECHNICAL DRAWING

Technical specifications

Drawing of a bush harvesting site layout. The drawing depicts fully mechanised bush harvesting and immediate processing into wood chips. This set-up is most suitable for large-scale bush thinning, e.g. for the purpose of supplying biomass in larger quantities. Such off-take includes the potential export of bush in processed form (pellets) or energetic utilisation (e.g. local biomass power plants or biomass boilers in the industry). Currently two such energy solutions exist in Namibia, one at a local brewery and one at a local cement factory. Note that a range of bush harvesting methods exist, ranging from fully mechanised (as depicted) to manual bush harvesting (e.g. with axes). The site layout and principles are the same in all scenarios, but harvesting speed and costs differ.



Author: M.J. de Wet Pr. Eng., NRGen Advisors (Pty) LTD.

The bush harvesting process: Bushes are harvested selectively with and excavator, to which a hydraulic sheer cutter is attached. The biomass is stacked in rows and left for drying some six to eight weeks (depending on weather conditions). The biomass is then further processed with a chipper and collected with a trailer for further transport off the farm (e.g. to a biomass power plant or industrial off-taker). As a rule of thumb, one third of the standing biomass is removed, leaving two thirds standing. Harvesting starts with smaller plants and then moves to larger ones, cutting only plants with 15 centimetres of diameter or less (as per Namibian forestry regulations).

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **1 hectare**)
- Currency used for cost calculation: **Namibia Dollar (NAD)**
- Exchange rate (to USD): 1 USD = 0.078 Namibia Dollar (NAD)
- Average wage cost of hired labour per day: Namibia Dollar (NAD) 110

Most important factors affecting the costs

(1) Investment in machinery (if not applied manually). (2) Maintenance of machinery (high wear and tear due to hardness of wood and high mineral content). (3) Remoteness of farms/land from buyers/ markets.

Establishment activities

1. Bush harvesting/felling (Timing/ frequency: Year around)
2. Stacking (and drying) (Timing/ frequency: Year around)
3. Feeding the chipping operation (Timing/ frequency: Year around)
4. Transport (Timing/ frequency: Year around)

Comment: The restorative measure includes bush harvesting/ felling as well as aftercare measures. Additional activities include the processing (e.g. into chips) and transport of the woody material off the farm/ land.

Establishment inputs and costs

Specify input	Unit	Quantity	Costs per Unit (Namibia Dollar (NAD))	Total costs per input (Namibia Dollar (NAD))	% of costs borne by land users
Labour					
1 x Mechanic	person days	0.2	2,000.00	400.00	
4 x Operators	person days	0.8	300.00	24.00	
1 x Operation manager chipping	person days	0.2	1,000.00	200.00	
1 x Chipping operator	person days	2	150.00	300.00	
Equipment					
1 x 12t Excavator	pieces	1	120.00	120.00	
2 x Hydraulic grab and shearing attachments	pieces	2	60.00	120.00	
2 x Three wheel loggers	pieces	2	180.00	360.00	
1 x Chipper	pieces	1	840.00	840.00	
Other					
Management and administration overhead	lump sum	1	200.00	200.00	12.0
Total costs for establishment of the Technology				**2,780.00**	

Comment: Cost of bush harvesting can be calculated per hectare (e.g. land owner's perspective) or per tonne (in fuel supply agreements with off-takers). All given costs are approximations, as costs vary widely depending on the local framework conditions on a given piece of land. Typically the costs to harvest and process bush on one hectare range from 2,000 NAD to 4,000 NAD.

Maintenance activities
1. Aftercare (Timing/ frequency: Annually)

Total maintenance costs (estimation) 500.00

Comment: When land is thinned it creates a vacuum in which weeds and woody plants (sometimes more aggressive colonisers than the original encroacher species) will quickly establish themselves. Regular aftercare needs to be applied in order to prevent the excessive re-growth of bush (and therewith new degradation of the land). Various methods are in use to manage the re-growth of bush following harvesting. These include selective application of arboricides, stem burning, and intensive browsing by goats or antelopes.

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [x] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [ ] humid
- [ ] sub-humid
- [x] semi-arid
- [ ] arid

Specifications on climate
Average annual rainfall in mm: 350.0

Namibia is a semi-arid country and rainfall ranges roughly from 150-550 mm per year (rough approximation due to the vastness of the area described).

Name of the meteorological station: Various

Slope
- [ ] flat (0-2%)
- [x] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landform
- [x] plateau/ plains
- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [x] valley floors

Altitude
- [ ] 0-100 m a.s.l.
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- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [ ] medium (1-3%)
- [x] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [ ] medium
- [x] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] fine/ heavy (clay)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Is salinity a problem?
- [ ] yes
- [x] no

Occurrence of flooding
- [ ] yes
- [x] no

Species diversity
- [ ] high
- [ ] medium
- [x] low

Habitat diversity
- [ ] high
- [x] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [ ] mixed (subsistence/ commercial
- [x] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [x] average
- [ ] rich
- [ ] very rich

Level of mechanisation
- [ ] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] sedentary
- [ ] semi-nomadic
- [ ] nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- < 0.5 ha
- 0.5-1 ha
- 1-2 ha
- 2-5 ha
- 5-15 ha
- 15-50 ha
- 50-100 ha
- 100-500 ha
- 500-1,000 ha
- ✓ 1,000-10,000 ha
- > 10,000 ha

Scale
- small-scale
- medium-scale
- ✓ large-scale

Comment: Typical commercial farm size is 5,000 ha. The size increases with decreasing rainfall (towards southern Namibia).

Land ownership
- state
- company
- communal/ village
- group
- individual, not titled
- ✓ individual, titled

Land use rights
- open access (unorganized)
- communal (organized)
- leased
- ✓ individual

Water use rights
- open access (unorganized)
- communal (organized)
- leased
- ✓ individual

Access to services and infrastructure

health	poor			✓	good
education	poor			✓	good
technical assistance	poor		✓		good
employment (e.g. off-farm)	poor	✓			good
markets	poor		✓		good
energy	poor		✓		good
roads and transport	poor		✓		good
drinking water and sanitation	poor			✓	good
financial services	poor	✓			good

IMPACTS – BENEFITS AND DISADVANTAGES

Socio-economic impacts

fodder production	decreased						✓		increased	**Comment:** Bush-based animal feed production has been successfully trailed and is implemented by various farmers across Namibia.
animal production	decreased						✓		increased	**Comment:** Carrying capacity of bush controlled land increases if regular aftercare is implemented.
energy generation (e.g. hydro, bio)	decreased						✓		increased	**Comment:** Bush-to-electricity value chain under development. Several industrial off-takers use woody biomass for boilers (heat), the national power utility currently develops a first biomass power plant.
water availability for livestock	decreased						✓		increased	**Comment:** Studies show a direct positive correlation between the extent of bush control and the availability of groundwater.
farm income	decreased						✓		increased	**Comment:** Bush based value addition, e.g. charcoal production, leads to additional income for land owners and farm workers.
diversity of income sources	increased					✓			decreased	**Comment:** Bush based value addition, e.g. charcoal production, leads to additional income for land owners and farm workers.

Ecological impacts

biomass/ above ground C	decreased		✓						increased	
plant diversity	decreased					✓			increased	
invasive alien species	increased							✓	reduced	**Comment:** Alien species are completely removed where possible (e.g. Prosopis).

Benefits compared with establishment costs

Short-term returns	very negative		✓						very positive
Long-term returns	very negative							✓	very positive

Benefits compared with maintenance costs

Short-term returns	very negative		✓						very positive
Long-term returns	very negative							✓	very positive

Comment: Bush thinned land takes 3-5 years to fully recover its productive grass layer, thus direct economic benefits are only experienced with a delay.

CLIMATE CHANGE

Climate change/ extreme to which the Technology exposed — **How the Technology copes with these changes/ extremes is**

Gradual climate change

annual rainfall decrease	not well at all		✓				very well

Climate-related extremes (disasters)

drought	not well at all	✓					very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ✓ single cases/ experimental
- 1-10%
- 10-50%
- more than 50%

Of all those who have adopted the Technology, how many have did so without receiving material incentives?

- 0-10%
- 10-50%
- ✓ 50-90%
- 90-100%

Number of households and/ or area covered

120,000 hectares are bush thinned per year in Namibia; figures on the increase.

Has the Technology been modified recently to adapt to changing conditions?

- ✓ yes
- no

To which changing conditions?

- climatic change/ extremes
- ✓ changing markets
- labour availability (e.g. due to migration)

Specify adaptation of the Technology

Increasingly bush harvesting is carried out with mechanised means, aiming at large scale production for large biomass off-takers, both in the country and internationally.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Strengths

Land user's view

- Effective measure against bush encroachment.
- Costs can be balanced with additional income through the sale of the biomass/biomass based products.

Key resource person's view

- Apart from the main purpose of rehabilitating rangeland, bush control has various side benefits, such as employment creation and industrialisation.
- Bush control and biomass utilisation can contribute to energy security in the country.
- The available range of technologies (from manual to fully mechanised) allows to develop viable concept for all types of land/ land ownership scenarios.

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view

- High initial costs involved. → Development of dedicated financial products.
- Possible negative consequences, such as more aggressive regrowth of species. → Increased knowledge dissemination, skills development and mentorship programmes.

Key resource person's view

- Necessity of cross-sector collaboration, e.g. agriculture, forestry, environment, industry, energy and resulting complexity. → Introduction of effective steering body on national level.
- Challenges to sustain operations in communal areas/on land that is not owned by individuals. → Development of concepts for community based projects and cooperation with relevant regional authorities and decision making bodies (e.g. Regional Councils, Conservancies).

REFERENCES

Compiler: Johannes Laufs (johannes.laufs@giz.de)
Resource persons: Johannes Laufs (johannes.laufs@giz.de) - SLM specialist; Frank Gschwender (frank.gschwender@giz.de) - SLM specialist
Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/technologies/view/technologies_2203/
Linked SLM data: SLM Approach: Bush Control and Biomass Utilisation https://qcat.wocat.net/en/wocat/approaches/view/approaches_2809/
Documentation was facilitated by: Institution: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). Project: GIZ Support to De-bushing Project
Date of documentation: May 9, 2017; **Last update:** Feb. 21, 2018

Key references
Baseline Assessment for De-bushing Programme in Namibia (2014): GIZ Support to De-bushing Project, www.dasnamibia.org/downloads
Demand Survey for the implementation of a De-bushing Advisory Service (2015): GIZ Support to De-bushing Project, www.dasnamibia.org/downloads
Value Added user-opportunities for encroacher bush (2015): GIZ Support to De-bushing Project, www.dasnamibia.org/downloads
Compendium of harvesting technologies for encroacher bush (2015): GIZ Support to De-bushing Project, www.dasnamibia.org/downloads
Assessment of biomass resource and potential yield in Namibia (2015): GIZ Support to De-bushing Project, www.dasnamibia.org/downloads
Strategic Environmental Assessment (SEA) on bush thinning and biomass utilisation (2015): GIZ Support to De-bushing Project, www.dasnamibia.org/downloads
Assesment of financial products and incentive schemes for bush harvesting and value addition (2015): GIZ Support to De-bushing Project, www.dasnamibia.org/downloads
Environmental and forestry bush harvesting guidelines and generic Environmental Management Plan (2016): GIZ Support to De-bushing Project, www.dasnamibia.org/downloads
Regional assessment of the economics of land degradation related to bush encroachment in Otjozondjupa, Namibia: GIZ Support to De-bushing Project, www.dasnamibia.org/downloads

Links to relevant information which is available online
De-bushing Advisory Service (DAS) Namibia, Resource Section: www.dasnamibia.org/downloads
Namibia Biomass Industry Group (N-BiG): www.n-big.org
Videos: https://www.youtube.com/channel/UCwCICCfwf0SdVBqg2ZcAcKA
Namibia Charcoal Association (NCA): www.ncanamibia.com

Rehabilitation of gully erosion in the Mapungubwe National Park in South Africa (J. Buckle).

Reshaping of gully erosion through integration of silt fences, erosion blankets and brush packing (South Africa)

Yaki da Garmani

DESCRIPTION

The rehabilitation of active gully erosion by re-sloping the banks of the gully in an effort to manage the energy of the water entering the system. Bare soil is protected from erosion by covering it with erosion blankets, brush packing and the establishment of silt fences.

This gully reshaping project was conducted in the Mapungubwe National Park in the Limpopo Province of South Africa. The area receives summer rainfall with an annual average of around 600 to 700 mm. Thunderstorms are common. Due to overgrazing on highly erodible soils, gully headcuts are actively migrating upstream. The reshaping technology can be considered for any gully of up to 2 meters in depth (even on duplex – highly erodible soils – gypsum must, however, be added to the relocated topsoil in this case). The purpose of re-sloping is to reduce the gradient of gully heads and sidewalls, thereby reducing the energy of runoff water. This also leads to enhanced vegetation cover and reduced sediment transport in the gully. Resloping of gullies is performed in stages:

Stage One: Remove all viable and useful plants in and around the active gully system that will be affected by the reshaping – store these for replanting.

Stage Two: Relocate the usable topsoil to the edge of the gully reshape footprint.

Stage Three: Reshaping of the gully banks to a 1:3 slope (relative to the new valley floor level after refilling with bank material – see figure). Start by removing the top of the bank and placing it on the gully floor. Make sure to compact the soil from the banks – breaking up clods to smaller particles. Continue to remove more of the bank material and compact it in layers to form a disk shape profile (cross section – see sketch).

Stage Four: Spread the topsoil evenly over the newly created gentle sloping profile. Add indigenous grass seed (if available: if not, exotic grasses).

Stage Five: Construct silt fences (made of fabric filter cloth – Geotextile) above the water entry points and inside the newly formed profile (around 10 mapart).

Stage Six: Cover the area with soil erosion blankets (bio-jute) and/or mulch and/or brush packing with thorny local woody biomass.

Stage Seven: Replant recovered plants – protect the area with fences if possible until grass cover established.

LOCATION

Location: Mapungubwe National Park, Limpopo province, South Africa

No. of Technology sites analysed: single site

Geo-reference of selected sites
- 29.24485, -22.23775
- 29.24485, -22.23775
- 29.24485, -22.23775

Spread of the Technology: applied at specific points/ concentrated on a small area

Date of implementation: 2017

Type of introduction
- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ☑ through projects/ external interventions


Gully erosion occurring in the Mapungubwe National Park (J Buckle).


Reshaping of the gully (J Buckle).

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- ☐ improve production
- ✓ reduce, prevent, restore land degradation
- ✓ conserve ecosystem
- ✓ protect a watershed/ downstream areas – in combination with other Technologies
- ☐ preserve/ improve biodiversity
- ✓ reduce risk of disasters
- ☐ adapt to climate change/ extremes and its impacts
- ☐ mitigate climate change and its impacts
- ☐ create beneficial economic impact
- ✓ create beneficial social impact

Land use


Grazing land – Extensive grazing land: Ranching


Waterways, waterbodies, wetlands – Drainage lines, waterways, Swamps, wetlands
Main products/ services: Sediment trap, alluvial flood plain

Water supply

- ✓ rainfed
- ☐ mixed rainfed-irrigated
- ☐ full irrigation

Number of growing seasons per year: 1
Livestock density: High – game (various species)

Purpose related to land degradation

- ☐ prevent land degradation
- ✓ reduce land degradation
- ✓ restore/ rehabilitate severely degraded land
- ☐ adapt to land degradation
- ☐ not applicable

Degradation addressed

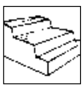

soil erosion by water – Wg: gully erosion/ gullying, Wo: offsite degradation effects

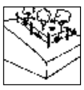

water degradation – Hp: decline of surface water quality, Hw: reduction of the buffering capacity of wetland areas

SLM group

- improved ground/ vegetation cover
- cross-slope measure
- surface water management (spring, river, lakes, sea)

SLM measures


structural measures – S6: Walls, barriers, palisades, fences


management measures – M3: Layout according to natural and human environment

TECHNICAL DRAWING

Technical specifications

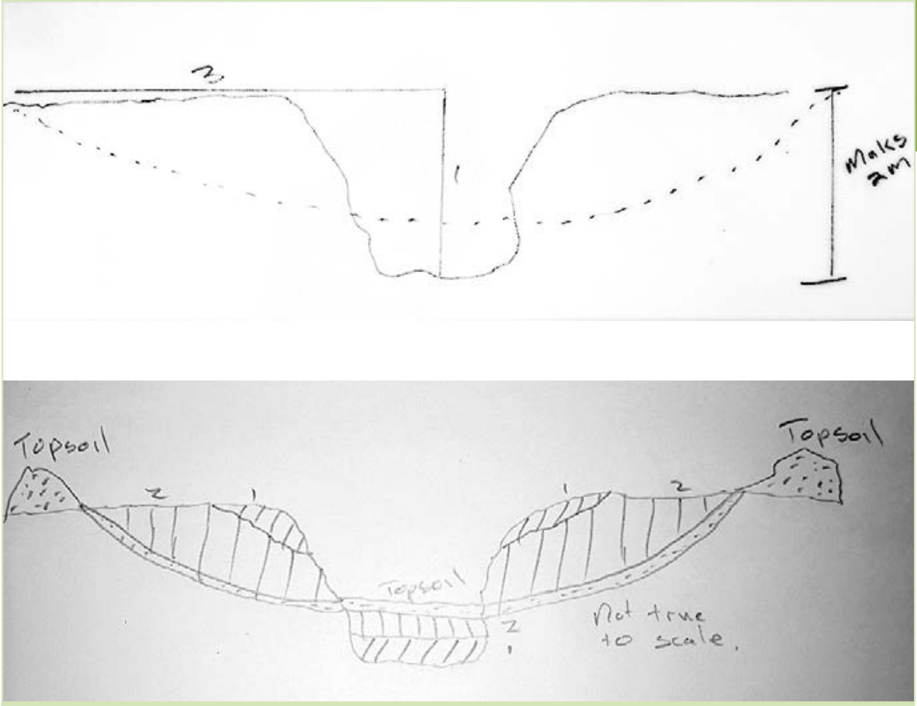
Rehabilitation of gully erosion – 0.5 m to 2 m deep.

Reslope gully banks from vertical to an approximately 30-degree slope.

Silt fences are established above gull head-cut – silt fences inside the reshaped gully – in the region of 10 m apart.

Brush packing with thorny biomass to prevent grazing and provide a microclimate for grass seed to germinate and establish.

Silt fences are temporary sediment control devices used on rehabilitation sites to reduce sediment movement downhill. A typical fence consists of a piece of synthetic filter fabric (also called a geotextile) stretched between a series of wooden or metal fence stakes along a horizontal contour level.



Author: J Buckle.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area unit: **0.017 ha**)
- Exchange rate (to USD): 1 USD = 12.00
- Average wage cost of hired labour per day: R140/ day

Most important factors affecting the costs

Labour availability, soil hardness, availability of material, transport cost.

Establishment activities

1. Remove plants (Timing/ frequency: 2 to 3 months before the summer rain).
2. Remove topsoil (Timing/ frequency: 2 to 3 months before the summer rain).
3. Reshaping, compacting, layering (Timing/ frequency: 2 to 3 months before the summer rain).
4. Reseeding (Timing/ frequency: 2 to 3 months before the summer rain).
5. Soil erosion blankets installation (Timing/ frequency: 2 to 3 months before the summer rain).
6. Silt fences (Timing/ frequency: 2 to 3 months before the summer rain).
7. Brush packing (Timing/ frequency: 2 to 3 months before the summer rain).

Establishment inputs and costs

Specify input	Unit	Quantity	Costs per Unit (n.a.)	Total costs per input (n.a.)
Labour				
Unskilled labour (including transport)	per day	60	240.00	14,400.00
Equipment				
Picks, spades, hand compactor, pliers, hopper, bow saws, hammer, wheel barrow (renting the equipment)	per day	35	20.00	700.00
Plant material				
Grass seed mix	per kilogram	2	75.00	150.00
Construction material				
Erosion blankets	per square meter	170	15.00	2,550.00
Silt fences	per meter	16	15.00	240.00
			Total costs for establishment of the Technology	**18,040.00**

If land user bore less than 100% of costs, indicate who covered the remaining costs

Department of Environmental Affairs – NRM programmes.

Maintenance activities

1. After floods restore site (silt fences and brush packing) (Timing/ frequency: After floods).

Maintenance inputs and costs (per 0.017 ha)

Specify input	Unit	Quantity	Costs per Unit (n.a.)	Total costs per input (n.a.)
Labour				
Restoration of site after flooding events	per day	6	240.00	1,440.00
Equipment				
Tools to restore fences and brush packing	per day	3	20.00	60.00
Construction material				
Silt fences	per day	10	15.00	150.00
			Total costs for establishment of the Technology	**1,650.00**

NATURAL ENVIRONMENT

Average annual rainfall
- < 250 mm
- 251-500 mm
- ✓ 501-750 mm
- 751-1,000 mm
- 1,001-1,500 mm
- 1,501-2,000 mm
- 2,001-3,000 mm
- 3,001-4,000 mm
- > 4,000 mm

Agro-climatic zone
- humid
- sub-humid
- ✓ semi-arid
- arid

Specifications on climate

Average annual rainfall in mm: 650.0

Summer thunderstorms

Hot summers and dry winters

Slope
- ✓ flat (0-2%)
- gentle (3-5%)
- moderate (6-10%)
- rolling (11-15%)
- hilly (16-30%)
- steep (31-60%)
- very steep (>60%)

Landform
- plateau/ plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- ✓ valley floors

Altitude
- 0-100 m a.s.l.
- 101-500 m a.s.l.
- ✓ 501-1,000 m a.s.l.
- 1,001-1,500 m a.s.l.
- 1,501-2,000 m a.s.l.
- 2,001-2,500 m a.s.l.
- 2,501-3,000 m a.s.l.
- 3,001-4,000 m a.s.l.
- > 4,000 m a.s.l.

Technology is applied in
- convex situations
- ✓ concave situations
- not relevant

Soil depth
- very shallow (0-20 cm)
- shallow (21-50 cm)
- moderately deep (51-80 cm)
- deep (81-120 cm)
- ✓ very deep (> 120 cm)

Soil texture (topsoil)
- coarse/ light (sandy)
- ✓ medium (loamy, silty)
- fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- coarse/ light (sandy)
- medium (loamy, silty)
- ✓ fine/ heavy (clay)

Topsoil organic matter content
- ✓ high (>3%)
- medium (1-3%)
- low (<1%)

Groundwater table
- on surface
- ✓ < 5 m
- 5-50 m
- > 50 m

Availability of surface water
- excess
- good
- ✓ medium
- poor/ none

Water quality (untreated)
- good drinking water
- poor drinking water (treatment required)
- fine/ heavy (clay)
- for agricultural use only (irrigation)
- ✓ unusable

Is salinity a problem?
- ✓ yes
- no

Occurrence of flooding
- ✓ yes
- no

Species diversity
- ✓ high
- medium
- low

Habitat diversity
- high
- medium
- ✓ low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- subsistence (self-supply)
- ✓ mixed (subsistence/ commercial
- commercial/ market

Off-farm income
- ✓ less than 10% of all income
- 10-50% of all income
- > 50% of all income

Relative level of wealth
- very poor
- ✓ poor
- average
- rich
- very rich

Level of mechanisation
- ✓ manual work
- animal traction
- mechanized/ motorized

Sedentary or nomadic
- ☐ sedentary
- ☐ semi-nomadic
- ☐ nomadic
- ✓ protected area

Individuals or groups
- ☐ individual/ household
- ☐ groups/ community
- ☐ cooperative
- ✓ employee (company, government)

Gender
- ✓ women
- ✓ men

Age
- ☐ children
- ☐ youth
- ✓ middle-aged
- ☐ elderly

Area used per household
- ☐ < 0.5 ha
- ☐ 0.5-1 ha
- ☐ 1-2 ha
- ☐ 2-5 ha
- ☐ 5-15 ha
- ☐ 15-50 ha
- ☐ 50-100 ha
- ☐ 100-500 ha
- ☐ 500-1,000 ha
- ✓ 1,000-10,000 ha
- ☐ > 10,000 ha

Scale
- ☐ small-scale
- ✓ medium-scale
- ☐ large-scale

Land ownership
- ✓ state
- ☐ company
- ☐ communal/ village
- ☐ group
- ☐ individual, not titled
- ☐ individual, titled

Land use rights
- ☐ open access (unorganized)
- ✓ communal (organized)
- ☐ leased
- ☐ individual
- ✓ state

Water use rights
- ☐ open access (unorganized)
- ☐ communal (organized)
- ☐ leased
- ☐ individual
- ✓ government land

Access to services and infrastructure

health	poor	✓			good
education	poor	✓			good
technical assistance	poor	✓			good
employment (e.g. off-farm)	poor	✓			good
markets	poor	✓			good
energy	poor		✓		good
roads and transport	poor		✓		good
drinking water and sanitation	poor	✓			good
financial services	poor	✓			good

IMPACTS – BENEFITS AND DISADVANTAGES

Socio-economic impacts

fodder production	decreased						✓		increased	**Comment:** Natural fodder for game.
land management	hindered						✓		simplified	**Comment:** Habitat for wildlife and plants improve.
water availability for livestock	decreased						✓		increased	**Comment:** Improved water quantity for game.
water quality for livestock	decreased						✓		increased	**Comment:** Better quality water for game.
diversity of income sources	increased					✓			decreased	**Comment:** Improve aesthetic value for tourism.
job creation	increased						✓		decreased	**Comment:** Job creation for communities outside the protected area.
Improved skill levels	increased			✓					decreased	**Comment:** Community receive training in rehabilitation methods.

Socio-cultural impacts

food security/ self-sufficiency	reduced						✓		improved	**Comment:** Improved income for communities.
recreational opportunities	reduced						✓		improved	**Comment:** Aesthetic improvement for tourism.
national institutions	weakened						✓		strengthened	**Comment:** Improvement of the protected area for SANPARKS.
SLM/ land degradation knowledge	reduced						✓		improved	**Comment:** Training received by communities.

Ecological impacts

water quantity	decreased						✓		increased
water quality	decreased						✓		increased
surface runoff	increased						✓		decreased
soil cover	reduced						✓		improved
soil loss	increased						✓		decreased
soil accumulation	decreased						✓		increased
soil crusting/ sealing	increased					✓			reduced
soil organic matter/ below ground C	increased					✓			reduced
vegetation cover	decreased					✓			increased

biomass/ above ground C	decreased					✓		increased
plant diversity	decreased					✓		increased
habitat diversity	decreased					✓		increased
flood impacts	increased					✓		decreased
drought impacts	increased					✓		decreased
micro-climate	worsened					✓		improved

Off-site impacts

damage on public/ private infrastructure	increased					✓		reduced
buffering/ filtering capacity (by soil, vegetation, wetlands	reduced					✓		improved

Comments regarding impact assessment: The accumulative effect of treating all gully head-cut erosion in the floodplain will have an effect on sediment loads in the Limpopo river.

Benefits compared with establishment costs

Short-term returns	very negative			✓				very positive
Long-term returns	very negative					✓		very positive

Benefits compared with maintenance costs

Short-term returns	very negative			✓				very positive
Long-term returns	very negative					✓		very positive

CLIMATE CHANGE

Climate change/ extreme to which the Technology exposed

How the Technology copes with these changes/ extremes is

Gradual climate change

annual temperature increase	not well at all				✓		very well	
seasonal temperature increase	not well at all				✓		very well	Season: summer
annual rainfall	not well at all				✓		very well	Season: summer
seasonal rainfall decrease	not well at all				✓		very well	

Climate-related extremes (disasters)

local thunderstorm	not well at all				✓		very well
land fire	not well at all				✓		very well
flash flood	not well at all				✓		very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ✓ single cases/ experimental
- 1-10%
- 10-50%
- more than 50%

Of all those who have adopted the Technology, how many have did so without receiving material incentives?

- ✓ 0-10%
- 10-50%
- 50-90%
- 90-100%

Has the Technology been modified recently to adapt to changing conditions?

- ✓ yes
- no

To which changing conditions?

- ✓ climatic change/ extremes
- changing markets
- labour availability (e.g. due to migration)

Specify adaptation of the Technology

Preventative erosion measures above the intervention.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Strengths

Land user's view
- Good technology to stabilise degraded landscapes.
- Technology helps to improve the habitat – biodiversity in the protected area.
- Technology helps to reduce the off-site effects of polluted surface water and sediment accumulation in rivers.

Key resource person's view
- Good technology to stabilise degraded landscapes.
- Technology helps to improve the habitat – biodiversity in the protected area.
- Technology helps to reduce the off-site effects of sediment accumulation in rivers.

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view
- Sensitive to flooding. → Better timing of intervention.
- Sensitive to fire. → Construct fire breaks around interventions.

REFERENCES

Compiler: Dirk Pretorius (dirk@smc-synergy.co.za)
Resource persons: Jacob Buckle (JBuckle@environment.gov.za) - SLM specialist
Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/technologies/view/technologies_3359/
Linked SLM data: SLM Approach: Working for Water https://qcat.wocat.net/en/wocat/approaches/view/approaches_2338/
Documentation was facilitated by: Institution: SMC Synergy (SMC Synergy) - South Africa. Project: Working on Ecosystems (Natural Resource Management Programmes – DEA, South Africa)
Date of documentation: Jan. 22, 2018; **Last update:** April 20, 2018

Key references
Wetland Rehabilitation Guidelines, W Russel, 2009, ISBN 978-1-77005-640-4: Water Research Commission - South Africa - WRC report TT 341/09
Practical Techniques for Habitat & Wildlife Management: a guide for game ranches, conservation areas and farmland, Ken Coetzee, 2016,ISBN: 978-0-986-70844-9: New Voices Publishing

SUPPLEMENTARY FEEDING (TG4)

Hay for animal feed and dried manure for cooking fires in Debre May, Amhara, Ethiopia (ILRI/ Phil Norton).

In a nutshell

Short description

Additional feed, or supplements, provided on a regular basis to livestock beyond the normal ration level for increased milk and meat production or in times of drought for maintenance. In emergency may involve (a) fodder collection from within or outside the rangeland area: comprising fresh fodder, hay, tree pods; (b) production or buying of processed or compound feed: namely silage, feed supplements (bales, pellets), urea and molasses blocks, minerals and salt licks, etc.

Emergency feeding is especially important in preventing mortality – but also to avoid excessive weight loss particularly in young stock, pregnant and lactating animals. If during floods and droughts livestock are unable to access vegetation for grazing and cannot feed elsewhere, some supplementary feeding is necessary.

Principles

- Fodder quantity and quality are substituted or added to supplementary feed.
- Reduces localised overgrazing.
- Is a resilience strategy to cope with shocks and emergencies.
- More intensive systems strongly depend on supplementary feeding for animals and require high and balanced levels of energy, protein and minerals at particularly stages of their growth (young, gravid, lactating).

Most common technologies

Dryland fodder: possible in some rainfed regions especially through cereal crop residues (maize in wetter zones; sorghum and millet in drier areas) as well as legume crop residues (especially cowpeas in the Sahel).

Irrigated pastures: (i) intercropped spatially integrating fodder into small-scale irrigation e.g. vetch, cowpea; (ii) irrigated fodder where pastoralism dominates: multiple-cut perennial fodder varieties can be considered e.g. napier grass, or alfalfa (lucerne).

Fodder/ forage banks: may be planted, or, more commonly (and traditionally), established through resting enclosures for in-situ conservation and rehabilitation of vegetation as dry-season fodder reserves (e.g. Ngitiri/ Ngitili traditional agroforestry system). Agroforestry (trees integrated with crops and other productive land uses) and silvo-pastoralism (a specific form of agroforestry, mixing trees with pasture) have multiple benefits – including fodder. Land users allow and protect emerging seedlings to grow on their land.

Cut-and-carry grazing system: fodder production fed green or conserved to supplement grazing or for fattening or dairy production to livestock that are usually stalled, tethered, or kept in pastures close to home: **(i) fresh fodder:** rainfed, cultivated – or sometimes irrigated – fodder. The fodder is cut, bundled and fed to herder's own cattle, or sold to livestock traders; **(ii) hay making:** dried and stored fodder is becoming more common as dry season/ supplementary fodder; **(iii) zero grazing** is at the fringe of

Health of land resources addressed		
rangeland vegetation		++
invasive alien species		+
soil loss		+++
soil resources (OM, nutrients)		+
water resources		++
biodiversity		+
ESS addressed		
fodder production		+++
fodder quality		++
water availability		na
stream flow		++
food security/ self-sufficiency		+
SRM knowledge		+
conflict mitigation		++
equity (gender, disadv. group)		++
governance		++
DRR (drought, floods, fire)		+
CC adaptation		++
C and GHG emissions		++
Benefit-cost ratio		
Inputs	short-term	long-term
Establishment	+	+++
Maintenance	+	+++

Importance: +++ high, ++ medium, + low, +/– neutral, na: not available

rangelands and increasingly belonging to the settled crop production system with various degrees of supplementary feeding.

Minerals and salt licks: provide animals with essential minerals as well as salt. These may be from natural deposits or artificial blocks. Phosphorus deficiency (for example) is widespread and acute in SSA. Herders take their livestock long distances for periodic access to natural salt/ mineral licks (e.g. *cure salée*, Niger).

Processed and compound feed: these include silage (fodder preserved through fermentation), urea and molasses blocks.

Improving feed quality and availability for low emissions development (LED) options: Producing and using improved forage for animal feeds is most suited to intensive and semi-intensive dairy farms and mixed systems in the higher potential areas to feed animals on farms with limited grazing. LED could potentially reduce emission intensities by 8–24% in Kenya, and by up to 27% on mixed systems in Ethiopia (Ericksen and Crane 2018).

Rangeland use system (RUS)
Found mainly in systems where crop production is integrated – 'agropastoral' and 'pastures' systems, to a lesser extent in 'bounded without wildlife' system.

Main benefits
- Improves utilisation of existing dry pasture.
- Meets livestocks' requirements and potential by providing extra (and balanced) nutrients.
- Improves production to ensure that meat or milk quantity and quality targets are met.
- Reduces pressure on vulnerable pastures to avoid overgrazing and ensure that pasture growth rates are optimised.
- Offers additional source of income.

Main disadvantages
- High cost of implementation.
- The direct impact on the land and its health is minimal in extent.

Applicability and adoption
Little used in the traditional pastoral systems of SSA but is increasingly employed under agropastoral regimes as grazing land is diminishing. The more intensive producers, especially those with stall-fed animals based around cut-and-carry and having access to markets of such supplements are aware of the value of supplementary feed (e.g. hay, cakes, molasses, mineral licks).

The adoption of the different technologies are from low to medium, as many are closely dependent on external financial support. There is often a lack of availability of quality seed and suitable land. There are furthermore insufficiently developed fodder markets.

Zero grazing, south-west Uganda

Zero-grazing shed and fodder preparation in Rubagano, Mbarara district (Charles L. Malingu)

In the predominantly annual cropping systems, free grazing livestock often damage crops and are a cause of conflict. However, farmers observe that crop yields have declined due to nutrient mining and soil erosion on steep slopes. Stall-fed livestock is an efficient method to produce organic fertilizers (manure) and reduce labour by cutting and storing fodder for use over a period instead of grazing in distant pastures daily.

https://qcat.wocat.net/en/summary/1189

Area closure of degraded land, Ethiopia

After identifying the area to "be closed", ditches and terraces are constructed using stones combined with grasses and/ or multipurpose shrubs such as vetiver grass, dinsho grass, sesbania trees, etc. Commonly, the shared benefits from area closures are green fodder or hay for livestock (cut-and-carry), timber from plantations, and honey.

https://qcat.wocat.net/en/summary/1599/

Hay and apiculture for youths' income generation (WLRC, Gizaw Desta).

Pasture regeneration and haymaking, Kenya

Open access to land is reducing, land fragmentation increasing and grazing mobility more and more restricted. To adapt pastoralism, eight Maasai households in Kajiado County have decided to venture into intensification and joined efforts to set aside land for haymaking and build a storage. Reseeding has led to good cover of leafy grasses, and cutting grass to a protective mulch/ litter layer on the soil surface.

https://qcat.wocat.net/en/summary/4022/

Hay stored to provide feed throughout the season, (Rima Mekdaschi Studer).

Cure salée, Ingall, Niger (#curesalee hashtag on Twitter).

Saltlicks from Fachi, Niger (Commons.wikimedia.org).

Alliance farming beneficiary in Boyo Division (Mboscuda North West Region).

Alliance Farming (Cameroon)

Alliance Farming

DESCRIPTION

Alliance farming refers to collaboration between crop farmers and pastoralists, who agree to use the same land and related resources (crop residues as fodder for pastoralists; dung as fertilizer for crop farmers) for their mutual benefit.

Alliance farming is partnership between pastoralists and subsistence farmers to share resources. They agree to use the same land and related resources sequentially: growing crops during the rains, and grazing cattle in the dry season. It is a further development of the conflict mediation process under which cattle are allowed to graze on cropland after harvest. The cattle consume crop residues and weeds (including some grass) on the farm and they produce dung and urine in turn, which increases nitrogen content and organic matter in the soil. This enhances its fertility and makes it more productive for the next round of crop cultivation. The crops grown are mainly annuals including maize, beans, soybeans and groundnuts. The livestock are mainly zebu cattle for beef (Bos indicus). There exists several variants (or components) of this arrangement: 1) The farmer constructs a night paddock (a corral) in farmland and invites pastoralists to kraal their animals in the paddock overnight; 2) The farmer arranges with the pastoralist to farm on areas where animals have been held overnight, in grazing land – and constructs a fence to protect the crops; 3) In communities where transhumance is common, the farmer allows a pastoralist to graze his cattle on crop residues remaining after harvest; 4) Pastoralists allow farmers to collect dung and apply it in their farms. Contracts for the most part are verbal and non-written, and each party counts on the good conscience and honesty of the other.

LOCATION

Location: This approach has been piloted in 23 communities in the North West Region, North West Region, Cameroon.

No. of Technology sites analysed: 100-1,000 sites

Geo-reference of selected sites
- 10.52037, 6.37028

Spread of the Technology: applied at specific points/ concentrated on a small area.

Date of implementation: 2011; less than 10 years ago (recently).

Type of introduction
- ☐ through land users' innovation
- ☑ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ☑ through projects/ external interventions

Comment: Some aspects of this technology were already in practise in the region over the decades but due the facilitation of Mbororo Social and Cultural Development Association (MBOSCUDA) this technology is being adopted now by many locals.

Alliance farming beneficiary: crop farmer in Boyo Division (MBOSCUDA North West Region).

Alliance farming beneficiary: pastoralist strategically herding his animals between fences erected by farmers in Wum, Menchum Division. (MBOSCUDA North West Region).

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- ✓ improve production
- ✓ reduce, prevent, restore land degradation
- ✓ conserve ecosystem
- ✓ protect a watershed/ downstream areas – in combination with other Technologies
- preserve/ improve biodiversity
- reduce risk of disasters
- adapt to climate change/ extremes and its impacts
- mitigate climate change and its impacts
- create beneficial economic impact
- ✓ create beneficial social impact

Land use

Grazing land – Extensive grazing land: Nomadism, Semi-nomadism/ pastoralism
Main animal species and products: Zebu cattle under extensive production which produce dung and urine.

Mixed (crops/ grazing/ trees), incl. agroforestry - Agro-pastoralism
Main products/ services: Annuals such as maize, beans, soybeans and groundnuts, while livestock kept under extensive system of production produce dung and urine to enrich the soil.

Water supply

- ✓ rainfed
- mixed rainfed-irrigated
- full irrigation

Number of growing seasons per year: 1
Land use before implementation of the Technology: Land use is changing due to the use of this technology but this change is principally driven by the increasing demographics. Through the use of this technology, much more rangelands is being cultivated for crop production.

Purpose related to land degradation

- prevent land degradation
- ✓ reduce land degradation
- ✓ restore/ rehabilitate severely degraded land
- adapt to land degradation
- not applicable

Comment: Some degraded land is being rehabilitated as pastoralists do invite farmers to come farm in the rangelands which have been invaded by braken fern. By tilling of the soil and removing the rhizomes in them, the spread of the invasive species is being put to check.

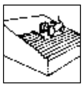
Degradation addressed

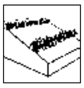
chemical soil deterioration – Cn: fertility decline and reduced organic matter content (not caused by erosion)

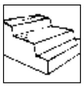
biological degradation – Bc: reduction of vegetation cover

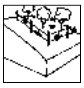
SLM group
- pastoralism and grazing land management
- integrated crop-livestock management
- integrated soil fertility management

SLM measures


agronomic measures – A1: Vegetation/ soil cover, A2: Organic matter/ soil fertility


vegetative measures – V2: Grasses and perennial herbaceous plants, V4: Replacement or removal of alien/ invasive species


structural measures – S6: Walls, barriers, palisades, fences


management measures – M1: Change of land use type, M4: Major change in timing of activities

TECHNICAL DRAWING

Technical specifications
- Alliance farming is an advanced outcome of the conflict mediation process whereby cattle are allowed to graze on crop lands after harvest.
- Livestock consume crop residues and weeds (including grass).
- When the land is used to paddock cattle, their manure and urine fertilize the soil making it more productive when the crop farmers return to cultivate.
- Crops are planted on the plot of land once the cattle are taken away.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs
- Costs are calculated: per Technology area (size and area unit: **0.5 hectares**)
- Currency used for cost calculation: **FCFA**
- Exchange rate (to USD): 1 USD = 569.495 FCFA
- Average wage cost of hired labour per day: 1,500.00 FCFA

Most important factors affecting the costs
The only costs pertain to herding the animal to farmer's farm which is done by pastoralist or his a herder he has paid.

Establishment activities
1. Farmer harvests annual crop e.g. maize, beans (Timing/ frequency: At the end of growing season which is usually in October).
2. Farmer invites pastoralist to bring herd to graze off crop residues (Timing/ frequency: After harvest of crops in October).
3. Cattle graze on crop residues and weeds on farm (Timing/ frequency: During grazing in the dry season from mid-November onwards).
4. Dung and faeces passed out by animal increases N content of soil (Timing/ frequency: During grazing, mostly in the dry season mid- November to mid-March).
5. Pastoralist takes animals away from farm (Timing/ frequency: At the beginning of the rains in mid-March).
6. Farmer then returns to till soil and plant annual crops in the field (Timing/frequency: At the beginning of the growing season by mid-March).

Costs and inputs needed for establishment
Land users bore all of the costs.

Comment: A low input technology.

NATURAL ENVIRONMENT

Average annual rainfall
- < 250 mm
- 251-500 mm
- 501-750 mm
- 751-1,000 mm
- ✓ 1,001-1,500 mm
- ✓ 1,501-2,000 mm
- 2,001-3,000 mm
- 3,001-4,000 mm
- > 4,000 mm

Agro-climatic zone
- humid
- ✓ sub-humid
- semi-arid
- arid

Specifications on climate
It is a uni-modal in nature with rains coming in by mid March and going by mid October.

Name of the meteorological station: Institute of Agricultural Research for Development.

Sub-humid climate with mainly sudan savana characterized by undulating hills and short grass species interspersed with shrubs.

Slope
- flat (0-2%)
- gentle (3-5%)
- moderate (6-10%)
- ✓ rolling (11-15%)
- hilly (16-30%)
- steep (31-60%)
- very steep (>60%)

Landform
- ✓ plateau/ plains
- ridges
- mountain slopes
- ✓ hill slopes
- footslopes
- valley floors

Altitude
- 0-100 m a.s.l.
- 101-500 m a.s.l.
- 501-1,000 m a.s.l.
- ✓ 1,001-1,500 m a.s.l.
- ✓ 1,501-2,000 m a.s.l.
- 2,001-2,500 m a.s.l.
- 2,501-3,000 m a.s.l.
- 3,001-4,000 m a.s.l.
- > 4,000 m a.s.l.

Technology is applied in
- convex situations
- concave situations
- ✓ not relevant

Soil depth
- very shallow (0-20 cm)
- ✓ shallow (21-50 cm)
- ✓ moderately deep (51-80 cm)
- deep (81-120 cm)
- very deep (> 120 cm)

Soil texture (topsoil)
- ✓ coarse/ light (sandy)
- medium (loamy, silty)
- fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- coarse/ light (sandy)
- ✓ medium (loamy, silty)
- fine/ heavy (clay)

Topsoil organic matter content
- high (>3%)
- ✓ medium (1-3%)
- low (<1%)

Groundwater table
- on surface
- < 5 m
- ✓ 5-50 m
- > 50 m

Availability of surface water
- excess
- good
- ✓ medium
- poor/ none

Water quality (untreated)
- ✓ good drinking water
- poor drinking water (treatment required)
- fine/ heavy (clay)
- for agricultural use only (irrigation)
- unusable

Is salinity a problem?
- yes
- ✓ no

Occurrence of flooding
- yes
- ✓ no

Species diversity
- high
- ✓ medium
- low

Habitat diversity
- high
- ✓ medium
- low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- ✓ subsistence (self-supply)
- ✓ mixed (subsistence/ commercial
- commercial/ market

Off-farm income
- ✓ less than 10% of all income
- ✓ 10-50% of all income
- > 50% of all income

Relative level of wealth
- very poor
- ✓ poor
- ✓ average
- rich
- very rich

Level of mechanisation
- ✓ manual work
- animal traction
- mechanized/ motorized

Sedentary or nomadic
- ✓ sedentary
- ✓ semi-nomadic
- nomadic

Individuals or groups
- ✓ individual/ household
- ✓ groups/ community
- cooperative
- employee (company, government)

Gender
- ✓ women
- ✓ men

Age
- children
- ✓ youth
- ✓ middle-aged
- elderly

Comment: The land users are predominantly resource poor livestock and crop farmers.

Area used per household
- ✓ < 0.5 ha
- ✓ 0.5-1 ha
- 1-2 ha
- 2-5 ha
- 5-15 ha
- 15-50 ha
- 50-100 ha
- 100-500 ha
- 500-1,000 ha
- 1,000-10,000 ha
- > 10,000 ha

Scale
- small-scale
- ✓ medium-scale
- large-scale

Land ownership
- state
- company
- ✓ communal/ village
- group
- ✓ individual, not titled
- individual, titled

Land use rights
- ✓ open access (unorganized)
- communal (organized)
- ✓ leased
- individual

Water use rights
- ✓ open access (unorganized)
- ✓ communal (organized)
- leased
- individual

Access to services and infrastructure

health	poor	✓			good
education	poor	✓			good
technical assistance	poor	✓			good
employment (e.g. off-farm)	poor	✓			good
markets	poor		✓		good
energy	poor	✓			good
roads and transport	poor	✓			good
drinking water and sanitation	poor	✓			good
financial services	poor	✓			good

IMPACTS – BENEFITS AND DISADVANTAGES

Socio-economic impacts

crop production — decreased □□□□□✓□ increased

Before SLM: 0
After SLM: 2
Comment: Improved soil fertility from dung and urine leads to increase crop production.

crop quality — decreased □□□□✓□□ increased

Before SLM: 0
After SLM: 1
Comment: Improved crop quality as little or no pesticides are used.

fodder production — decreased □□□□□✓□ increased

Before SLM: 0
After SLM: 2
Comment: Increase fodder production from crop residues such as maize stover, legume haulms and sweet potato vines.

fodder quality — decreased □□□□□✓□ increased

Before SLM: 0
After SLM: 2
Comment: Farmers do not use chemicals on the crops so quality of resulting crop residues is also good.

animal production — decreased □□□□□✓□ increased

CommBefore SLM: 0
After SLM: 2
Comment: The greater access that the livestock have to crop residues has led to increased animal production.

wood production — decreased □□□□□✓□ increased

Before SLM: 0
After SLM: 2
Comment: Improved soil fertility from dung and urine leads to increase crop production.

risk of production failure — increased □□□□✓□□ decreased

Before SLM: 0
After SLM: 1
Comment: The risk of production failure has decreased since farmers have increased the effective sizes of their farm holdings.

land management — hindered □□□□□✓□ simplified

Before SLM: -1
After SLM: 2
Comment: Better land management now with the same land put to multiple uses and more productive than previously i.e. when the two land uses were separated.

farm income — decreased □□□□□✓□ increased

Before SLM: 0
After SLM: 2
Comment: Farm income has increased from improved production and productivity of crops and animals.

diversity of income sources — increased □□□□□✓□ decreased

Before SLM: 0
After SLM: 2
Comment: Income sources have been diversified. With increased income from farms, farmers most especially are going for other off- farm enterprises such as petty trading.

economic disparities — decreased □□□□✓□□ increased

Before SLM: -1
After SLM: 1
Comment: Economic disparities are being bridged because of the increased income from either livestock production or crop farming.

workload — increased □□□□✓□□ decreased

Before SLM: -1
After SLM: 1
Comment: Workload is also being eased as farmers and pastoralists are witnessing improved crop and livestock productivity. Farmers, especially, do not have to bring much more new land under cultivation.

Socio-cultural impacts

food security/ self-sufficiency — reduced □□□□□✓□ improved

Before SLM: -1
After SLM: 2
Comment: Food self-sufficiency of alliance farming practising families has improved from the increase in production.

health situation

worsened □ □ □ □ ✓ □ □ improved

Before SLM: 0
After SLM: 1
Comment: From the improved income as a result of increased production and productivity, alliance practitioners have more disposal income to take care of medical bills.

land use/ water rights

worsened □ □ □ □ □ ✓ □ improved

Before SLM: -1
After SLM: 2
Comment: Land use rights especially of pastoralists has improved since farmers now acknowledge that pastoralists do own land. Pastoralists, due to their late arrival in the region, are looked upon as 'strangers' by their farming neighbours. However this perception is changing because of the positive engagement between the these two main land users.

cultural opportunities (spiritual, religious, aesthetic etc.)

reduced □ □ □ □ □ ✓ □ improved

Before SLM: -1
After SLM: 2
Comment: Increase cross-cultural dialogue within the community: pastoralists are predominantly Moslems while crop farmers are mainly Christians.

community institutions

weakened □ □ □ □ □ ✓ □ strengthened

Before SLM: -1
After SLM: 2
Comment: Community institutions like the Dialogue Platforms have been strengthened, as they have grown in recognition among community members as a low-stake solution to resource use conflicts.

national institutions

weakened □ □ □ □ ✓ □ □ strengthened

Before SLM: 0
After SLM: 1
Comment: Agro-Pastoral Commissions, which are the statutory bodies adjudicating conflicts between farmers and pastoralists, have come to see effectiveness of the Dialogue Platforms and are incorporating the Alternative Conflict Management practices in their modus operandi.

conflict mitigation

worsened □ □ □ □ □ ✓ □ improved

Before SLM: -2
After SLM: 2
Comment: There has been a great decrease in the number, frequency and intensity of the conflicts as the two sets of land users have seen good reason to collaborate instead of antagonize each other.

situation of socially and economically disadvantaged groups (gender, age, status, ethnicity etc.)

worsened □ □ □ □ □ ✓ □ improv ed

Before SLM: -1
After SLM: 2
Comment: The self-esteem of the Mbororos who make up the majority of pastoralists community has been improved through this positive engagement with farmers.

Ecological impacts

nutrient cycling/ recharge

decreased □ □ □ □ □ ✓ □ increased

Before SLM: 0
After SLM: 2
Comment: Nutrient cycling has improved as dung and urine are returned to improve soil fertility and help subsequent crops.

soil organic matter/ below ground C

decreased □ □ □ □ □ ✓ □ increased

Before SLM: 0
After SLM: 2
Comment: Soil organic matter has also being improved from the increase crop residues which animals do not eat all.

invasive alien species

increased □ □ □ □ ✓ □ □ reduced

Before SLM: -1
After SLM: 1
Comment: The spread of alien species such as bracken fern on rangelands is being controlled since farmers are being invited by pastoralists to come and cultivate crops on rangelands. The tilling of the soil is a good mechanical method of controlling the spread of these invasive species.

Benefits compared with establishment costs

		1	2	3	4	5	6	7	
Short-term returns	very negative						✓		very positive
Long-term returns	very negative						✓		very positive

Benefits compared with maintenance costs

		1	2	3	4	5	6	7	
Short-term returns	very negative						✓		very positive
Long-term returns	very negative						✓		very positive

CLIMATE CHANGE

Climate change/ extreme to which the Technology exposed

How the Technology copes with these changes/ extremes is

Gradual climate change

		1	2	3	4	5		
annual rainfall decrease	not well at all		✓				very well	
seasonal rainfall decrease	not well at all		✓				very well	Season: wet/ rainy season

Climate-related extremes (disasters)

		1	2	3	4	5	
local rainstorm	not well at all		✓				very well
local hailstorm	not well at all		✓				very well
heatwave	not well at all		✓				very well
drought	not well at all		✓				very well
land fire	not well at all		✓				very well
general (river) flood	not well at all		✓				very well
insect/ worm infestation	not well at all		✓				very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- ✓ single cases/ experimental
- ☐ 1-10%
- ☐ 10-50%
- ☐ more than 50%

Of all those who have adopted the Technology, how many have did so without receiving material incentives?

- ✓ 0-10%
- ☐ 10-50%
- ☐ 50-90%
- ☐ 90-100%

Number of households and/ or area covered

More than 800 alliance farming pairs have been facilitated by this process.

Has the Technology been modified recently to adapt to changing conditions?

- ☐ yes
- ✓ no

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Strengths

Land user's view

- Technology leads to increased crop yields because of the improved soil fertility.
- Technology leads to improved crop quality because of the use of organic manure and less chemicals fertilizers. The use of chemical fertilizers can lead to leaching of inorganic nutrients into ground water, and also eutrophication of water bodies.
- It has led to stronger social relationships between farmers and pastoralists.
- Invasive species such as *Pteridium aquilinium* (bracken fern) that has invaded rangelands is being controlled. Tilling of the farms is a mechanical method of stopping its growth and spread.

Key resource person's view

- More productive use of land than when two land uses were separate.
- More environmentally friendly since organic manure is being used.

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view

- The ratio of pastoralists to farmers is really low (about 1:6) meaning that there are not many pastoralists to form Alliance Farming pairs with willing farmers. → Increasing herd sizes to ensure more production of manure could alleviate this problem.

Key resource person's view

- Agreements are verbal. → Formalizing the contracts.
- Some variants of the technology, for example that in which pastoralists allow farmers to collect dung to go to farm in another area may lead to nutrient export. The dung does not contribute to improve the fertility of the soil where it was collected but does so at a different site where farming will take place. There is no net loss of nutrients out of the whole system though. → Transportation of dung to different sites should be discouraged. Farming should take place as much as possible on the farm that supplied crop residues to feed the animals.

REFERENCES

Compiler: Blasius Azuhnwi (azuhnwibn@yahoo.com)

Resource persons: Blasius Azuhnwi (azuhnwibn@yahoo.com) - SLM specialist; Duni Jiedoh (jeidohduni@gmail.com) - SLM specialist; Usmanu Mallam Sali (saliusmanu@gmail.com) - SLM specialist; Abubakar Hammadu Bawuro (abubawuro@gmail.com) - SLM specialist

Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/technologies/view/technologies_3342/

Linked SLM data: SLM Approach: Promoting farmers and pastoralists consultations in managing rangelands. https://qcat.wocat.net/en/wocat/approaches/view/approaches_3319/

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Key references

MBOSCUDA Searchlight Magazine Vols 1, 2,3. 2014, 2015, 2016: Free copies

Blasius Azuhnwi and Fiona Flintan (2017)- Making Rangelands Secure, Issue Paper 8, Rangelands Series: From ILC Rome for free

Dairy cattle feeding on fodder in the parlour (Amon Aine).

Dairy cattle fed with supplementary fodder (Uganda)

Ebinyasi bye ente

DESCRIPTION

Elephant grass (*Pennisteum purpureum*) and calliandra (*Calliandra calothyrsus*), are harvested and chopped using a chaff cutter to produce fodder for dairy cows. The chaff is then mixed with cotton seed cake, molasses and maize bran to improve palatability and nutrient quality for dairy cows. The cattle graze in paddocks during the day and receive the fodder at evening milking.

High quality fodder for livestock is made by mixing chaff of elephant grass (*Pennisteum purpureum*) and calliandra (*Calliandra calothyrsus*) with maize bran, cotton seed cake and molasses. These fodder pastures are grown on a 10 acre piece of land and harvested twice a week for chopping into chaff. For calliandra (a leguminous tree), leaves are harvested while elephant grass is cut at ground level. This vegetation is transported to the electric chaff cutter by tractor. At its best, the chaff is evenly cut, free of dust, of good colour and has a fresh aroma. The chaff is chopped into small pieces which allows for easy mixing with supplements. Chaff in Uganda can be produced on farm or purchased from commercial chaff cutting mills, which grow pastures and process them for sell to farmers during pasture scarcity in the long dry spells.

The farmer in Bushenyi District learnt the technology at a trade show. Today, he processes fodder for his 50 dairy cattle under an intensive system. His grazing/paddock land is about 20 hectares in total and is divided into 8 paddocks which are used in rotation. The cows graze for 8 hours daily. Every evening their diet is supplemented with the processed fodder in the milking parlour. The fields are allowed to mature at intervals to produce a continuous supply of grass for fodder throughout the growing season. The fodder processing procedure includes:

i) Cutting mature pasture grass at ground level and collecting the grass from the fields;

ii) Transportation of elephant grass and calliandra from the fields to the fodder shed;

iii) Offloading and sorting of pasture grass/ fodder into different classes of similar diameter and lengths for easy handling during chaff cutting;

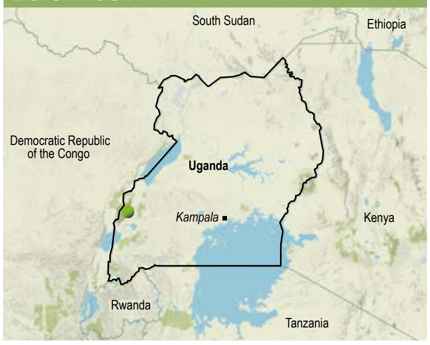
iv) Chopping of pastures/ fodder into small pieces using the electric chaff cutter;

v) Mixing the chaffed fodder, cotton seed cake, molasses and maize bran to improve the palatability and nutrient quality of the chaffed fodder.

vi). Putting the processed fodder into troughs for cattle to feed on during milking.

Processing enough pasture grass into chaff for cattle feeding is described by the farmer to be a relatively expensive and a labour intensive process. The key expenses in establishing the system include costs of buying fodder (if not readily available on the farm), purchasing a chaff cutter and buying supplements. The farmer requires 0.5 tonnes of chaffed fodder mixed with supplements to feed 50 dairy cows on a daily basis. The main costs are labour, fodder supplements, the electric chaff cutter, tractor hire and daily operation costs.

LOCATION



Location: Bushenyi District, Kyamuhunga sub county, Uganda, Western Region, Uganda

No. of Technology sites analysed: single site

Geo-reference of selected sites
• 30.1243, 0.4024

Spread of the Technology: evenly spread over an area (approx. 0.1-1 km²)

Date of implementation: 2016; less than 10 years ago (recently)

Type of introduction

- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☑ during experiments/ research
- ☐ through projects/ external interventions

Comment: (type of project, etc.): Chopping pastures for silage making.

Inside the fodder shelter: a bundle of sorted fodder awaiting chaffing (Aine Amon).

The farm with paddocks, fish ponds and tea (Amon Aine).

The fodder cut into small pieces mixes easily with supplements to make a well nutrient balanced ration. This is palatable and encourages cattle to eat non-selectively and without spilling,hence minimizing wastage. The processed fodder is easy to store in bags and can be kept on wooden pallets raised off ground in a cool store. The farmer notes that the chaffed fodder can further be processed into hay or silage for storage to be fed to cattle during the seasons of pasture scarcity, especially the long dry spells of early June to late August and early December to late February. The system enables the farmer to keep more productive animals on his land than he could using other feeding regimes: in other words this is an intensive system that maximizes production per unit area.

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- ✓ improve production
- reduce, prevent, restore land degradation
- conserve ecosystem
- protect a watershed/ downstream areas – in combination with other Technologies
- preserve/ improve biodiversity
- ✓ reduce risk of disasters
- ✓ adapt to climate change/ extremes and its impacts
- mitigate climate change and its impacts
- ✓ create beneficial economic impact
- create beneficial social impact

Land use

Grazing land – Intensive grazing/ fodder production: Cut-and-carry/ zero grazing, Improved pastures

Comment: The farmer has a 400 acres of land under cattle grazing, tea growing, pasture growing and fish farming.

Water supply

- rainfed
- ✓ mixed rainfed-irrigated
- full irrigation

Comment: In the dry season the farmer irrigates with water from the valley.

Number of growing seasons per year: 2
Livestock density: 50 cows on 22 hectares including the milking parlour, fodder shed and stores are established.

Purpose related to land degradation

- prevent land degradation
- ✓ reduce land degradation
- restore/ rehabilitate severely degraded land
- ✓ adapt to land degradation
- not applicable

Degradation addressed

physical soil deterioration – Pc: compaction, Pu: loss of bio-productive function due to other activities

biological degradation – Bc: reduction of vegetation cover, Bh: loss of habitats

Comment: Increased productivity per soil unit.

SLM group

- pastoralism and grazing land management
- integrated crop-livestock management
- improved plant varieties/ animal breeds

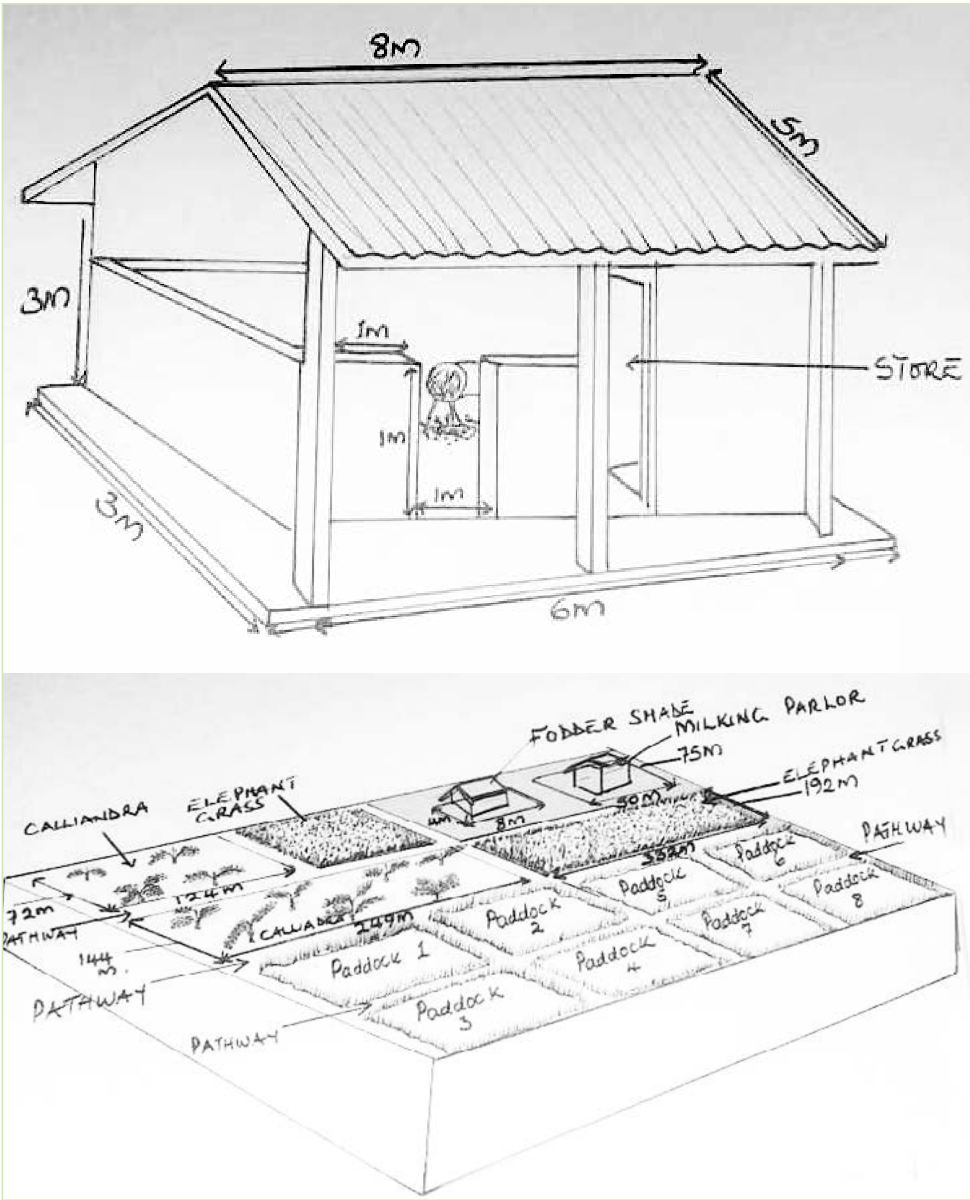
SLM measures

Comment: The process is for making high quality pasture supplement for cattle.

TECHNICAL DRAWING

Technical specifications

The key requirements for the system are the fodder shed, chaff cutter and sources of pastures. The fodder shed of 3×6×6 m was constructed close to the milking parlour for efficiency. A store of 2×2×2 m for the chaff cutter and other equipment was constructed in one of the corners of the shed. Apart from the store, all other walls are constructed up to one meter height leaving two metres open to the roof for ventilation.



Author: Mrs Prosy Kaheru.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area
- Currency used for cost calculation: **Uganda shillings**
- Exchange rate (to USD): 1 USD = 3,638.00 Uganda shillings
- Average wage cost of hired labour per day: 10,000.00

Most important factors affecting the costs

Establishing the fodder shade, purchasing the chaff cutter and daily operation costs.

Establishment activities

1. Clearing and Preparation of the garden. (Timing/ frequency: Best done at the end of the dry season.)
2. Planting of the desired improved pastures for fodder. (Timing/ frequency: At the start of the rain season.)
3. Construction of the fodder shed and store. (Timing/ frequency: Before the pastures are mature enough to start harvesting.)
4. Purchase and establishment of the chaff cutter. (Timing/ frequency: After establishment of the fodder shelter and store.)

Establishment inputs and costs (per 3 km²)

Specify input	Unit	Quantity	Costs per Unit (Uganda shillings)	Total costs per input (Uganda shillings)
Labour				
Labour	man/day	100	10,000.00	120,000.00
Equipment				
Hoe	pieces	6	15,000.00	30,000.00
Panga	pieces	16	5,000.00	5,000.00
Hammer	pieces	4	5,000.00	5,000.00
wheel burrow	person days	4	5,000.00	5,000.00
Tractor hire	hours	100	50,000.00	50,000.00
chaff cutter	unit	10	150,000.00	150,000.00
Construction material				
Metal rods	pieces	4	20,000.00	8,000.00
Cement	50kg bags	20	29,000.00	58,000.00
Sand	tonnes	2.5	70,000.00	175,000.00
Bricks	pieces	10,000	150.00	1,500,000.00
Timber	pieces	20	5,000.00	10,000.00
Iron	pieces	24	42,000.00	1,008,000.00
Gravel	trips	1	75,000.00	75,000.00
Total costs for establishment of the Technology				**5,683,000.00**

Comment: Biogas solutions Uganda funded 10% ie establishment of mixing chamber for biogas which works as the mixing chamber for the irrigation fertilizer technology.

Maintenance activities

1. Cutting and collecting of mature elephant grass (*Pennisteum purpureum*),and calliandra (*Calliandra calothyrsus*) to one point in the fields. (Timing/ frequency: each morning.)
2. Transportation of pasture grass to the fodder shed. (Timing/ frequency: After cutting.)
3. Offloading and sorting of pasture at the fodder shed. (Timing/ frequency: None)
4. Chopping of grass into small units using the electric chaff cutter. (Timing/ frequency: None)
5. Mixing the chaff with supplements. (Timing/ frequency: When the pastures are well chopped.)
6. Feeding the processed fodder in troughs. (Timing/ frequency: 30 minutes to milking time at dusk.)

Maintenance inputs and costs

Specify input	Unit	Quantity	Costs per Unit (Uganda shillings)	Total costs per input (Uganda shillings)	% of costs borne by land users
Labour					
Labour	man/month	4	10,000.00	40,000.00	100
Equipment					
Panga					
Other					
Elephant grass (*Pennisteum purpureum*) and calliandra (*Calliandracalothyrsus*)	tonnes	0	100,000.00	50,000.00	100
Maize bran	tonnes	0.0625	88,000.00	5,500.00	100
Molasses	tonnes	0.13	17,3000.00	22,490.00	100
Cotton seed cake	tonnes	0.0625	88,000.00	5,500.00	100
Total costs for establishment of the Technology				**123,490.00**	

NATURAL ENVIRONMENT

Average annual rainfall
- ☐ < 250 mm
- ☐ 251-500 mm
- ☐ 501-750 mm
- ☐ 751-1,000 mm
- ☐ 1,001-1,500 mm
- ☑ 1,501-2,000 mm
- ☐ 2,001-3,000 mm
- ☐ 3,001-4,000 mm
- ☐ > 4,000 mm

Agro-climatic zone
- ☑ humid
- ☐ sub-humid
- ☐ semi-arid
- ☐ arid

Specifications on climate
March to May and Sept to Nov.

Slope
- [ ] flat (0-2%)
- [x] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landform
- [x] plateau/ plains
- [ ] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [ ] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [x] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [x] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [x] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [x] medium (1-3%)
- [ ] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [x] medium
- [ ] poor/ none

Water quality (untreated)
- [ ] good drinking water
- [x] poor drinking water (treatment required)
- [ ] fine/ heavy (clay)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Is salinity a problem?
- [ ] yes
- [x] no

Occurrence of flooding
- [ ] yes
- [x] no

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [x] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [ ] mixed (subsistence/ commercial
- [x] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [ ] average
- [ ] rich
- [x] very rich

Level of mechanisation
- [ ] manual work
- [ ] animal traction
- [x] mechanized/ motorized

Sedentary or nomadic
- [x] sedentary
- [ ] semi-nomadic
- [ ] nomadic

Individuals or groups
- [x] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [x] men

Age
- [ ] children
- [ ] youth
- [ ] middle-aged
- [x] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [x] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [ ] small-scale
- [ ] medium-scale
- [x] large-scale

Land ownership
- [ ] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Water use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual

Access to services and infrastructure

health	poor		✓		good
education	poor		✓		good
technical assistance	poor	✓			good
employment (e.g. off-farm)	poor		✓		good
markets	poor		✓		good
energy	poor		✓		good
roads and transport	poor		✓		good
drinking water and sanitation	poor			✓	good
financial services	poor			✓	good

IMPACTS – BENEFITS AND DISADVANTAGES

Socio-economic impacts

fodder production	decreased	□ □ □ □ □ ✓ □	increased	
fodder quality	decreased	□ □ □ □ □ ✓ □	increased	**Comment:** Supplements are added to chaffed fodder.
animal production	decreased	□ □ □ □ □ ✓ □	increased	**Comment:** The grazing cows are supplemented with fodder at milking in the evening.
risk of production failure	increased	□ □ □ □ □ ✓ □	decreased	**Comment:** Better quality and quantity pastures available for feeding livestock.
expenses on agricultural inputs	decreased	□ □ □ □ ✓ □ □	increased	
farm income	decreased	□ □ □ □ □ ✓ □	increased	**Comment:** Increased milk production per cow.
workload	increased	□ ✓ □ □ □ □ □	decreased	**Comment:** Need to grow pasture grass and process them into chaffed supplemented fodder.

Ecological impacts

vegetation cover	decreased	□ □ □ □ ✓ □ □	increased	
biomass/ above ground C	decreased	□ ✓ □ □ □ □ □	increased	**Comment:** Cut and carry systems can drain the fields of nutrients if not replenished with fertilizer.
beneficial species (predators, earthworms, pollinators)	decreased	□ □ □ □ □ ✓ □	increased	**Comment:** Calliandra and elephant grass.
drought impacts	decreased	□ □ □ □ □ ✓ □	increased	**Comment:** It is possible to store and supplement livestock feed in the dry season if processed into hay.

Off-site impacts

damage on public/ private infrastructure	increased	□ □ □ □ ✓ □ □	reduced	**Comment:** Cattle have enough feed and therefore don't need to trespass onto neighbours' fields.

Benefits compared with establishment costs

Short-term returns	very negative	□ ✓ □ □ □ □ □	very positive
Long-term returns	very negative	□ □ □ □ □ ✓ □	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	□ ✓ □ □ □ □ □	very positive
Long-term returns	very negative	□ □ □ □ □ ✓ □	very positive

CLIMATE CHANGE

Climate change/ extreme to which the Technology is exposed

How the Technology copes with these changes/ extremes

Gradual climate change

annual temperature increase	not well at all	□ ✓ □ □ □	very well	
seasonal temperature increase	not well at all	□ □ ✓ □ □	very well	Season: dry season
annual rainfall decrease	not well at all	□ □ □ ✓ □	very well	
seasonal rainfall decrease	not well at all	□ □ □ ✓ □	very well	Season: wet/ rainy season

Climate-related extremes (disasters)

local rainstorm	not well at all	□ □ □ ✓ □	very well
drought	not well at all	□ ✓ □ □ □	very well
landslide	not well at all	□ □ □ ✓ □	very well
epidemic diseases	not well at all	□ ✓ □ □ □	very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- □ single cases/ experimental
- ✓ 1-10%
- □ 10-50%
- □ more than 50%

Of all those who have adopted the Technology, how many have did so without receiving material incentives?

- □ 0-10%
- □ 10-50%
- □ 50-90%
- ✓ 90-100%

Has the Technology been modified recently to adapt to changing conditions?

- □ yes
- ✓ no

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Strengths

Land user's view
- The animals feed in the paddocks during the day and are supplemented with more palatable fodder at the milking parlor, to improve their diet.
- The nutrient quality of the fodder is supplemented to make a more balanced ration for the animals.
- Under this semi intensive farming system, more animals can be reared per unit area in contrast to a paddock-only system.

Key resource person's view
- The farmer can further process the pastures into hay or silage for storage.
- The animals are not so much affected by pasture scarcities.
- There is chance to irrigate the pastures to cope with the long dry seasons.

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view
- Expensive to maintain. Production of enough grass at one go and storage for use in the next few days. → Production of enough pastures at ago and storing them for use in the next few days.

Key resource person's view
- Need for labour for processing. Further mechanization of the process. → Further Mechanization of the process.

REFERENCES

Compiler: Aine Amon (aine3amon@gmail.com)
Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/technologies/view/technologies_3367/
Video: https://player.vimeo.com/video/261290691
Documentation was facilitated by: Institution: National Agricultural Research Organisation (NARO) - Uganda. Project: Scaling-up SLM practices by smallholder farmers (IFAD)
Date of documentation: Jan. 31, 2018; **Last update:** June 20, 2018

INFRASTRUCTURE IMPROVEMENT (TG5)

Water supply for livestock at Dangol borehole, Mopti, Mali (Amara Keita).

In a nutshell

Short description

Infrastructure improvement includes the establishment of water points, wells, boreholes, ponds, pans and dams (fed by macro-catchments), floodwater spreading, trenches, drinking water quality protection, livestock corridors, and access roads and transport routes for animals and livestock feed. Infrastructure implies structural measures that allow greater mobility of livestock herds, and rangeland management improvement – particularly regarding access to water resources and pasture.

Water sources in the arid and semi-arid lands include natural rivers, springs, waterholes and constructed sources such as shallow wells, boreholes, dams, ponds, sand dams, subsurface dams and *berkads* – underground cisterns common among Somali pastoralists. Rivers are open to all, whereas springs, boreholes and dams might be managed by government institutions, privately or at a community level. These differences in user rights have implications for water and rangeland management.

Principles

- Water availability is a grazing management tool: areas without water may be underutilized.
- Strategic placement of waterpoints can provide for healthy livestock and sound rangeland conditions.
- Development of water resources and its management must be designed carefully to avoid accelerated degradation through prolonging access to water and thus forage or polluting water points.
- Emergency situations can be addressed through infrastructure (e.g. stock passage routes) that permits ready access to forage and water, and markets.

Most common technologies

Water supply/ water points: wells and boreholes (artesian or pumped), dams, pans and ponds. Various methods of water harvesting and storage are used in semi-arid, such as *berkads* (cistern) in Somalia and *hafir* (dug tanks) in Sudan.

Floodwater spreading and storing: spate irrigation has been traditionally practised: (a) floodwater harvesting within streambeds (e.g. water-spreading weirs); (b) floodwater diversion, where the floods – or spates – from the seasonal rivers are diverted into adjacent embanked fields. **Sub-surface dams** and **sand dams are weirs**, built on impermeable rock layers, in rivers, which dry seasonally. They hold back subsurface flow – which is then stored in sand behind the structure.

Livestock/ transhumance corridor: formally defined passageways, which channel the movements of livestock herds through farming areas by linking pastures, water points and corralling areas. The main goal is conflict prevention between agriculturalists and pastoralists regarding the use of limited land and water resources. Characteristics include:

Health of land resources addressed	
rangeland vegetation	++
invasive alien species	+/-
soil loss	+++
soil resources (OM, nutrients)	+
water resources	+++
biodiversity	+
ESS addressed	
fodder production	+++
fodder quality	++
water availability	+++
stream flow	++
food security/ self-sufficiency	++
SRM knowledge	++
conflict mitigation	++
equity (gender, disadv. group)	+
governance	++
DRR (drought, floods, fire)	++
CC adaptation	++
C and GHG emissions	+

Benefit-cost ratio		
Inputs	short-term	long-term
Establishment	++	+++
Maintenance	+++	+++

Importance: +++ high, ++ medium, + low, +/– neutral, na: not available

(i) width from 50 to 100 m depending on the extent of land-use pressure; (ii) multidirectional; (iii) usually marked by clear signs.

Transport roads and marketing infrastructure such as access to markets for animals and feed, slaughter facilities, holding grounds – as well as veterinary clinics – are central to rangelands and can be the difference between maintaining economic livestock enterprises and the inability to make a viable living.

General infrastructures: schools, grain banks, and health centres are also essential to livelihoods in the rangelands.

Rangeland use system (RUS)
Applied in 'agropastoral' and 'pastoral' systems as well as 'bounded without wildlife' and 'pastures' systems.

Main benefits
- Improves accessibility of water all year round – or seasonally. Reduced distances covered and time spent in search of water for livestock.
- Allows recovery of vegetation and biodiversity
- Provides effective measures for adapting to climate change in regions experiencing increasing variability in rainfall.
- Improves resilience of pastoral communities.
- Reduces conflict incidences (depending on the situation).

Main disadvantages
- High technical expertise required; management and often external material support needed.
- Often expensive for establishment as well as maintenance (e.g. building materials, transport, labour).
- Maintenance often proves to be the bottleneck to rangeland communities.
- Can lead to conflict (depending on the situation).
- Need continuous planning and development in order to be able to adapt to changing needs.
- Potential loss of pastoral culture and traditional practices.

Applicability and adoption
A minimum level of infrastructure is needed in all rangeland systems and must include flexibility to changing needs. Improvements in rural infrastructure, overall, are rare in the Sahel. In West Africa, there are a number of established transhumance corridors (western and eastern), which depend on continuous infrastructure support and improvement. Information about corridors, water and overnight resting points could facilitate decision-making and policy. Road construction and rehabilitation are currently common across the rangelands of East Africa, spurred to a large extent by external investors.

Spate irrigation is found quite widely but particularly in the Horn of Africa (van Steenbergen 2010). Water spreading weirs need specific natural landscapes, large wide-spread valleys with low slopes. They have been applied in Burkina Faso, Chad, Ethiopia and Niger.

There is a small to moderate trend towards spontaneous adoption of measures to improve infrastructure and some self-help groups have started pooling together their resources for implementation.

Well distribution, Niger

At traditional well during dry season (Abdoulmohamine Khamed Attayo).

Under the "modern sustainable pastoralism" concept several practices were promoted: establishment of water harvesting structures, better passageways for herds, improved fodder production as well as optimal and efficient distribution of water points. The latter assures a balanced distribution of herds, and thus avoids overuse of vegetation around a limited number of wells.

https://qcat.wocat.net/en/summary/2178/

« *Couloirs de passage* », Niger

Livestock corridors in Niger are regulated through the *"code rural"*. Internal corridors are negotiated in a general village assembly involving all stakeholders. For external corridors the involvement of transhumance herders and neighbouring villages is indispensable. Once an agreement is achieved, demarcation with stones and/or selected tree species is carried out by the local land users - with financial and technical assistance of the government or NGOs.

https://qcat.wocat.net/en/summary/3358/

A herd of small ruminants on a well established "*couloir*" (Fodé Boubacar Camara, PAFN Niger).

Indigenous pond and livestock watering trough, Tanzania

The size of the excavated groundwater collection ponds varies depending on the area available, groundwater level, slope and soil characteristics. In this case study they are 4 m long, 3 m wide and 1 m deep (12,000 l capacity), the slope is moderate (5–8%) and the soil is a deep clay loam. Water troughs (known as *Elyato* locally) are constructed adjacent to the pond to allow livestock access to clean drinking water.

https://qcat.wocat.net/en/summary/3880/

Cattle drinking water from a trough, Missenyi, Tanzania (Allan Bubelwa).

Herds waiting to be watered in southern Somalia (Wolfgang Bayer).

Cattle drinking in one of the ponds of 'Forage Christine' (SNV).

'Forage Christine' (Burkina Faso)

Yaki da Garmani

DESCRIPTION

A modern hydraulic complex in the centre of the Sahelian region of Burkina Faso for watering livestock in the dry season.

The well called 'Forage Christine' was constructed in 1971 by a French engineer, which named it after his wife, and opened it for the first time in 1972. Due to conflicts between Burkina and Mali it was ruined in 1976, and then again in 1985. In 1996 the National Office for Wells and Boreholes (ONFP), a government agency, rehabilitated the well and made two supplementary boreholes. The complex consists of a main well with an operating flow rate of 120 m^3/h, having a submersible pump of brand KSB, type OPA 150s-65/8, and a pump capacity of 60 m^3/h. Next to the main well there is a secondary well, which is equipped with a hand-operated pump with a capacity of 18 m^3/h.

The energy for pumping water from the wells is provided by a generator with an engine of brand DEUTZ (type: F3 – 6L 912) and a switch of brand LEROY SOMER – Type LSA 42.1 L8L C1/4, a voltage of 400 V and continuous power of 50 kW. The generator has a switch and a battery. A diesel tank with a volume of approximately 9 m^3 was installed for the power supply to the generator. The pumped water is stored in an elevated water tank, which is located at a distance of about 200 m from the well, and has a volume of 50 m^3. The water from the elevated water tank is distributed to four artificial ponds with a dimension of 50 m x 50 m x 1.5 m at equal distances on all sides of the central reservoir. The water is conducted to the artificial ponds through PVC piping, which is buried underground over a distance of 8 km, or 2 km for each pond. The water flow is controlled by nine valves of type Nr. 4000, Reg. Nr. W 1.129, installed on the pipes. The hydraulic complex was installed in 1996 by the National Agency for Water and Sanitation (ONEA). The complex is managed by the livestock keepers through the User Association of 'Forage Christine' (AUFC). The statutes of this organisation were adopted on 2 May 2014. The well is managed according to a set of requirements which specify the terms for access to water: date of opening and closure of the well, the amount to be paid per animal and the management of the cash money provided.

'Forage Christine' is a major water infrastructure, established in the northern part of the Sahel region in Burkina Faso between longitude 0°45'W and latitude 14°48'N, providing drinking water to herds within an area of 100 to 300 km from its central location between Burkina Faso, Mali and Niger. It was established in 1971 in the context of major droughts that had affected the Sahel, and it was opened for the first time in 1972. It is located in the middle of the Sahel region of Burkina Faso, at two km from the pond of Tin-Arkachen in the department of Déou, at approximately 45 km from the capital of the department, and 85 km from Gorom-Gorom. At the sub-regional level, the well is a around ten km from the border with Mali, and at 100 km from the border with Niger. The climate is of Sahelian type, and has a rainy season of 3 to 4 months (from June-July to September), which is subject to strong temporal and spatial variations in precipitation, and a dry season of 8 to 9 months. The climatic conditions are characterized by highly irregular winds,

LOCATION

Location: Déou, Sahel/Oudalan, Burkina Faso

No. of Technology sites analysed: single site

Comment: The infrastructure was created in 1971, but the facilities for use were installed in 1996.

Geo-reference of selected sites
• -0.24236, 13.83766

Spread of the Technology: applied at specific points/ concentrated on a small area

Comment: The well is located in the municipality of Déou, but is used for livestock from the entire Sahel region in Burkina Faso, Mali and Niger.

Date of implementation: 1971

Type of introduction

- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ☑ through projects/ external interventions

Animals drinking at the main pond of 'Forage Christine' (SNV).

Animals drinking at the main pond of 'Forage Christine' (SNV).

precipitation, evapotranspiration and moisture due to fluctuations in atmospheric circulation patterns. Annual precipitation is around 500 mm on average, with roughly 30 rainy days, and is marked by significant inter-annual variations. The stream network of the region consists of several streams, with one permanent river: Béli. To this river, ponds and many depressions are connected, which disappear after the month of January. The soils are very diverse in general, and mostly of sandy texture. They do not provide a good medium for plant growth due to the low permeability, which reduces water infiltration. Therefore water availability appears to be one of the major limitations for rainfed agriculture, in addition to the limited retention and availability of nutrients. According to the phytogeographic division of Burkina Faso (Fontes and Guinko, 1995), the area of 'Forage Christine' is situated in the northern or strict Sahelian phyto-geographic sector. This sector is characterized by a set of typical Saharan and Sahelian vegetation species which mainly occur in shrub and woody steppes (49%) and grassy steppes (24%), which form the larger part of the rangelands. This vegetation provides the most important natural grazing land to livestock.

With regard to the human environment, the last General Population and Housing Census mentions a population of 25,321 inhabitants for the municipality of Déou. Yet this number varies significantly due to the seasonal migration of people from other regions to use water and forage resources. The ethnic groups in the region are mainly Fulbé, Kurumba, Songhai, Tuareg, Mossi and Hausa people.

Economic activities in the region are livestock keeping, farming, craftmanship, fishing, trade, tourism and hunting. Several socio-economic groups are guiding these activities. Some 60 farmer groups, 53 groups of livestock keepers, six of which for female livestock keepers, and three organisations for environmental protection. With regard to infrastructure for education, sanitation and socio-economical conditions, the municipality of Déou has three markets, 18 schools, one middle school, 47 permanent functional literacy centers (CPAF), one recreation centre, six cereal banks, three healthcare and welfare centers (CSPS), three medical stores, one tourist camp and one financial institution.

Farming and livestock keeping continue to be the most important socio-economic activities. The agricultural crops produced include millet, sorghum, maize, cowpea, rice and groundnut. In 2009, a total area of 345.5 ha was sown for these crops. The Sahel region in Burkina Faso has excellent conditions for livestock keeping. The animal species found in the region are mainly cattle, sheep, goats, pigs, camels, donkeys and horses and poultry. Several facilities and installations for water supply to pastoral areas are available in the region, as well as storage facilities for agricultural and agro-industrial by-products (SPAI) and infrastructure for trade and animal health care. The municipality of Déou disposes of one reservoir, five artificial ponds, 43 firm wells, ten vaccination centres, one store for agricultural and agro-industrial by-products (SPAI), one animal shelter, a facility for slaughtering and a livestock market.

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- improve production
- reduce, prevent, restore land degradation
- conserve ecosystem
- protect a watershed/ downstream areas – in combination with other Technologies
- preserve/ improve biodiversity
- reduce risk of disasters
- ✓ adapt to climate change/ extremes and its impacts
- mitigate climate change and its impacts
- ✓ create beneficial economic impact
- ✓ create beneficial social impact

Land use

Grazing land – Extensive grazing land: Semi-nomadism/ pastoralism
Main animal species and products: Animal species: cattle, sheep, camels, donkeys and goats.

Comment: In addition to livestock keeping, subsistence farming is practiced. The main crops are sorghum, millet, groundnut and cowpea. The size of the fields varies between 0.5 and 3 ha. The farm type is family-based.

Water supply

- ✓ rainfed
- mixed rainfed-irrigated
- full irrigation

Number of growing seasons per year: 1
Land use before implementation of the Technology: No change in land use due to the implementation of the technology.

Purpose related to land degradation

- prevent land degradation
- ✓ reduce land degradation
- restore/ rehabilitate severely degraded land
- adapt to land degradation
- not applicable

Degradation addressed

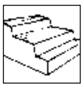
water degradation – Ha: aridification, Hs: change in quantity of surface water, Hg: change in groundwater/ aquifer level, Hp: decline of surface water quality.

Comment: The technology aims to remediate water scarcity for livestock during the dry season.

SLM group

- pastoralism and grazing land management
- ground water management

SLM measures

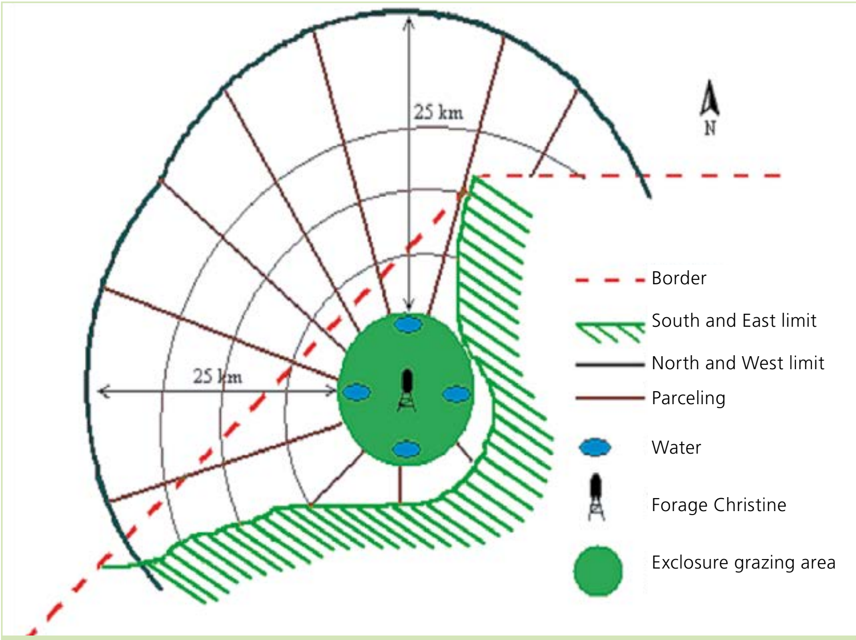


structural measures – S7: Water harvesting/ supply/ irrigation equipment

TECHNICAL DRAWING

Technical specifications

1. Main well, flow rate 120 m³/h.
2. Secondary well, flow rate 18 m³/h.
3. Submersible pump, brand KSB, type OPA 150s-65/8, flow rate 60 m³/h, year of construction 1996.
4. Elevated water storage tank, volume 50 m³.
5. Four ponds of 50 m x 50 m x 1.5 m.



Author: SNV.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology unit:
- Currency used for cost calculation: **FCFA**
- Exchange rate (to USD): 1 USD = 550.00 FCFA
- Average wage cost of hired labour per day: 35,000.00 per month

Most important factors affecting the costs

1. Availability of fuel for the generator.
2. Failures in the functioning of the generator to fill the storage tanks.

Establishment activities

1. Main well (Timing/ frequency: None)
2. Elevated water storage tank (Timing/ frequency: None)
3. Artificial ponds (Timing/ frequency: None)

Maintenance activities

1. Use of diesel (Timing/ frequency: year)
2. Use of oil and filters (Timing/ frequency: year)
3. Periodic maintenance of the generator (Timing/ frequency: year)
4. Fuel delivery (Timing/ frequency: year)
5. Transport costs of the maintenance operator (Timing/ frequency: year)
6. Wage of the guard (Timing/ frequency: year)
7. Compensation of the manager of the generator (Timing/ frequency: year)
8. Charges for accounting (Timing/ frequency: year)

Establishment inputs and costs

Specify input	Unit	Quantity	Cost per unit (FCFA)	Total cost per input (FCFA)
Labour				
Periodic maintenance of the generator	season	1	150,000.00	150,000.00
Compensation of the GE manager	person-month	12	37,500.00	450,000.00
Charges for accounting	person-month	12	175.00	2,100.00
Wage of the guard	person-month	12	50,000.00	600,000.00
Other				
Use of diesel	season	1	2,921,400.00	2,921,000.00
Use of oil, filters	season	1	68,000.00	68,000.00
Reparations to the hydraulic complex	season			
Fuel delivery	season	1	125,000.00	125,000.00
Transport costs of maintenance operator	season	1	60,000.00	60,000.00
Total costs for establishment of the Technology				**4,376,100.00**

If land user bore less than 100% of costs, indicate who covered the remaining costs
The municipality, the management committee and the NGOs operating in the area (SNV).

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [x] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [ ] humid
- [ ] sub-humid
- [x] semi-arid
- [ ] arid

Specifications on climate
Average annual rainfall in mm: 500.0

Mean annual rainfall is around 500 mm, with approximately 30 rainy days and characterized by a strong variation between years. The water system has many streams, of which only one is permanent (the Béli river). To this river, ponds and many depressions are connected, which disappear after the month of January.

Name of the meteorological station: Station of Gorom-Gorom
The climate is of Sahelian type, and has a rainy season of 3 to 4 months (from June-July to September), which is subject to strong temporal and spatial variations in precipitation, and a dry season of 8 to 9 months. The climatic conditions are characterized by highly irregular winds, precipitation, evapotranspiration and moisture due to fluctuations in atmospheric circulation patterns.

Slope
- [ ] flat (0-2%)
- [x] gentle (3-5%)
- [ ] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Soil depth
- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [x] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [ ] medium (1-3%)
- [x] low (<1%)

Comment: The soils are very diverse in general, and mostly of sandy texture. They do not provide a good medium for plant growth due to the low permeability, which reduces water infiltration.

Groundwater table
- [x] on surface
- [ ] < 5 m
- [ ] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [ ] medium
- [x] poor/ none

Water quality (untreated)
- [ ] good drinking water
- [x] poor drinking water (treatment required)
- [ ] fine/ heavy (clay)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Is salinity a problem?
- [ ] yes
- [x] no

Occurrence of flooding
- [ ] yes
- [x] no

Comment: Limited water availability appears to be one of the major limitations for rainfed agriculture, in addition to the low retention and availability of nutrients.

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [ ] medium
- [x] low

Comment: The area around the 'Forage Christine' is characterized by a variety of typical Saharan and Sahelian vegetation units which mainly occur in shrub and woody steppes (48.85%) and grassy steppes (24.37%), and which form the larger part of the rangelands.

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [x] subsistence (self-supply)
- [ ] mixed (subsistence/ commercial
- [ ] commercial/ market

Off-farm income
- [x] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [x] very poor
- [x] poor
- [ ] average
- [ ] rich
- [ ] very rich

Level of mechanisation
- [x] manual work
- [x] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [x] sedentary
- [x] semi-nomadic
- [ ] nomadic

Individuals or groups
- [x] individual/ household
- [x] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [x] women
- [x] men

Age
- [ ] children
- [x] youth
- [x] middle-aged
- [ ] elderly

Comment: Several socio-economic groups are guiding the activities of land users. These include 60 farmer groups, 53 groups of livestock keepers, six of which for female livestock keepers, and three organisations for environmental protection.

Area used per household
- [ ] < 0.5 ha
- [x] 0.5-1 ha
- [x] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [ ] > 10,000 ha

Scale
- [x] small-scale
- [x] medium-scale
- [ ] large-scale

Comment: Most of the agro pastoralist are smallholder farmers, livestock keeping is their main livelihood activity.

Land ownership
- [x] state
- [ ] company
- [x] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled

Land use rights
- [x] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Water use rights
- [x] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor	✓ box 2 of 3	good
education	poor	✓ box 1 of 3	good
technical assistance	poor	✓ box 1 of 3	good
employment (e.g. off-farm)	poor	✓ box 1 of 3	good
markets	poor	✓ box 1 of 3	good
energy	poor	✓ box 1 of 3	good
roads and transport	poor	✓ box 1 of 3	good
drinking water and sanitation	poor	✓ box 1 of 3	good
financial services	poor	✓ box 1 of 3	good

IMPACTS – BENEFITS AND DISADVANTAGES

Socio-economic impacts

animal production	decreased	✓ box 6 of 7	increased
water availability for livestock	decreased	✓ box 7 of 7	increased
water quality for livestock	decreased	✓ box 7 of 7	increased

Socio-cultural impacts

land use/ water rights	worsened	✓ box 6 of 7	improved

Ecological impacts

drought impacts	increased	✓ box 1 of 7	decreased

Off-site impacts

damage on public/ private infrastructure	increased	✓ box 6 of 7	reduced
reliable and stable stream flows in dry season (incl. low flows	reduced	✓ box 4 of 7	increased

Benefits compared with establishment costs

Short-term returns	very negative	✓ (rightmost)	very positive
Long-term returns	very negative	✓ (rightmost)	very positive

Benefits compared with maintenance costs

Short-term returns	very negative	✓ (rightmost)	very positive
Long-term returns	very negative	✓ (rightmost)	very positive

CLIMATE CHANGE

Climate change/ extreme to which the Technology is exposed

How the Technology copes with these changes/ extremes

Climate-related extremes (disasters)

drought	not well at all	✓ (rightmost)	very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- single cases/ experimental
- 1-10%
- 10-50%
- ✓ more than 50%

Has the Technology been modified recently to adapt to changing conditions?

- yes
- ✓ no

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Strengths

Land user's view

- Existence of a temporary coordinating committee on the site of the well, acting as an interface between the authorities and the livestock keepers using the well.
- The arrangement of the use of the artificial ponds according to the terms set by the authorities and the technical services.
- Monitoring of animal health and informing the livestock keeping service in case of suspected infectious diseases.

Key resource person's view

- Water availability and access to water for users when the well is operational; potential users are willing to contribute to the operation of the well.
- Water availability for livestock.
- Strong involvement of the authorities and the technical services in issues relating to 'Forage Christine'.
- Implementation of several methods to solve management problems.
- Good organisation of the management of the water source.

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view

- Lack of transparency in the use and management of contributions intended to cover the functioning and the maintenance of the generator and the wage of the guard, who also operates the generator and supervises the related installations. → Good functioning of the management committee and committee meetings will enable to overcome this disadvantage.
- A low level of representation of the different population groups in the management committee (only the Djelgobé of Gandéfabou are members; these people settled in the area in Boula and claim to be the indigenous people in the area). → Involving all groups using the well more closely in order to have an appropriate representative in the management committee.
- Lack of consultation between the management committee and the livestock keepers having their residence in the area. → Stimulating the management committee to communicate more closely with the neighbouring livestock keepers through a framework for consultation on the way in which they manage the infrastructure of the 'Forage Christine'.
- Insufficient awareness of the roles and responsibilities of the management committee by the livestock keepers (only the role of the guard is known to the livestock keepers).
- The undemocratic establishment of the management committee (self-appointed members), which explains why livestock keepers consider the committee as an imposed structure.

Key resource person's view

- The non-involvement of livestock keepers (potential users) in the management of the well in some management methods (concession to RMC); their weak involvement in the management of the well, and their continued low representation in the committees (2 to 3 persons). → Involving livestock keepers more closely in the management committees and in the decision-making bodies related to 'Forage Christine'. Increasing the number of representatives of livestock keepers in the management bodies of the well.
- The failure to address the concerns of livestock keepers in the implementation of the management methods. → Ensuring that the livestock keepers are considered by the management committee, and that they can effectively participate in the committee.

- The inappropriate use of contributions from users of the well for operating the facilities of the well in a sustainable way. → Ensuring that the funds generated by the well are managed properly by the management committee.
- Competition for water between humans and animals. → Providing wells or pumps for human consumption of water.
- Huge inflow of animals which overgraze the area, thereby threatening the environment. → Raising awareness among livestock keepers and herders on the need to manage the natural resources properly in the area influenced by 'Forage Christine', with the aim to mitigate the environmental degradation that could result from overgrazing.

REFERENCES

Compiler: Nouhoun Zampaligré (nouhoun@gmail.com

Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/technologies/view/technologies_2994/

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Key references

Boundaoné et al., 2015. Textes fondamentaux et outils de gestion du forage Christine, PGP-FC/GRP, SVN, 60 p.:

SNV, 2011. Etude pour la sécurisation des ressources foncières pastorales autour du Forage Christine dans la province de l'Oudalan. Final report, 142 p.

Links to relevant information which is available online

News paper article: Elevage dans le Sahel : 'Christine' ou le symbole de l'hydraulique pastorale. : http://lefaso.net/spip.php?article31821

Excavation at Leyhele (IUCN archieve).

Subsurface dams (SSD) (Kenya)

DESCRIPTION

These are constructions stretching across the sand filled dry riverbed, down towards the impermeable floor of the riverbed. They are totally submerged into the ground. For example by fully covering after construction by sand. This are done along dry rivers with huge sand deposits, which has high yield potential and where water can be easily extracted. The aim is to raise groundwater tables and increase the storage capacity for water withdrawals.

The technology is applied in northern rangeland of Isiolo County which is managed under communal management systems. The aim of technology to reduce pasture and water availability imbalances. The dimensions of subsurface dam include: a length of water spread (103 m), width of the dam (15 m), width of water spread (18 m), effective dam height (2 m), volume of retained sand (103 x 0.5 (15 +18) x0.5 x 2.0 = 5,098.50 m^3) and the volume of water that can be abstracted from the sand bed (25/100 x 5,098.50 m^3 = 1274.625 m^3).

The technology functions as underground water storage infrastructure and the typical activities include, excavation of top porous soil, excavation of sample pits within the excavated area, checking filtration rates of soil, compaction of soil on which dam liners are laid, smoothing the sharp liners along which the dam liners are laid, making grooves to anchor the dam liner, laying the dam liner, anchoring the dam liner with a mixture of cement, water proof and sand with water (motor) and finally drying of the motor and filling back of sand.

The development of Subsurface Dams (SSDs) was done through Cash for Work programme where local labours comprising of 40-50 persons are engaged in excavation, compactions and developing the liners. Farm tools like jembe, panga, spades and human labour are required to develop the SSD. The technology improves water supply/availability, thereby extending the period of livestock grazing in areas where typically water is depleted before the pasture hence improves water access for livestock in ways that support wider management and utilization of the rangeland and as such strength the resilience of pastoralists to droughts. This effectively gives pastoral groups, an extra grazing time (typically 2 extra months), a period usually not too long to encourage land degradation through over-grazing but long enough to enable pastoralist utilize the remaining pasture in wet season grazing areas. In so doing, the technology enable balanced use of vast communal lands without livestock retreating to dry season grazing areas.

In the process of the landscape level participatory planning with the communities: i) they identified different challenges, including need for decommissioning certain water points that they consider are contributing to over grazing and also attracting other communities, hence drive frequent conflicts, secondly, ii) they mapped areas in the rangeland where there is mismatch between water and pasture availability, most of these areas are in wet season grazing areas. So the next discussion was on what strategic water infrastructures that will enable herders to graze for 2-3 extra months to enable them utilize the grass before they migrate to the traditional dry season grazing areas. So by design, the technology should only yield water that can allow settling for those extra months, not longer to the detriment of the rangeland.

LOCATION

Location: Garba Tula, Isiolo County, Northern Kenya, Kenya

No. of Technology sites analysed: 2-10 sites

Comment: The well is located in the municipality of Déou, but is used for livestock from the entire Sahel region in Burkina Faso, Mali and Niger.

Geo-reference of selected sites
- 38.63623, 0.58383
- 38.85596, 0.64425
- 38.72412, 0.79805

Spread of the Technology: applied at specific points/ concentrated on a small area.

Comment: Subsurface Dams are only suitable in areas along the river, with suitable density of sand deposits.

Type of introduction

- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ✓ through projects/ external interventions

Excavation process (from IUCN archive).

(IUCN archieve).

The technology was instrumental in fostering both balanced utilization of land and strengthening sustainable use of the vast rangeland by ensuring that herders utilize available pastures in the wet seasons grazing areas before moving to dry seasons grazing areas. The water stored through the technology stays longer, in this case study, the water lasted for 5 months after the end of the rainy season.

The area receives bimodal rainfall, long rain in March-May and short rain in November-December. With changing seasons/climate, the dry seasons can last up to 1 year in case of rainfall failure. Typically, dry seasons are 6-7 months (May- November).

Normally, the water is depleted within 2 months after the rainy period. The technology is also cheap and easy to understand and construct (especially in areas with clay as the underlying impermeable material) with a possibility of the communities to be taught how to identify suitable site and the entire process of construction. However, in areas without clay soil, the excavation of clay and transportation can be labour intensive and expensive.

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- ✓ improve production
- ✓ reduce, prevent, restore land degradation
- conserve ecosystem
- protect a watershed/ downstream areas – in combination with other Technologies
- preserve/ improve biodiversity
- reduce risk of disasters
- ✓ adapt to climate change/ extremes and its impacts
- ✓ mitigate climate change and its impacts
- ✓ create beneficial economic impact
- ✓ create beneficial social impact

Land use

Grazing land – Extensive grazing land: Semi-nomadism/ pastoralism
Comment: Communal grazing area that is shared by 2 and more pastoral groups.

Water supply

- ✓ rainfed
- mixed rainfed-irrigated
- full irrigation

Livestock density: Fluctuates, depending on seasons and pasture availability.

Purpose related to land degradation

- ✓ prevent land degradation
- ✓ reduce land degradation
- restore/ rehabilitate severely degraded land
- adapt to land degradation
- not applicable

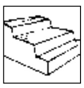
Comment: The SSD technology increase water availability is period immediately after the rain, hence ensuring better pasture utilization and more sustainable use of land.

Degradation addressed
Comment: Mismatch of pasture and water resources – there are areas where pastures are plenty but surface rain water is depleted earlier than pasture.

SLM group

- pastoralism and grazing land management

SLM measures

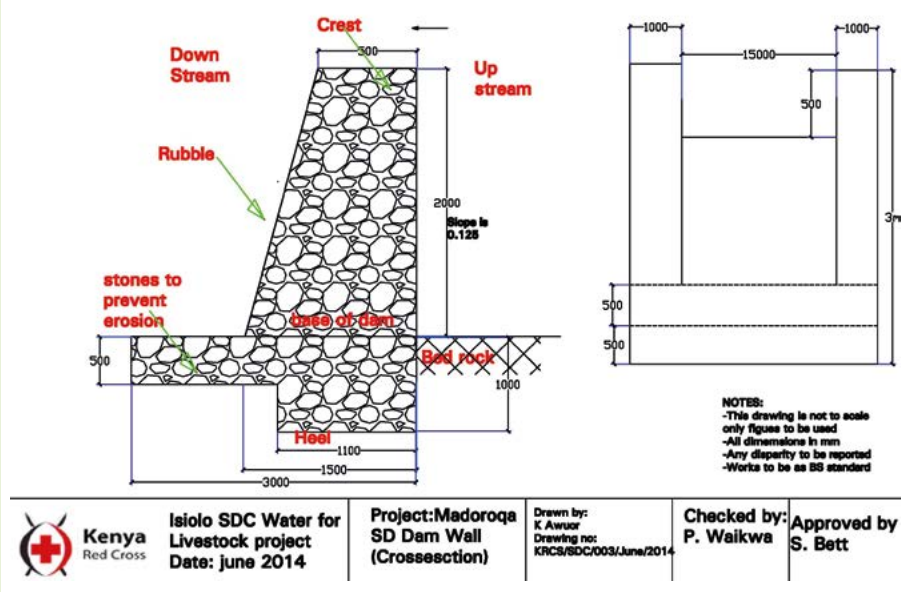


structural measures – S5: Dams, pans, ponds

TECHNICAL DRAWING

Technical specifications

The SSD has initial excavation works. The construction of the SSD was constructed by 50 labourers. The area of excavation is subdivided into 45 square chambers of 4x2.3x2.2 = 20.2 m^3 (not to scale). Each of the chambers were excavated by 5 labourers. The estimated time for excavation as per the plan was estimated to be five days. Excavation and transportation of the clay from the clay pit was estimated to take an approximate of five days while the compacting of the clay will follow one week later, and laying out of the concrete and refilling of the sand for another week. The liner will then be finally placed. In summary, the excavation of sand takes 5 days, and the excavation of clay soil takes another 5 days while concrete placing, compacting of clay as well as putting of liner and refilling of sand takes 10 days.



Author: Guyo Roba.

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated: per Technology area (size and area (unit: **chamber**)
- Currency used for cost calculation: **US Dollars**
- Average wage cost of hired labour per day: 3.50 USD per day

Most important factors affecting the costs

Distance of the subsurface dam from villages, extent of destruction by floods and human activities.

Establishment activities

1. Removing sand over dyke and man-days for excavating and transporting soil to dam site (Timing/ frequency: 21 days for 45 casual labourers).
2. Building and compaction soil in dam wall (Timing/ frequency: 3 days for 45 casual labourers).
3. Supplying water for compaction (Timing/ frequency: 0.5 day for 45 casual labourers).
4. Back-filling sand on dam (Timing/ frequency: 1 day for 45 casual labourers).
5. Supplying water for compacting clay in dam wall (Timing/ frequency: 2 days for 45 casual labourers).
6. Compacting soil and placing liners (Timing/ frequency: 12 days for 45 casual labourers).

Comment: The construction of SSD was done through 'Cash for work' which is participatory process that involves community mobilization, identification of beneficiaries and formation of 'Cash for work' committees, registrations and verification of beneficiaries and implementation/supervision of the work.

Establishment inputs and costs (per chamber)

Specify input	Unit	Quantity	Cost per unit (US Dollars)	Total cost per input (US Dollars)
Labour				
Tools – jembe, spade etc.	pieces	80	5.33	426.40
Removing sand over dyke and man-days for excavating and transporting soil to dam site	per day	945	4.00	3,780.00
Building and compaction soil in dam wall	per day	135	4.00	540.00
Equipment				
Supplying water for compaction	per day	22	4.00	90.00
Back-filling sand on dam	per day	45	4.00	180.00
Supplying water for compacting soil in dam wall	per day	90	4.00	360.00
Compacting soil and placing liners	per day	540	4.00	2,160.00
Total costs for establishment of the Technology				**7,536.40**

Comment: As stated, the cash for work approach means that people get paid 4 USD per day for working on SSD until completion. There are phases where people participated in preliminary phases in meetings and consultation without payments but the actual work was done on cash for work basis.

Maintenance activities

1. Training of communities to manage and maintain the structures (Timing/ frequency: yearly)

Maintenance inputs and costs (per chamber)

Specify input	Unit	Quantity	Cost per unit (US Dollars)	Total cost per input (US Dollars)
Labour				
Labour for site protection and maintenance of hygiene	per site	10	100.00	1,000.00
Total costs for establishment of the Technology				**1,000.00**

Comment: Water User Associations on the sites are trained on the management of the structures on behalf of the community e.g. on the protection of structure and hygiene maintenance.

NATURAL ENVIRONMENT

Average annual rainfall
- < 250 mm
- 251-500 mm
- ✓ 501-750 mm
- 751-1,000 mm
- 1,001-1,500 mm
- 1,501-2,000 mm
- 2,001-3,000 mm
- 3,001-4,000 mm
- > 4,000 mm

Agro-climatic zone
- humid
- sub-humid
- ✓ semi-arid
- arid

Specifications on climate

Because of the climate change, the rainfall is becoming more erratic.

Name of the meteorological station: Isiolo

Slope
- flat (0-2%)
- gentle (3-5%)
- moderate (6-10%)
- ✓ rolling (11-15%)
- hilly (16-30%)
- steep (31-60%)
- very steep (>60%)

Landform
- ✓ plateau/ plains
- ✓ ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

Altitude
- 0-100 m a.s.l.
- 101-500 m a.s.l.
- ✓ 501-1,000 m a.s.l.
- 1,001-1,500 m a.s.l.
- 1,501-2,000 m a.s.l.
- 2,001-2,500 m a.s.l.
- 2,501-3,000 m a.s.l.
- 3,001-4,000 m a.s.l.
- > 4,000 m a.s.l.

Technology is applied in
- convex situations
- ✓ concave situations
- not relevant

Soil depth
- very shallow (0-20 cm)
- shallow (21-50 cm)
- moderately deep (51-80 cm)
- ✓ deep (81-120 cm)
- very deep (> 120 cm)

Soil texture (topsoil)
- ✓ coarse/ light (sandy)
- medium (loamy, silty)
- fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- ✓ coarse/ light (sandy)
- medium (loamy, silty)
- fine/ heavy (clay)

Topsoil organic matter content
- high (>3%)
- ✓ medium (1-3%)
- low (<1%)

Groundwater table
- on surface
- < 5 m
- ✓ 5-50 m
- > 50 m

Availability of surface water
- excess
- good
- medium
- ✓ poor/ none

Water quality (untreated)
- ✓ good drinking water
- poor drinking water (treatment required)
- fine/ heavy (clay)
- for agricultural use only (irrigation)
- unusable

Is salinity a problem?
- yes
- ✓ no

Occurrence of flooding
- yes
- ✓ no

Species diversity
- ✓ high
- medium
- low

Habitat diversity
- ✓ high
- medium
- low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- subsistence (self-supply)
- ✓ mixed (subsistence/ commercial
- commercial/ market

Off-farm income
- ✓ less than 10% of all income
- 10-50% of all income
- > 50% of all income

Relative level of wealth
- very poor
- poor
- ✓ average
- rich
- very rich

Level of mechanisation
- ✓ manual work
- animal traction
- mechanized/ motorized

Sedentary or nomadic
- [ ] sedentary
- [x] semi-nomadic
- [ ] nomadic

Individuals or groups
- [ ] individual/ household
- [x] groups/ community
- [ ] cooperative
- [ ] employee (company, government)

Gender
- [ ] women
- [x] men

Age
- [ ] children
- [ ] youth
- [x] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha
- [ ] 100-500 ha
- [ ] 500-1,000 ha
- [ ] 1,000-10,000 ha
- [x] > 10,000 ha

Scale
- [ ] small-scale
- [ ] medium-scale
- [x] large-scale

Land ownership
- [ ] state
- [ ] company
- [x] communal/ village
- [ ] group
- [ ] individual, not titled
- [ ] individual, titled

Land use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Water use rights
- [ ] open access (unorganized)
- [x] communal (organized)
- [ ] leased
- [ ] individual

Access to services and infrastructure

health	poor	✓			good
education	poor		✓		good
technical assistance	poor		✓		good
employment (e.g. off-farm)	poor	✓			good
markets	poor	✓			good
energy	poor		✓		good
roads and transport	poor	✓			good
drinking water and sanitation	poor		✓		good
financial services	poor	✓			good

IMPACTS – BENEFITS AND DISADVANTAGES

Socio-economic impacts

animal production	decreased						✓		increased
land management	hindered						✓		simplified
water availability for livestock	decreased							✓	increased

Ecological impacts

drought impacts	increased						✓		decreased

Off-site impacts

water availability (groundwater, springs)	decreased						✓		increased

Benefits compared with establishment costs

Short-term returns	very negative						✓		very positive
Long-term returns	very negative						✓		very positive

Benefits compared with maintenance costs

Short-term returns	very negative						✓		very positive
Long-term returns	very negative							✓	very positive

Comment: The technology has limited running and maintenance costs once its done fairly well.

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology
- [ ] single cases/ experimental
- [x] 1-10%
- [ ] 10-50%
- [ ] more than 50%

Of all those who have adopted the Technology, how many have did so without receiving material incentives?
- [x] 0-10%
- [ ] 10-50%
- [ ] 50-90%
- [ ] 90-100%

Has the Technology been modified recently to adapt to changing conditions?
- [ ] yes
- [x] no

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Strengths

Land user's view

- The technology created opportunity to graze in wet season grazing areas for an average extra 2 months period after rainy seasons. The technology has provided additional water that gave herders extra days to graze in wet season areas and utilize the pasture that would have been unutilized due to water constrains. In so doing, the land users utilized the pasture without retreating to traditional dry season grazing areas.
- The extra grazing months has reduced overall livestock mortality during droughts and also improved resilience of pastoral community.
- The distance travelled and effort required to access water was reduced. Community members reported reduced distances covered and time spent in search of water for livestock. In some instances the distance reduced from 12-15 km to 3 km. Community members also mentioned reduction in conflict incidences over water resources in some areas due to adequate supply of water as a result of construction of water infrastructure.
- The balanced utilization of the grazing area through SSD water provision, enables herd to graze in wet season grazing for slightly longer period and utilize pasture optimally, this however, does not mean that during that garzing period, there will be overgrazing. The volume of water available restricts the number of animals sustained by the grazing area.

Key resource person's view

- The technology has created an opportunity to optimally use the grazing area and overall reduced land degradation. The technology Improves access to water for livestock in ways which promote more sustainable management of rangeland resources and as such strengthening the resilience of local communities.
- The validation process prior to construction of the SSD is draws critical lessons of identifying and agreeing on where to construct the SSD in a way that fit within broader sustainable rangeland management in a manner that ensured sustainable and efficient utilization of pasture and browse resources in targeted areas. The increase in water supply allowed livestock to graze additional 2-3 months in target areas before shifting to dry grazing areas where previously they migrated before exhausting the pasture and browse resources due to water scarcity. The dry season grazing area is towards Merti, in Kom and Sabarwawa where there are deep boreholes, under, lock and key and only opened during dry seasons. In typical year, the dry season period is about 7 months. But when one rain season fail it goes to about 11 months.

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view

- When the construction season for SSD is not well planned, there is likelihood/risks of the dams being washed away by flash floods. → Better planning and timing of the development of SDD, just slightly before the onset of rainfall.

REFERENCES

Compiler: Guyo Roba (guyo.roba@iucn.org)
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Links to relevant information which is available online

Promoting resilience by influencing water infrastructure development in community managed rangelands of Kenya: https://portals.iucn.org/library/sites/library/files/documents/2014-088.pdf

Balancing water infrastructure in community-managed rangelands in the arid and semi-arid lands of Kenya: https://portals.iucn.org/library/sites/library/files/documents/2014-089.pdf

COMMUNITY BASED NATURAL RESOURCE MANAGEMENT (AG1)

General assembly of the pastoralist field school *"Champ Ecole Pastorale"*, Niger (Mahamane Abdoulaye).

In a nutshell

Short description
Community based natural resource management (CBNRM) refers to the collective use, management and planning of natural resources, and gives rural communities a stake in the management of their land (small to medium-scale) and a feeling of ownership. It reduces poverty, inequality and exclusion, vulnerability and risks faced by the rural population especially the poor. CBNRM involves organisation of communities, formation of user groups to plan and govern improved management of the natural resources – namely vegetation, soil, water and animals. It includes land use planning at the local scale. Savings groups may also be formed. CBNRM combines the generation of economic benefits for rural communities.

Principles
- Build from the community level, involving land users and their initiatives from the beginning to the end.
- Ensure participatory and collaborative planning, activities and accountability, involving and giving communities responsibility at all stages.
- Identify and build on community-based traditions, innovations and adaptations.
- Develop links connecting a wide span of stakeholders from community-based organisations (CBOs), to non-governmental organisations (NGOs) to the government (GOs), and international organisations (multi-stakeholder integration).

Most common approaches
Local level participatory planning: involving all land users and communities in planning, implementation and evaluation.

Participatory resource mapping: enabling communities to jointly plan rangeland management through consensus. They map out in detail the resources they depend on, the qualities they attribute to these resources, who uses them, who depends on them and how they manage them.

Joint rangeland management planning: involving all livestock keepers, seasonally, in planning how they manage livestock and as well as cropland to improve livelihoods through informed, sustainable use of their resources, in an equitable manner.

Pastoralist field schools and demo sites: pastoralist field schools are "schools without walls" that introduce good agricultural and marketing practices while building on local knowledge through hands-on experimental and participatory learning[1]. Demonstration sites can help accelerate the adoption of innovations alongside traditional practices.

Conflict resolution: e.g. dialogue platforms, alliances, information sharing and decision making forums. All aim to prevent – or resolve – conflict.

ESS addressed	
food security/ self-sufficiency	+++
SRM knowledge	+++
conflict mitigation	+++
empower disadvantaged groups	++
Improve gender	+++
equality	++
governance	++
CC adaptation	+

Importance: +++ high, ++ medium, + low, +/- neutral, na: not available

Participatory community resource mapping, Kenya
The "Rangelands Initiative Africa" is working to make rangelands more tenure-secure. The Social Tenure Domain Model (STDM) recognises that secure tenure builds confidence among the resource users, and therefore promotes confidence in investment at different levels: small-scale, large-scale, urban and rural investors who all benefit from security of tenure.

https://qcat.wocat.net/en/summary/4032/
http://pubs.iied.org/17401IIED

Farmers negotiating the starting point for the mapping exercise (Reconcile, Ken Otieno).

[1] https://qcat.wocat.net/en/summary/2324/

Savings and pasture user groups and/or associations: Savings groups are composed of individuals who save together and take small loans from those savings. They are a powerful economic and social development platform, enabling minor investments and acting as a type of insurance buffer in cases of stock loss etc.[2] Savings groups (SGs) are especially prevalent across sub-Saharan Africa (e.g. rotating savings and credit associations (ROSCAs)).[3]

Rangeland use system (RUS)

CBNRM is mainly relevant to systems where crop production is integrated – 'agropastoral' and 'pastures'. Also, found in 'pastoral' and 'bounded with wildlife' systems.

Main benefits

- Close interaction and exchange between the different stakeholders (land users, NGOs, local government officials, SLM specialists, universities).
- Can provide a science-practice link.
- Capacity built through "learning by doing" (e.g. through field schools).
- Inter-community dialogue in natural resources sharing and access.
- Conflict resolution and mitigation.

Main disadvantages

- Danger of poor financial management.
- Lack of accountability from the leaders – and lack of demand for accountability from the members.
- Conflicting group and individual interests.
- Lack of a written constitution and grazing by-laws to reinforce traditional decision making.

Applicability and adoption

CBNRM is the most "natural" way of managing common resources (pastureland and water) in agreement and inclusion of all concerned. There are new initiatives to "restore" CBNRM by the formation of user groups. Customary land tenure systems play a major role in rangeland governance. Pastoralists have (or have had) strong traditional institutions that play a significant role in regulating natural resource use and conservation, manage risks, protect resources and promote collective action. Improve and utilise legal frameworks, institutions, governance, and policies.

Dialogue platforms (DP), Cameroon

DP facilitate consultations in managing rangelands. They bring together rangeland users including farmers, pastoralists/ agropastoralists to learn, discuss and implement low stake conflict mitigation strategies and mutually beneficial alliances. In alliance farming they agree to use the same land and related resources sequentially: growing crops during the rains, and grazing cattle in the dry season.

https://qcat.wocat.net/en/summary/3401/
https://qcat.wocat.net/en/summary/3918/

Dialogue Platform members holding discussions in Ashong, Cameroon (MBOSCUDA North West Region).

Alliance farming beneficiary: pastoralist strategically herding his animals between fences erected by farmers (MBOSCUDA North West Region).

Community based natural resource management (CBNRM) in Zimbabwe

Based on the lessons learnt of the long-term 'Communal Areas Management Programme for Indigenous Resources' (CAMPFIRE), Zimbabwe is ushering in a new era of CBNRM. It is moving away from place-based wildlife management initiatives to more internationally linked forestry carbon projects, which focus on the sequestration of carbon through conservation of forests and the subsequent trading of carbon credits.

http://campfirezimbabwe.org/index.php; Harrison et al. 2015

(https://firstforwildlife.com/2015/08/18/the-campfire-program-in-zimbabwe/)

[2] https://seepnetwork.org/Thematic-Areas-Savings-Groups
[3] http://sg4africa.org/

Pastoralist field schools (PFS) members working to improve their pasture land (FAO).

Pastoralist field schools (Ethiopia)

DESCRIPTION

Pastoralist field schools improve livelihoods and resilience of pastoral communities through a process of hands-on experimental and participatory learning. They are 'schools without walls' that introduce good agricultural and marketing practices while building on local knowledge. The PFS approach builds heavily on the basic principles of discovery based learning to address a wide range of issues affecting pastoral livelihoods.

The Pastoral Field School (PFS) approach was the key development tool used in the FAO project entitled 'Improved food security, livelihoods and resilience of vulnerable pastoral communities in the Greater Horn of Africa through the pastoralist field school approach'. The project was implemented between June 2011 and July 2015 and targeted agropastoralists in the West Pokot and Turkana areas of Kenya, the Karamoja area of Uganda and Borena and Guji Zones of Ethiopia. Indirect beneficiaries included Non-governmental organisations (NGO) and development actors involved in PFS actions across the region, largely through capacity building. The project was implemented through FAO regional and country offices in close collaboration with selected implementation partners in the countries, including communities, both local and international NGOs and governments.

The PFS approach is an adaptation of the Farmer Field School (FFS) approach. The FFS approach emerged in South East Asia in 1989 as a way to better engage farmers in a field-based enquiry for participatory identification and adoption/adaptation of solutions to local problems. The approach builds on the principles of adult and non-formal education, and experimental and emancipatory learning with a focus on learning processes and building analytical capacity as opposed to traditional extension approaches that focus on top-down dissemination of information to farmers. The PFS approach was first tested in 2006 in Kenya by FAO, Vétérinaires Sans Frontières Belgium and the International Livestock Research Institute (ILRI).

A PFS can be described as 'school without walls' that introduces new pastoral techniques and practices (including SLM technologies) while building on indigenous knowledge, with community empowerment as a result. Through experiential and participatory learning techniques applied in a group setting (25-30 members), with regular meetings over a season/production cycle, (agro-)pastoralists learn how to analyse their situation and make informed decisions about their livelihood practices and resource use strategies. When empowered to make informed decisions and adapt to changes in the environment, community members are better able to support disaster risk reduction and mitigation of climate change impacts. A facilitator (trained by an experienced field schoolmaster trainer and with a good understanding of pastoral issues) guides the learning process and ensures that the group activities are interlinked with a community managed disaster risk reduction plan. The technical topics covered can include animal production and health, pasture and range management, dryland farming, livestock fodder production, community-managed disaster risk reduction and alternative incomes. The informal nature of the approach fur-

LOCATION

Location: Borena zone, Oromia region, Ethiopia

Geo-reference of selected sites

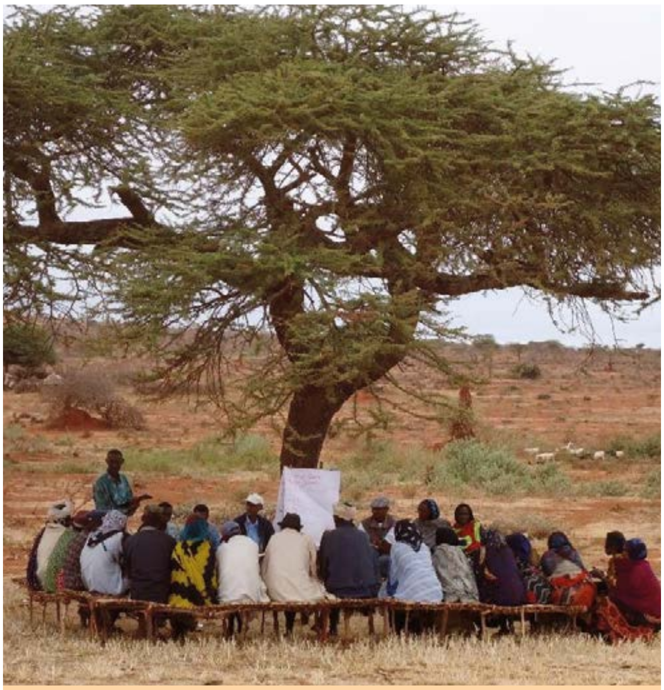
- 38.99267, 4.72321

Initiation date: 2011

Comment: The approach was used within the framework of the FAO project entitled 'Improved food security, livelihoods and resilience of vulnerable pastoral communities in the Greater Horn of Africa through the pastoral field school approach'. The project was implemented from 1 June 2011 to 31 July 2015. PFS learning enabled members to continue PFS activities and learning also after the end of the project.

Type of Approach

- ☐ traditional/ indigenous
- ☑ recent local initiative/ innovative
- ☐ project/ programme based



Pastoralist field school meeting (FAO).

PFS member presenting the results of the agro-ecosystem analysis (AESA) during a PFS session (FAO).

ther provides an excellent entry point to address social issues of gender inequities including gender-based violence, HIV, public health, population growth as well as conflict.

Mobility is an important factor to be considered in PFS as it bears on aspects such as the frequency and location of meetings. In some cases, PFS activities have to be interrupted during pastoral movements while in others the facilitator has to follow the field school group during migration. Agro-pastoralists may not always be available to participate in PFS activities as they may spend many hours or days with their livestock in search of water or fodder. Generally, PFS has a longer cycle than groups focusing on small-scale farming, and flexibility is needed when unforeseen events disrupt learning activities. Pastoralists and agro-pastoralists often live in conditions of high environmental uncertainty.

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims/ objectives of the approach

To strengthen the capacity of pastoral communities and support improved natural resources management and disaster risk management to reduce food insecurity vulnerability.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** Pastoralists were able, committed and willing to work in teams and to invest their time in PFS learning activities. – The community had a positive attitude to change and the local culture allowed for innovations.
- **Availability/ access to financial resources and services:** PFS activities, learning and group action facilitated leveraging of financial resources and services. All PFS groups developed savings and credit schemes.
- **Institutional setting:** Efforts towards institutionalization enhanced PFS sustainability, improved quality, and strengthened impact and continuity.
- **Knowledge about SLM, access to technical support:** PFS facilitators received technical support from subject matter specialists (e.g. animal scientists, veterinarians, agronomists). The specialists were invited to the PFS by the facilitators whenever technical inputs and assistance in designing appropriate experiments were needed. – SLM technologies/ PFS practices were built on indigenous knowledge and local practices.
- **Markets (to purchase inputs, sell products) and prices:** Promoting the use of locally available resources (e.g. agricultural and livestock inputs) was crucial to ensure PFS sustainability and the continuity of PFS activities.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Collaboration/ coordination of actors:** Networking among implementing actors and key stakeholders could have been stronger.
- **Policies:** The PFS approach wasn't part of Government structures and procedures, so no enabling policies were in place.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders/ implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Pastoralists- PFS members and their communties.	Field school activities were carried out by the pastoralists themselves, ensuring a strong level of involvement of the beneficiaries throughout all stages of implementation.
NGO	Gayo Pastoral Development Initiative.	Implement Pastoralist Field School in the Borena zone.
local government	Miyo Pastoral Development Association (Government Institution). Moyalle Pastoral Development Association (Government Institution).	Implement Pastoralist Field School in the Borena zone.
international organisation	Food and Agriculture Organization of the United Nations (FAO).	FAO was responsible for overseeing the overall implementation of the intervention, providing mentoring and technical support, create platform for harmonizing the field school approach and allocate required resources for implementation, provide guidance on linkages with related regional pastoral initiatives. The overall day-to-day management of the project was led by FAO's Resilience Team for Eastern Africa (RTEA), drawing on the technical expertise and experience of its headquarters in Nairobi, Kenya and its Subregional Office for Eastern Africa in Addis Ababa. Activities in Ethiopia were supported by the FAO Country Office. FAO field offices implemented the project in the targeted field locations, in collaboration with Non-Governmental Organizations (NGOs) and Government partners.

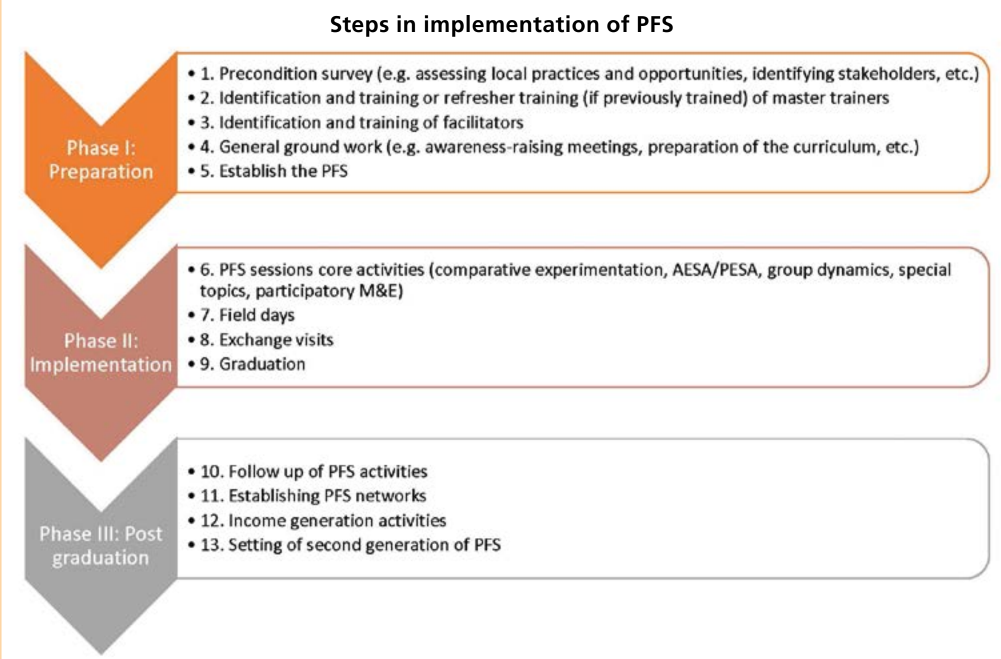
Lead agency
Food and Agriculture Organization of the United Nations (FAO).

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	Specify who was involved and describe activities
initiation/ motivation				✓		The PFS approach was presented to pastoral communities and their leaders as well as to local stakeholders (e.g. local government, development partners) to seek buy-in and collaboration.
planning				✓		Needs, priorities and opportunities for improvement were identified through a consultative process with the community before and throughout PFS implementation. The PFS members, not the facilitator, decided what was relevant to them and what they wanted the PFS to address.
implementation				✓		As per PFS principles, the pastoral community was involved in all activities during project implementation and had a decision-making role. The dissemination of PFS practices/SLM technologies was encouraged among members and pastoral communities. Exchange visits (educational tours to other PFS), field days (getting non-PFS members involved in PFS activities), and share fairs were organized to promote trade and exchange of ideas.
monitoring/ evaluation				✓		The expansion of monitoring and evaluation tools and processes was part of the regular PFS implementation, with exercises and tools embedded in the PFS sessions to assess progress and allow members to take corrective action based on the results.
impact assessment				✓		A major achievement of the intervention was the participatory impact assessment. The assessment was conducted using a mix of methods, including focus group discussions with PFS members, case stories, semi-structured interviews and scoring of perceived change before and after PFS membership.

Flow chart

Phases and steps of Pastoral Field Schools.



Author: FAO

Decision-making on the selection of SLM Technology

Decisions were taken by

- [ ] land users alone (self-initiative)
- [ ] mainly land users, supported by SLM specialists
- [ ] all relevant actors, as part of a participatory approach
- [x] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders

Comment: In PFS, learning is by doing, i.e. through practical activities and exercises. Throughout PFS implementation, members tested, validated, and adapted SLM technologies to their environments.

Decisions were made based on

- [ ] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [x] personal experience and opinions (undocumented)
- [x] hands-on testing and adaptation for local use

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE

The following activities or services have been part of the approach

- [x] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organisational development)
- [x] Monitoring and evaluation
- [x] Research

Capacity building/ training

Training was provided to the following stakeholders

- [x] land users
- [x] field staff/ advisers

Form of training

- [x] on-the-job
- [x] farmer-to-farmer
- [x] demonstration areas
- [ ] public meetings
- [ ] courses

Subjects covered

The curriculum of PFS groups generally focused on: methodology and implementation, participatory learning and facilitation, group management and technical topics.

Some of the technical topics covered by the facilitator include gender, NRM, nutrition, forage production and health, conflict management, business skills development, village community banks (VICOBA), rangeland management, soil and water conservation and community-managed disaster risk reduction (CMDRR), and water scheme management.

Advisory service

Advisory service was provided

- [x] on land users' fields
- [ ] at permanent centres

Comment: PFS are 'schools without walls' where capacity is developed from existing local knowledge. They are learning by doing and problem based, on the fields/ rangelands of the community. PFS usually comprises a group of 25-30 pastoralists who meet regularly in a local field setting, under the guidance of a trained facilitator. They make observations on livestock production and rangeland ecosystem, focus on a topic of study, and compare the effects of alternative practices. As a result of the observations and analyses done directly on-site, participants make decisions on how to improve their practices. All PFS follow this systematic action learning process where the key steps are observation, reflection, group discussion, analysis, decision making and action planning.

Institution strengthening

Institutions have been strengthened/ established
- no
- yes, a little
- ✓ yes, moderately
- yes, greatly

at the following level
- ✓ local
- regional
- ✓ national

Describe institution, roles and responsibilities, members, etc.
The two government institutions (Miyo Pastoral Development Association and Moyalle Pastoral Development Association). and the NGO (Gayo Pastoral Development Initiative) that implemented the approach in the target area has been strengthened through capacity building on PFS.

Type of support
- financial
- ✓ capacity building/ training
- equipment

Monitoring and evaluation

Monitoring was conducted by the Swiss Agency for Development and Cooperation (SDC) office in Addis Ababa as well as through field missions and regular dialogue with the FAO Country Office in Ethiopia. As per PFS principles, participatory M&E was also conducted during every PFS meeting. Both the PFS members and facilitator continuously assessed whether they were bringing any behavioural changes and actually achieving the learning objectives. Participatory M&E helped PFS practitioners actively observe and analyse situations and performances and understand what they were observing.

Research

Research treated the following topics
- sociology
- ✓ economics/ marketing
- ecology
- ✓ technology

Comment: When needed, researchers and subject matter experts were invited to provide technical support to PFS groups. PFS developed/ strengthened linkages between pastoral communities and researchers.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
- < 2,000
- ✓ 2,000-10,000
- 10,000-100,000
- 100,000-1,000,000
- > 1,000,000

Comment: The budget range above refers to the costs incurred for implementing a single PFS within the project. The Government of the Swiss Confederation, through the Swiss Agency for Development and Cooperation, contributed USD 2,154,100 for this FAO for this FAO project in Ethiopia, Kenya and Uganda.

The following services or incentives have been provided to land users
- ✓ financial/ material support provided to land users
- subsidies for specific inputs
- credit
- other incentives or instruments

Financial/ material support provided to land users
Each PFS group received direct grants of USD 940 for their learning activities and to purchase inputs for PFS experimentation.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	no	yes, little	yes, moderately	yes greatly
Did the Approach empower local land users, improve stakeholder participation? PFS enabled and empowered pastoralists, their families and pastoral communities to understand and respond to local challenges. PFS members improved their understanding of the environment, obtained knowledge and learned additional skills which lead to improved capacity to manage available resources. PFS groups showed a greater level of cooperation and mutual help compared to the situation prior to the PFS project. PFS groups demonstrated enhanced capacity to seek self-generated solutions to problems identified by the group, generally developed through the experimentation and field analysis component of PFS, which in turn positively impacted on adoption rates of new practices and technologies.				✓
Did the Approach enable evidence-based decision-making? PFS helped pastoralists to develop the skills required for informed decision-making in their environment				✓
Did the Approach help land users to implement and maintain SLM Technologies? As PFS members carried out PFS practices themselves and saw the direct results of the processes, they took ownership of the innovations and decisions on their livelihood activities. This was further enhanced by reduced production costs and the proceeds which the groups received from PFS practices that encouraged the members to continue with the efforts since they paid off.				✓

Did the Approach improve coordination and cost-effective implementation of SLM?
Policy dialogue for institutionalizing PFS as an extension approach were successfully conducted with the federal Ministry of Agriculture and regional agriculture bureau and donors. The initial policy processes were funded by the European Union (EU) and the Swiss Agency for Development and Cooperation (SDC). They involved field implementation of field schools with policy deliberations at the local Government levels and cascading slowly to the National level. Later, an FAO project funded by SDC continued with the institutionalization process at the National level, Universities and research institutions. Policy makers are now willing to use the approach in the (agro)-pastoral areas of Ethiopia.

Did the Approach mobilize/ improve access to financial resources for SLM implementation?
PFS increased the abilty of pastoralists to leverage appropriate financial services through group action and improved skills and knowledge. The savings and credit schemes built into PFS interventions and resulting income generating activities contributed to an increase in financial capital. In general the money contributed benefited both men and women equally. However, in many cases women were the more frequent beneficiaries since they frequently borrowed to engage in petty businesses.

Did the Approach improve knowledge and capacities of land users to implement SLM?
PFS activities increased the awareness of communities on the sustainable management of natural resources and its relation to group productive and income generating activities. The PFS approach, in contrast to most conventional extension approaches, strengthens the capacity of local communities to analyse their livelihood systems, identify their main constraints and test possible solutions. By merging their own traditional knowledge with external information, stakeholders can eventually identify and adopt the most suitable practices and technologies to their livelihood system and needs to become more productive, profitable and responsive to changing conditions.

Did the Approach improve knowledge and capacities of other stakeholders?
The PFS approach improved knowledge and capacities of stakeholders at different levels starting from Federal to communities level.

Did the Approach build/ strengthen institutions, collaboration between stakeholders?
The approach strengthens individuals' knowledge and practices whilst reinforcing collaborative learning and bonding. By learning together over an extended period of time, collaboration between stakeholders/ beneficiaries is strengthened.

Did the Approach mitigate conflicts?
Part of this approach includes incorporating conflict management more strongly. Through the PFS approach, stakeholders developed a greater understanding of how to plan for and mitigate disaster, and recognized how social factors such as conflict and gender inequality can exacerbate the effects of disasters.

Did the Approach empower socially and economically disadvantaged groups?
Many groups had set rules for dealing with individual financial requirements, as well as individual emergencies, requiring group cohesion and solidarity support mechanisms, thus enhancing the community internal safety net for vulnerable members.

Did the Approach improve gender equality and empower women and girls?
Women benefited from the initiative through empowerment and income generation through livelihood diversification. Women's empowerment – i.e. enabling their inherent potential – was considered as one of the most prominent impacts of the intervention. Changes in gender relations as a result of the PFS approach was prominent. Women appreciated the fact that the PFS groups offered the opportunity for them to discuss issues and challenges with men in an organised and moderated manner. In general, and given the prevailing cultural norms, women had the opportunity to make their voices and arguments heard in all PFS groups.

Did the Approach build/ strengthen institutions, collaboration between stakeholders?
The approach strengthens individuals' knowledge and practices whilst reinforcing collaborative learning and bonding. By learning together over an extended period of time, collaboration between stakeholders/ beneficiaries is strengthened.

Did the Approach encourage young people/ the next generation of land users to engage in SLM?
Elema Kensa, a young PFS lady member said, 'Women benefit from the enclosure in many ways. Before, women used to go very far in order bring food to our livestock. But, thanks to the PFS and our enclosure now we can harvest the grass nearby and give it to our livestock. Having this grass nearby reduces the burden of the women and this is a result of the education we got from PFS.'

Did the Approach improve issues of land tenure/ user rights that hindered implementation of SLM Technologies?
The community initiative led by the PFS group has taken to practicing the approach for their own livestock needs. The protected community grazing lands were fenced off, and livestock grazing was restricted and managed.

Did the Approach improve issues of land tenure/ user rights that hindered implementation of SLM Technologies?
The community initiative led by the PFS group has taken to practicing the approach for their own livestock needs. The protected community grazing lands were fenced off, and livestock grazing was restricted and managed.

Did the Approach lead to improved food security/ improved nutrition?
Supported by PFS training and financed through the group saving schemes, most PFS groups initiated alternative income sources, resulting in diversified livelihood options and thereby increased food security and nutrition. The domestic food situation improved since the start of PFS activities in the target area as a result of increased agricultural production and increased purchasing power to buy additional food from alternative income sources.

Did the Approach improve access to markets?
PFS activities increased access to input (e.g. agricultural equipment) and output markets and helped pastoralists to leverage appropriate markets and market information.

Did the Approach lead to improved access to water and sanitation?
Water for human and livestock use was improved through the improved water management practices applied by the group.

Did the Approach lead to more sustainable use/ sources of energy?
By closing off grazing areas, shrubs and trees were also protected. These species can be a source of fuelwood, but are often degraded.

Did the Approach lead to employment, income opportunities?
The PFS members developed different alternative income generating activities which range from petty business especially for women, beekeeping, purchasing animal for fattening and re-sale, and purchasing and sale of animals without fattening.

Main motivation of land users to implement SLM
- [x] increased production
- [x] increased profit(ability), improved cost-benefit-ratio
- [x] reduced land degradation
- [x] reduced risk of disasters
- [ ] reduced workload
- [ ] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [ ] environmental consciousness
- [ ] customs and beliefs, morals
- [x] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [ ] conflict mitigation

Sustainability of Approach activities
Can the land users sustain what had been implemented through the Approach (without external support)?
- [ ] no
- [x] yes
- [ ] uncertain

Comment: The PFS promoted practices that build on local knowledge and practice and that require locally available production inputs.

CONCLUSIONS AND LESSONS LEARNT

Strengths

Land user's view
- This activity has improved the status of women through enabling them and offering them a greater spectrum of livelihood options.
- PFS activities increased the awareness on sustainable management of the natural resources. This is an achievement as the PFS communities increase their income diversity and income generating capacity facilitated through natural resources.
- The groups decided by discussion on emerging issues to be dealt with. This built considerable coherence within the group and ensured that those topics that were important were selected.

Key resource person's view
- The PFS approach in general contributed to generating increased, appropriate and self-defined livelihood options. Members have therefore the opportunity to improve their livelihood portfolio by spreading their activity base and thus prepare better for emerging challenges of greater variability than the community is used to.
- The opportunity for members, especially women to meet, discuss at equal level with men and focus on problem solving. This is very much appreciated in a community setting where tribal institutions are respected. PFS groups show a greater level of cooperation and mutual help as compared to the situation prior the PFS intervention.
- The approach does not rely on highly trained external advisors but on pastoralists' own discovery and reflection. It can function well even with facilitators of relatively low technical skills. This allows for scaling up of interventions more easily, since solutions are obtained jointly through an experimentation process.

Weaknesses/ disadvantages/ risks → how to overcome

Land user's view
- Attending PFS sessions requires time and effort, something participants not always have. → This is mostly a problem at the beginning. As soon as it becomes clear to participants what the added value of the approach is then they are perfectly fine with putting in the required effort and time. It is therefore important to make clear right from the beginning what the (expected) benefits to participants are.
- Quality of implementation of PFS largely depends on the organisational, communication and methodological skills of facilitators as well as on their regular availability throughout the FFS cycle. In some instances, poor quality of facilitators has led to inadequate experimentation and ecosystem analysis. → Continuous support is required to improve the facilitation skills of facilitators.
- Aligning PFS approach into the government extension system requires commitment of policy makers. → National platforms, policy makers visit of PFS activities and use of public media are some the mechanisms for creating awareness for institutionalizing PFS into the government extension system.

Key resource person's view
- There is room for improving experimentation and linking it more strongly to an ecosystem analysis. → Better training of facilitators.
- While taking up the issue of conflict and conflict management, the approach does not always fully cover the complete socioeconomic interconnections that the problem of conflicts in pastoral areas is linked to. → Make sure that a detailed socio-economic analysis is undertaken before the interventions start. This will help in ensuring better coverage of all the complex relationships and interconnections.
- Different institutions implement PFS differently. → Harmonization of the field school approach is critical among the field school practitioners.

REFERENCES

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Resource persons: Deborah Duveskog (Deborah.Duveskog@fao.org) - SLM specialist; Solomon Nega (Solomon.Nega@fao.org) - SLM specialist

Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/approaches/view/approaches_3337/Video: https://player.vimeo.com/video/2

Documentation was facilitated by: Institution: FAO Kenya - Kenya; Food and Agriculture Organization of the United Nations (FAO) - Italy. Project: Improved food security, livelihoods and resilience of vulnerable pastoral communities in the Greater Horn of Africa through the pastoralist field school approach

Date of documentation: Jan. 5, 2018; **Last update:** April 24, 2018

Key references

Impact Assessment of Pastoralist Field Schools in Ethiopia, Kenya and Uganda: http://www.fao.org/fileadmin/user_upload/drought/docs/PFS%20IA%20report%20 final.pdf

Improved food security, livelihoods and resilience of vulnerable pastoral communities in the Greater Horn of Africa through the pastoral field school approach OSRO/RAF/103/SWI - Final report

Links to relevant information which is available online

Pastoralist field schools- Training of facilitators manual: http://www.fao.org/3/a-bl492e.pdf

Farmer field school guiadance document - Planning for quality programmes: http://www.fao.org/3/a-i5296e.pdf

Global farmer field school platform: http://www.fao.org/farmer-field-schools/en/

Pastoralist field schools: Discovery based learning in practice: http://www.celep.info/wp-content/uploads/2012/05/PFS-Reglap-learning-practice.pdf Farmer field schools for small-scale livestock producers- A guide for decision makers on improving livelihoods: http://www.fao.org/3/I8655EN/i8655en.pdf

Transhumant livestock keeper in the region of Maradi (VSF Belgium).

Community-based rangeland management in the southern Kenyan rangelands (Kenya)

DESCRIPTION

Olkiramatian Group Ranch strengthened the capacity of its community governance structures and began to engage in more rigorous implementation of seasonal grazing plans. This was based on traditional ecological knowledge and rangeland management practices. The group ranch incorporated conservation, research, and joint rangeland management planning with neighbouring communities.

Prior to implementation of the approach described here, rangeland management was carried out through customary institutions supported by a group ranch committee. However, many challenges hindered effective management of livestock and natural resources. These included:

- Poor financial management.
- Lack of accountability from the leaders – and lack of demand for accountability from the members.
- Conflicting group and individual interests.
- Lack of a written constitution and grazing by-laws to reinforce traditional decision making.

To minimize and overcome some of these weaknesses, the African Conservation Centre (ACC), a conservation NGO and Southern Rift Association of Land Owners (SORALO), a Maasai land trust, worked with Olkiramatian and other communities to help them strengthen their planning and governance and to reinvigorate the traditional system of grazing management. Initially, ACC worked with the community's governance and resource management committees to build local capacity for decision-making and resource management. Institutions previously responsible for resource management, which had existed under traditional systems, had begun to weaken from both internal and external pressures, undermining the long-term sustainability and equity of rangeland management. The group ranch emerged as the key modern institution within this community and needed to be strengthened to support traditional management. To do this several sequential steps were taken:

(i) First, the group ranch committee instituted a more objective way of identifying and electing office holders, to ensure a credible base for resource governance and building consensus among resource users;

(ii) Registration of group ranch members was re-initiated to ensure equal access and rights to resource use, and to provide clarity around membership;

(iii) Institutions responsible for rangeland management, including the group ranch committee, and the conservation and grazing subcommittees, were reinforced primarily through the strengthening of internal capacity;

(iv) ACC facilitated a process for consolidating the group ranch's governance and by-laws to help guide the implementation of the strategy, including enforcement;

LOCATION

Location: Kajiado West Constituency, Kajiado, Kenya

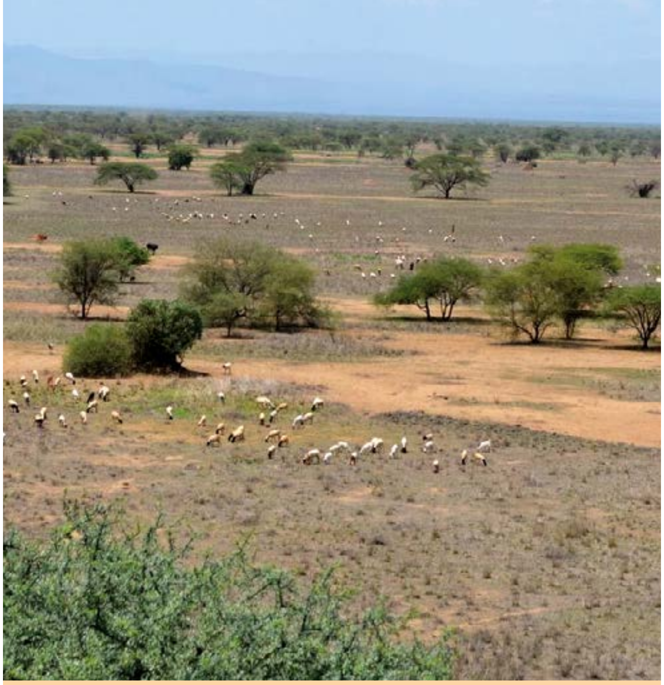
Geo-reference of selected sites
- 36.14302, -1.87017

Initiation date: 2004

Type of Approach

- ☐ traditional/ indigenous
- ☐ recent local initiative/ innovative
- ☐ project/ programme based
- ☑ hybrid traditional/ project-based

A community information feedback and management meeting at the Lale'enok Resource Centre (Lale'enok Resource Centre).



Rangeland management at Olkiramatian takes place over a large, heterogeneous landscape (Enoch Ontiri).

(v) The group ranch implemented provisions for holding leaders accountable, allowing the group ranch members to demand their rights;

(vi) Decision-making processes were facilitated by laying down procedures for sharing information and apportioning responsibilities among the leadership – as decided at annual general meetings;

(vii) Rangeland monitoring groups and rangers, mostly local youth, were trained and positioned;

(viii) Finally, the Lale'enok Resource Centre was established, together with community enterprises based on the use of natural resources. A women's group was included.

An important catalyst in the approach was the establishment of a community conservation area and lodge within the group ranch for the development of wildlife tourism. The conservation area capitalized on the existence of the community's dry season reserve where wildlife such as zebra and giraffes were abundant, which is only grazed by livestock after pasture is utilized elsewhere. This creation of a conservation area, coupled with the desire to generate revenue through tourism with its semi-exclusive access rights to parts of the conservation area, worked to reaffirm the traditional grazing management strategies by preventing settlement within the conservation area and encouraging longer resting of pasture following rain. This happened alongside the development of a research programme, which has helped to put community rangeland management on an evidence-based foundation.

With guidance, the community revised its grazing plan and zoned its land into four resource use areas, now embodied in the new group ranch constitution:

– Conservation or wildlife areas (which then allowed the creation of the conservancy);

– Agricultural/crop production areas;

– Livestock grazing areas (dry season and wet grazing areas);

– Human settlements.

The grazing sub-committee of the group ranch makes and implements decisions on livestock access to certain areas, with pasture rested between and across seasons. The conservancy is rested from livestock grazing as a 'grass bank' during the wet seasons, which can last up to 6 months. Settlement areas are also tightly managed under this approach to preserve pasture heterogeneity and prevent local degradation. Fines are imposed on herders who break grazing regulations. On a rolling basis the communities now utilize traditional ecological knowledge, ecological monitoring and expert knowledge, to reassess these grazing regimes under changing conditions. These rangeland management activities are also nested within joint, inter-community planning such as regular meetings of the grazing committees of clusters of group ranches.

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims/ objectives of the approach

To enhance sustainable livelihoods for pastoralist community members through informed, sustainable use of their resources in an equitable manner.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** Uniform ethnicity. Communal land tenure. The pre-existing customary institutions and the group ranch committees. The government decree on the establishment of group ranches. The strong traditional and cultural knowledge about rangeland and livestock management.
- **Institutional setting:** The group ranch was already established and practicing planned grazing according to customary rules.

- **Legal framework (land tenure, land and water use rights):** There is a strong body of legislation developing in Kenya to ensure sustainable use of rangeland resources. This includes the new Community Land Act (2016), which creates local governance institutions with protection of grazing; the Wildlife Act (2012), creating community conservation areas and allowing benefits and compensation from wildlife; the Water Act (2016) and the Water Resource Users Association encourage multi-user analysis and cooperation to protect the quantity and quality of water for all users within a catchment.
- **Land governance (decision-making, implementation and enforcement):** The group ranch committee is the highest decision-making body. There is a grazing sub-committee which manages the details of seasonal grazing patterns.
- **Knowledge about SLM, access to technical support:** The community is networked to researchers and technical experts from institutions including ACC, SORALO, Universities and TATA chemicals; through the Lale'enok Resource Centre. Mobile phones and access to internet has enhanced access to technical information. There is a wealth of traditional knowledge within the older generation who understand the requirements for sustainable management of the landscape.
- **Markets (to purchase inputs, sell products) and prices:** Livestock markets within reach of the community members – the Shompole crossborder livestock market is in the neighbouring conservancy.
- **Workload, availability of manpower:** The community members are involved in the process as part of their lifestyle. Planned grazing made it easier for them to take of their livestock and reduce the number of people required to herd their livestock.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** Cultural beliefs: large numbers of livestock are seen as a status symbol; resulting inpotential overstocking of livestock.
- **Availability/ access to financial resources and services:** Financial resources are limited for the group ranch committee; they depend on small collections at local markets and some donor financing to enact projects.
- **Knowledge about SLM, access to technical support:** Low capacity of the many community members to tap into the existing knowledge bases. Lack of technical capacity to address specific research needs identified by the community.
- **Markets (to purchase inputs, sell products) and prices:** Low livestock prices at the grassroots present a challenge to the growth of the livestock value chain. A solution may be the facilitation of more direct market linkages.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders/ implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Members and executives of the group ranch committee.	Individual members of the group ranch, as rangeland users and through their grazing patterns according to the ranch's grazing plans, contribute to management.
community-based organisations	Olkiramatian Group Ranch.	The group ranch, through its democratic structures, has the ultimate responsibility for decision-making for the group ranch, including rangeland management and grazing planning, partnerships, fund raising and financial management, etc.
SLM specialists/ agricultural advisers	Personnel of SORALO and ACC.	Provision of technical advice and support.
researcher	Students.	Students, both Kenyan and international, hosted by SORALO and ACC, carry out research on conservation, ecotourism, land use, rangeland condition, etc.
NGO	SORALO and ACC.	Research guidance, and connection with other government, NGO and donor agency stakeholders. Also provision of technical advice and support (see SLM Specialists/ Agricultural Advisers, above).

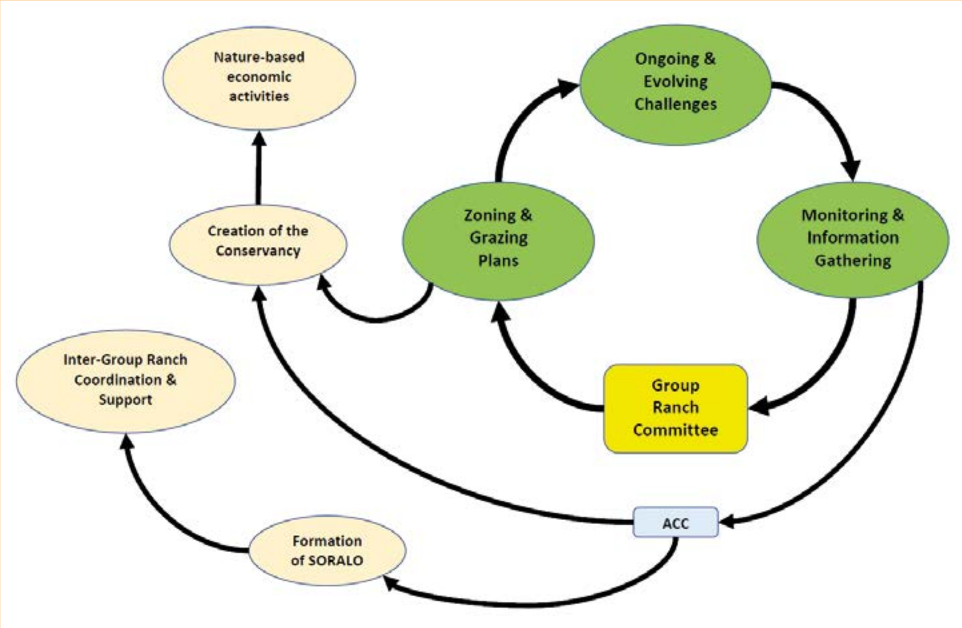
Lead agency
Olkiramatian Group Ranch.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	Specify who was involved and describe activities
initiation/ motivation					✓	The community invited ACC to come and support conservation work and improve ecotourism. A visiting researcher from ACC identified opportunities for reinvigorating the group ranch structure and nature-based enterprises. The work of the researcher contributed to the approach, but the ultimate push came from the community.
planning					✓	The community evolved into an organized group and was determined to employ good resource practices to improve the rangelands and the lives of the people. They sought the help of ACC in strengthening their capacity to fundraise and improve community enterprises. SORALO was established to continue supporting the community in networking and supporting the conservation work.
implementation				✓		The committee members, the individual members implement the approach. SORALO and to a less extent ACC, play advisory roles. The community members provide labour and time as their in-kind contribution. ACC help the community raise funds for the implementation.
monitoring/ evaluation				✓		With guidance from SORALO, monitoring is done by community members. The various committees have a monitoring component in their work.
research				✓		At the beginning, research was done by a scientist from ACC. Later on in the approach, the community youth have been trained and are actively involved in research activities.

Flow chart

Adaptation to evolving challenges through the community's governance structure – the group ranch committee – is at the centre of the approach.



Author: Enoch Ontiri and Lance Robinson.

Decision-making on the selection of SLM Technology

Decisions were taken by

- ☐ land users alone (self-initiative)
- ✓ mainly land users, supported by SLM specialists
- ☐ all relevant actors, as part of a participatory approach
- ☐ mainly SLM specialists, following consultation with land users
- ☐ SLM specialists alone
- ☐ politicians/ leaders

Decisions were made based on

- ☐ evaluation of well-documented SLM knowledge (evidence-based decision-making)
- ☐ research findings
- ☐ personal experience and opinions (undocumented)
- ✓ research and evidence-based decision-making played some role, but planning of technical practices to be implemented was primarily based on traditional knowledge

Comment: The group ranch members are the collective owners and, through the Group Ranch Committee, managers of the land. They receive support and guidance from organisations such as the African Conservation Centre (ACC) and Southern Rift Association of Land Owners (SORALO) on techniques and practices to apply, but are themselves the primary decision-makers.

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE

The following activities or services have been part of the approach

- ☑ Capacity building/ training
- ☑ Advisory service
- ☑ Institution strengthening (organisational development)
- ☑ Monitoring and evaluation
- ☑ Research

Capacity building/ training

Training was provided to the following stakeholders

- ☑ land users
- ☐ field staff/ advisers

Form of training

- ☐ on-the-job
- ☐ farmer-to-farmer
- ☐ demonstration areas
- ☐ public meetings
- ☐ courses
- ☑ training workshop

Subjects covered

The training to the women's group was on improved beadmaking and business management in order to exploit the tourism market. Selected youth were trained as wildlife rangers and others as rangeland monitors. Species-specific teams were trained in tracking particular species such as lions.

Advisory service

Advisory service was provided

- ☑ on land users' fields
- ☑ at permanent centres

Comment: Advisory services provided by SORALO and ACC. A permanent resource centre, Lale'enok is present in the region.

Institution strengthening

Institutions have been strengthened/ established

- ☐ no
- ☐ yes, a little
- ☑ yes, moderately
- ☐ yes, greatly

at the following level

- ☑ local
- ☐ regional
- ☐ national
- ☐ transboundary level

Describe institution, roles and responsibilities, members, etc.

The organisations African Conservation Centre (ACC) and Southern Rift Association of Land Owners (SORALO) have helped to strengthen the group ranch structures.

Type of support

- ☑ financial
- ☑ capacity building/ training
- ☐ equipment

Further details

Primarily support has been through capacity building and training with the group ranch committee and other committees. Additional support has been provided by SORALO through the provision of staff and labour for hosting community meetings; writing the constitution; producing maps and other information; conducting research into pertinent management issues.
ACC with funding from various sources helped to finance establishment of the conservation area and a lodge. The lodge pays a lease fee to the group ranch. Guests at the lodge pay a bed night fee which is paid to the group ranch committee and a conservation fee which goes to the conservation committee. The conservation fee pays for scouts and also finances conservation-related development such as fences, water pipelines, and other community projects.

Monitoring and evaluation

The community, especially youth, are involved in assessing the ecological status of the rangeland. There are ecological monitoring units which take censuses of flora and fauna. Community activity reports are written regularly. The major economic activity of livestock trade is monitored by a data collection team that visits the major livestock markets.

Research

Research treated the following topics

- ☐ sociology
- ☐ economics/ marketing
- ☑ ecology
- ☐ technology

Comment: Research questions are often answered by visiting students and local scientists at the Lale'enok Resource Centre. These questions cover a diverse range of issues related to the socioeconomic and ecological factors affecting local livelihoods.

African Conservation Centre. Southern Rift Association of Land Owners. Graduate students hosted by these organisations.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- ☑ < 2,000
- ☐ 2,000-10,000
- ☐ 10,000-100,000
- ☐ 100,000-1,000,000
- ☐ > 1,000,000

Comment: The primary resource used for implementation of the approach is the time of community members. Inputs from supporting organisations ACC and SORALO, while relevant, have been secondary to the approach and hence are not included in the budget here.

The following services or incentives have been provided to land users

- ☐ financial/ material support provided to land users
- ☐ subsidies for specific inputs
- ☐ credit
- ☑ other incentives or instruments

Other incentives or instruments

Ecotourism revenue provides some incentive to carry out and continue with rangeland management activities.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	no	yes, little	yes, moderately	yes greatly
Did the Approach empower local land users, improve stakeholder participation? As the approach was community-driven with decisions and actions fully in the hands of Olkiramatian members, this has bolstered them to carry on. In the early days, one of the support organisations-ACC-helped ensure more transparent decision-making and selection of leaders, and stronger accountability to group ranch members.				✓
Did the Approach enable evidence-based decision-making? Ecological monitoring and research are prominent aspects of the interventions and community-decision-making.			✓	
Did the Approach help land users to implement and maintain SLM Technologies? It facilitated the implementation of seasonal planned grazing.				✓
Did the Approach improve coordination and cost-effective implementation of SLM? Coordination with neighbouring group ranches has been a key aspect of the interventions.			✓	
Did the Approach improve knowledge and capacities of land users to implement SLM? Improved knowledge of rangeland and wildlife ecology.			✓	
Did the Approach mitigate conflicts? Involvement of customary institutions has contributed to mitigation and resolution of conflicts.				✓
Did the Approach improve issues of land tenure/ user rights that hindered implementation of SLM Technologies? In theory, tenure rights were already secure. However the weakness of the community institution – the group ranch – could have resulted in land fragmentation or alienation as it had done so in many other group ranches. Strengthening the group ranch's governance has strengthened tenure security.			✓	

Main motivation of land users to implement SLM

- ✓ increased production
- ✓ increased profit(ability), improved cost-benefit-ratio
- ✓ reduced land degradation
- reduced risk of disasters
- reduced workload
- payments/ subsidies
- ✓ rules and regulations (fines)/ enforcement
- prestige, social pressure/ social cohesion
- affiliation to movement/ project/ group/ networks
- ✓ environmental consciousness
- customs and beliefs, morals
- ✓ enhanced SLM knowledge and skills
- aesthetic improvement
- ✓ conflict mitigation

Sustainability of Approach activities

Can the land users sustain what had been implemented through the Approach (without external support)?

- no
- ✓ yes
- uncertain

Comment: The approach is based on ensuring strong, community-led governance. This has been achieved and is likely to be sustained.

CONCLUSIONS AND LESSONS LEARNT

Strengths

Land user's view

- The approaches emanates from a strong community with a working customary rangeland management structure. Communal ownership of land and the community's sense of belonging and customary (tribal) right of access and use of natural resources all make it easier for the approach to be successful.

Key resource person's view

- The approach is a bottom-up one that builds on traditional resource management practices, adapting them to evolving social, economic and biophysical conditions. This contributes to strong sense of community ownership.
- As a community driven and implemented the approach, the cost is minimal. With the incorporation of the conservation/wildlife tourism component, a secondary source of income for the community structures and some individuals in the community is realized.
- The climatic conditions that allow extensive livestock production and wildlife is also another advantage for the approach. The landscape lies between Nguruman escarpment on one side, Lake Magadi on the northwestern part and the Amboseli/ Mt. Kilimanjaro on the southern part. These contribute to some degree of isolation and protection of influxes of herders from other locations.
- The demonstrated success of the grazing management practices put in place has led to changed decisions and management practices reinforcing the community's willingness to continue with the system.

Weaknesses/ disadvantages/ risks → how to overcome

Land user's view

- There is concern among some community members about the incorporation of conservation activities potentially leading to restrictions on mobility and access to pastures. → Continued awareness raising about the benefits and pre-empting misunderstandings about the conservation activities.
- The community success in rangeland management is sometimes viewed as a source of failure. This is because the community holds some customary beliefs and norms that allow for practices like reciprocal grazing by other pastoralists on their land. In the case that Olkiramatian is the best quality grass bank during extended droughts, livestock from other communities flock there and mostly cause overgrazing, degradation, and social conflict. → The idea of SORALO networking all the landowners in the southern rangelands and are helping them establish similar approaches means the whole rangeland in southern Kenya will become a continuous, homogeneously managed landscape.

Key resource person's view

- The capacity of the group ranch committee to raise and attract appropriate human and financial resources is low. → Continued training on effective governance and help in putting in place working systems.
- The stocking rates of livestock per household are not corresponding to the holding capacity of the rangeland. → Continued action research and training of the locals on the need to reduce livestock numbers.

REFERENCES

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Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/approaches/view/approaches_3321/

Linked SLM data: SLM Technology: Ecosystem-wide seasonal grazing management in community land https://qcat.wocat.net/en/wocat/technologies/view/technologies_3372/

Documentation was facilitated by: Institution: International Livestock Research Institute (ILRI) - Kenya. Project: Restoration of degraded land for food security and poverty reduction in East Africa and the Sahel: taking successes in land restoration to scale (ILRI)

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Key references

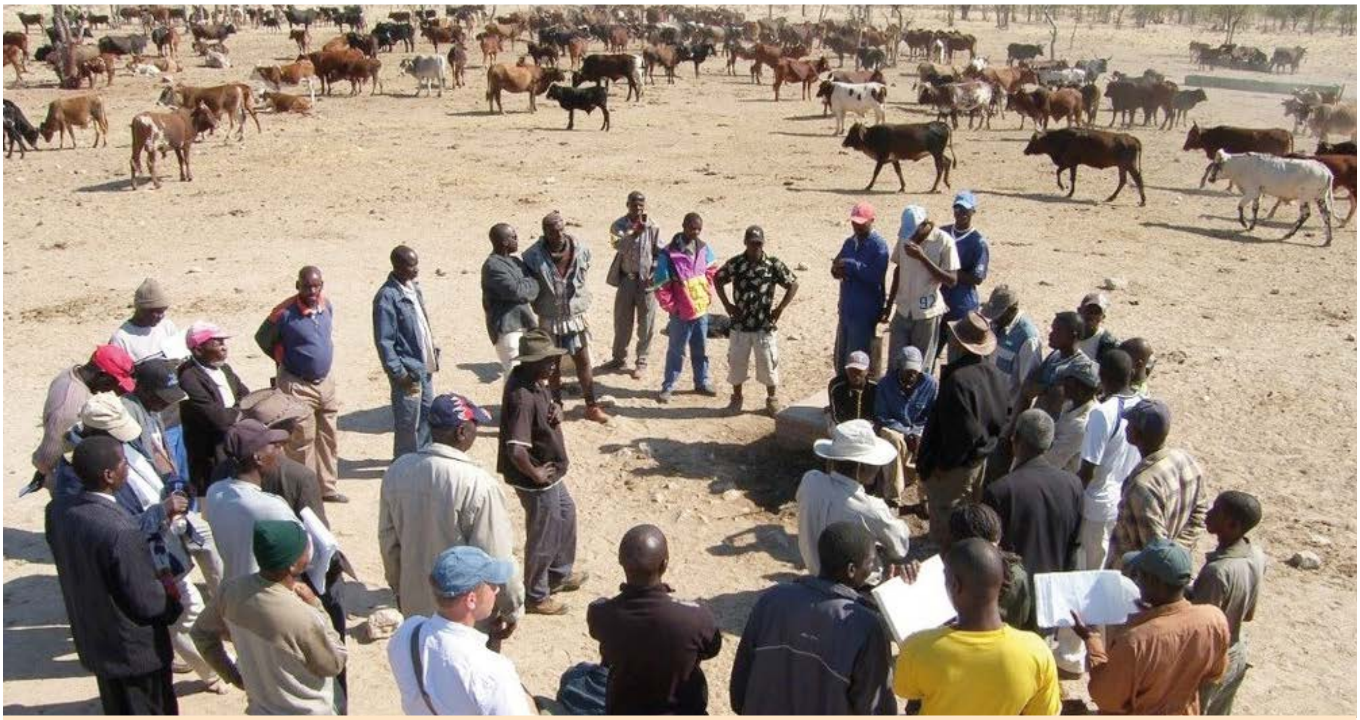
Community-based Rangeland Management in Shompole and Olkiramatian Group Ranches. Ontiri, Enoch M. and Lance W. Robinson. 2018.: cgspace.cgiar.org -- open access

Links to relevant information which is available online

Seasonal movements of wildlife and livestock in a heterogeneous pastoral landscape: Implications for coexistence and community based conservation: https://www.sciencedirect.com/science/article/pii/S2351989417301075

Lale'enok Resource centre: https://laleenok.wordpress.com/history/

LAND & WATER USE PLANNING (AG2)



Livestock owners from Erora, Namibia have hosted livestock owners and facilitators from all over the country and beyond (Collin Nott).

In a nutshell

Short description

Land & water use planning, in general, includes the establishment of concepts and management plans for conflict management, livestock and wildlife routes or corridors, set-up of water points, resting, rotation, facilitation of multi-level support, multi-stakeholder interaction and agreements, and support for improved medium to large-scale planning and implementation of rangeland practices. Land and water use planning is "the systematic assessment of land and water potential and of economic and social conditions in order to select and put into practice those practices that will best meet the needs of the people while safeguarding resources for the future" (FAO 2003).

Principles

- Facilitate planning process and tap the wealth of experiences and the lessons learnt.
- Enable capacity for development and negotiation of plans with all stakeholders.
- Clearly define the boundaries of the planning area and include relevant interactions of stakeholders.
- Create a platform for planning and negotiation.
- Allow a rolling planning and adaptation to include changing needs and conditions.
- Include modern technology using satellite images as basis for the development of plans.
- Establish early warning systems and drought risk management plans and strategies (access to dry season/drought/ emergency grazing grounds and water points).
- Take a regional perspective in managing transboundary pastoral resource use and related conflicts.

Most common approaches

Approaches that work with both government and communities to plan beyond administrative boundaries are:

Participatory rangeland management (PRM): addresses land access and tenure security, integrated and collaborative management approach between the various stakeholders.

Participatory land use planning (LUP): multi-level support and multi-stakeholder user agreements and interaction supports evidence-based planning, protection and management of shared resources across village boundaries, and watersheds.

User groups or associations: e.g. to set bylaws and to share rangeland resources equitably. Or self-help groups who plan regular and efficient cooperation among the livestock keepers and negotiates with land owners regarding access issues.

Territorial and watershed multi-stakeholder approach: offers a structure to build consensus among individual communities and development partners on natural resources/ territorial or watershed management and development issues[1]. Conflict management (livestock routes/ livestock corridors, resting, rotation).

[1] https://qcat.wocat.net/en/summary/2570/

ESS addressed	
food security/ self-sufficiency	++
SRM knowledge	+++
conflict mitigation	+++
empower disadvantaged groups	+
Improve gender	++
equality	++
governance	++
CC adaptation	+

Importance: +++ high, ++ medium, + low, +/- neutral, na: not available

Arrangements to convert degraded rangeland, Namibia

Making arrangements between commercial land users and agriculture students to raise the productivity of rangeland – through managing runoff. The objective is to share knowledge and experiences gained by the land user including growing valuable woody plants, grass and herbs, which students could then apply elsewhere.

https://qcat.wocat.net/en/summary/3410/

Students of the Namibia University of Science and Technology operate a dumpy level for marking contour lines (Ibo Zimmermann).

Participatory monitoring and evaluation: for example establishing a knowledge base and communication platform in collaboration with para-ecologists for monitoring changes in ecosystems, to aid decision-making in forest and rangeland management in Madagascar.[2] Or using a Geographical Information System to track water and forage resources and the movement of populations, etc. in Niger.[3]

Trusts: these are community conservancy membership organisations that fundraise for member conservancies, provide advice and guidance on management, support a wide range of training, monitor performance, and support conservancy partnerships with county and national government, investors and development partners. Examples are the Northern Rangeland Trust[4] and Chyulu Hills Conservation Trust.[5]

Rangeland use system (RUS)

Reported from all rangeland use systems but especially from 'agropastoral' system – though only once from 'parks & reserves'.

Main benefits

- Allocating land use to meet the needs of various people while safeguarding future resources.
- Including up- and down-stream interactions.
- Promote SRM by involving multiple stakeholders and seek to strike a balance among the diverse, and often conflicting, interests of these actors and making claims and rights spatially and temporarily explicit.

Main disadvantages

- Land use planning is becoming complex and multidisciplinary as planners face multiple problems that need to be addressed within a single planning framework.
- Difficult to plan the management of such approaches at large-scale, thus decision-makers and land users need to work together for positive results.
- Highly dependent on the perception of stakeholders and attitudes to the approach.

Applicability and adoption

Key to land use planning is to coordinate current and future societal needs, while minimising the potential for conflicts. Interventions that provide opportunities for reflection, feedback, and adaptations are better positioned to cope with new challenges and problems (identified and solved in a participatory manner), and therefore are more likely to be sustainable in the long term.

Pastoralists have (or have had) strong traditional institutions that play a significant role in regulating natural resource use and conservation, manage risks, protect resources and promote collective action.

The key for adoption is that people appreciate that the adoption of land use planning, through appropriate management practices, enables land users to maximise the economic and social benefits of land, while maintaining or enhancing the ecological support functions of its resources. Capacity building is crucial also because these approaches combine technologies, policies, and activities aimed at integrating socio-economic principles with environmental concerns: these are complex exercises that need to be guided.

[2] https://qcat.wocat.net/en/summary/3578/

[3] https://qcat.wocat.net/en/summary/3750/

[4] https://qcat.wocat.net/en/summary/4127/

[5] https://qcat.wocat.net/en/summary/4264/

Collective local management of natural resources, Mauritania

This approach transfers the responsibility of sylvo-pastoral resources management from the state to user associations. A local convention defines the rules, in particular for access, use and control of shared resources. The implementation of the convention is governed by a monitoring system. Two stages are necessary: (i) the transfer of management rights to the rural municipalities concerned, and (ii) the delegation of the management mandate by the municipalities to "Collective Local Management Associations". Between 2001 and 2011, the transfer of state management created forty local user associations. Since 2011, the approach has been applied by associations without project support, but with monitoring by state services and municipalities.

https://qcat.wocat.net/en/summary/3720/

Silvo-pastoral protection zone (Karl-Peter Kirsch-Jung).

Multistakeholder territorial planning, Mali

Multi-stakeholder meetings are organised to align visions of the different parties in an inclusive way and ensure investments. Terms of reference are drawn up at the beginning, data collection initiated and presented to all actors for informed decision-making. The aim is (i) to ensure that all actors involved in developing lowland areas participate in the planning process and (ii) to prepare the ground for the self-management of the lowland scheme from the outset of the process. The goal is to steer the identification and prioritisation of interventions carried out by local authorities towards the actual needs of local people. Interventions are agricultural (dams, ponds) or pastoral (improving rangeland, cattle market, route marking).

https://qcat.wocat.net/en/summary/2831/

Prioritisation of investments using an inclusive approach (HELVETAS – Swiss Intercooperation).

Sensitization of the leaders of transhumant pastoralists in the commune of Gaya in Niger (Ousmane Oumarou Bako).

Management of transboundary transhumance (Niger)

Concertation Transfrontalière sur la Transhumance

DESCRIPTION

Management of transboundary transhumance in order to create the conditions for conflict-free access to resources for livestock keeping in Niger and northern Benin.

This approach involves multiple actors, and is based on cooperation between them in the border region between Benin and Niger. The aim is to handle the concerns of livestock keepers practicing transhumance, who are victims of harassment and conflicts related to access to resources for livestock. It is a framework of exchange between the various actors in charge of managing the mobility of livestock keepers across the border.

The approach aims at the appropriation and application by the multiple stakeholders of the community legislation on transboundary transhumance – as adopted by the Economic Community of West African States (CEDEAO). The context is increased competition for access to natural resources, exacerbated by the effects of climate change. The approach consists of: (i) implementing a framework for cooperative management of transboundary transhumance between Benin and Niger; (ii) ensuring wide dissemination of community legislation of the CEDEAO on the management of the transhumance practices, and (iii) enabling conflict-free and sustainable access to resources for livestock keeping in the two countries.

The main methods used are: (i) the development of the Scheme for regional Land Management (SAF); (ii) building the necessary infrastructure for livestock keeping (marking of corridors and grazing areas, restoration and management of rangelands, establishment of vaccination centres, etc.); (iii) the raising of awareness among livestock keepers, through the organisation of livestock keepers on the ground (grassroots land commission, local committee of transhumance); (iv) the organisation of transboundary and local for a; and (v) monitoring of the implementation of recommendations forthcoming from the meetings.

The process took place in several stages: the actors of the civil society and the livestock keeping services first identified, together with the livestock keepers, the difficulties related to the transhumance in the two countries. Next they proceeded to inform the livestock keepers and farmers about the community legislation of the CEDEAO. Under the responsibility of the authorities of the two countries, transboundary and local fora were organized periodically to discuss difficulties related to transhumance. The census of all transhumant livestock keepers enabled facilitation of the delivery of travel documents (International Certificate of Transhumance – CIT – and identity document). The committee for receiving the transhumant livestock keepers was established and is functional. It is composed of municipalities, the civil society, and heads of the livestock keepers. Its role is to receive and guide the livestock keepers and to facilitate their stay. A mechanism has been put in place to monitor the implementation of the decisions and recommendations during the periodic meetings between the parties.

The regional council is the contracting authority, and ensures the general coordination of the process, and the monitoring of the recommendations. The administrative and customary

LOCATION

Location: Region of Dosso in Niger, and Department of Alibori in Benin. Corridor for transhumance between Niger and Benin.

Geo-reference of selected sites
- 3.44816, 11.88409

Initiation date: 2016

Comment: The approach is a continuous process of reflection and actions between the legal entities on the border between Benin and Niger.

Type of Approach
- ☐ traditional/ indigenous
- ☐ recent local initiative/ innovative
- ☑ project/ programme based

Awareness-raising of the leaders of transhumant livestock keepers in the municipality of Gaya in Niger (Ousmane Oumarou Bako).

Demarcation of a corridor by the communities and the municipality of Dankassari in Niger (Issaka Dan Dano).

authorities participate in information and awareness-raising of the population, and in the management of conflicts. The municipalities implement the recommendations and facilitate access to travel documents. The role of the civil society organisations is to watch the process, to identify the key actors, and to inform and make aware the leaders of the livestock keepers and the transhumant livestock keepers. The services for livestock keeping issue the International Certificate of Transhumance (CIT), and take part in awareness-raising and census of the transhumant livestock keepers. The land commissions secure the resources for livestock keeping. The water and forestry services provide information about the management of protected and listed resources. The Programme to Support the Livestock Keeping Sector (PASEL7) finances the process and provides technical support.

The livestock keepers have appreciated the participatory and inclusive character of the approach, which has enabled them to share their concerns with all key actors, and to use their language (Fulfulde) in the exchange during the sessions of awareness-raising. The livestock keepers have also appreciated the selection of the municipality of Karimama in Benin as the main entrance zone to Benin for transhumant livestock keepers. However, the livestock keepers regretted the poor logistical organisation of the sessions for awareness-raising, which did not enable participation of the maximum number of livestock keepers in any of the municipalities in Niger.

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims/ objectives of the approach

The objective of the approach is to achieve understanding and application of the community legislation on transboundary transhumance, which was adopted by the heads of State and Government of the Economic Community of West African States (CEDEAO) in order to prevent and reduce conflicts related to the mobility of livestock keeping, and to foster a better use of resources for livestock keeping in the two countries.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** Facilitate the arrangement of social agreements in the process of securing land resources for livestock keeping.
- **Availability/ access to financial resources and services:** Availability of funding from the Programme to Support the Livestock Keeping Sector (PASEL7) to organize the process.
- **Institutional setting:** Emergence of new actors like the local and regional authorities in the two countries.
- **Collaboration/ coordination of actors:** Existence of a framework for cooperation between multiple actors, and for synergy in actions, led by the Regional Council of Dosso.
- **Policies:** Existence of laws and regulations governing the transboundary transhumance in the framework of the Economic Community of West African States (CEDEAO), and existence of an act on pastoralism and a rural code in Niger.
- **Land governance (decision-making, implementation and enforcement):** Existence of functional decentralized structures in the rural code of Niger and within the region of Dosso.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** The difficulties are most often related to the ignorance of herders accompanying animals in transhumance. They are illiterate and lack knowledge of the regulations on mobility across the border.
- **Availability/ access to financial resources and services:** Weak mobilization of other funding sources to ensure the co-funding of the cross-border meetings.
- **Institutional setting:** The meetings have not yet been formalized.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders/ implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Communities of Peul livestock keepers, generally young herders and their families.	They provide the information and profit from the actions.
community-based organisations	Grass-roots groups of livestock keepers, who are members of the umbrella organisations of livestock keepers (Association for the Revitalization of Livestock Keeping in Niger – AREN, National Federation of Livestock Keepers in Niger – FENEN Daddo, Group of Cultural Action and Development of Young Livestock Keepers – GAJEL).	Awareness-raising and coaching of livestock keepers.
SLM specialists/ agricultural advisers	Decentralized services for livestock keeping.	Issue International Certificates of Transhumance (CIT), participate in the awareness-raising of the livestock keepers, conduct the census of transhumant livestock keepers, carry out the vaccination of the animals.
NGO	Organisations of livestock keepers (NGOs and associations).	Social mobilization and awareness-raising among the livestock keepers.
local government	Local and regional authorities: Regional councils and municipalities.	Programme management, general coordination of the process, facilitating the issuance of civil status documents.
international organisation	Swiss Cooperation in Niger, Vétérinaires Sans Frontières, Belgium.	Funding the process Accompanying the process.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	Specify who was involved and describe activities
initiation/ motivation				✓		The regional council planned the activity following discussions with livestock keepers from the region.
planning				✓		Exchanges with the livestock keepers to specify problems and to suggest appropriate strategies and actions.
implementation					✓	The initiative to practice transhumance and the compliance with regulatory requirements are within the competence of the livestock keeper.
monitoring/ evaluation				✓		The communities provide useful information and take decisions regarding solutions.

Flow chart

This scheme summarizes the organisation of the transboundary meetings, as set out in the description of the approach.

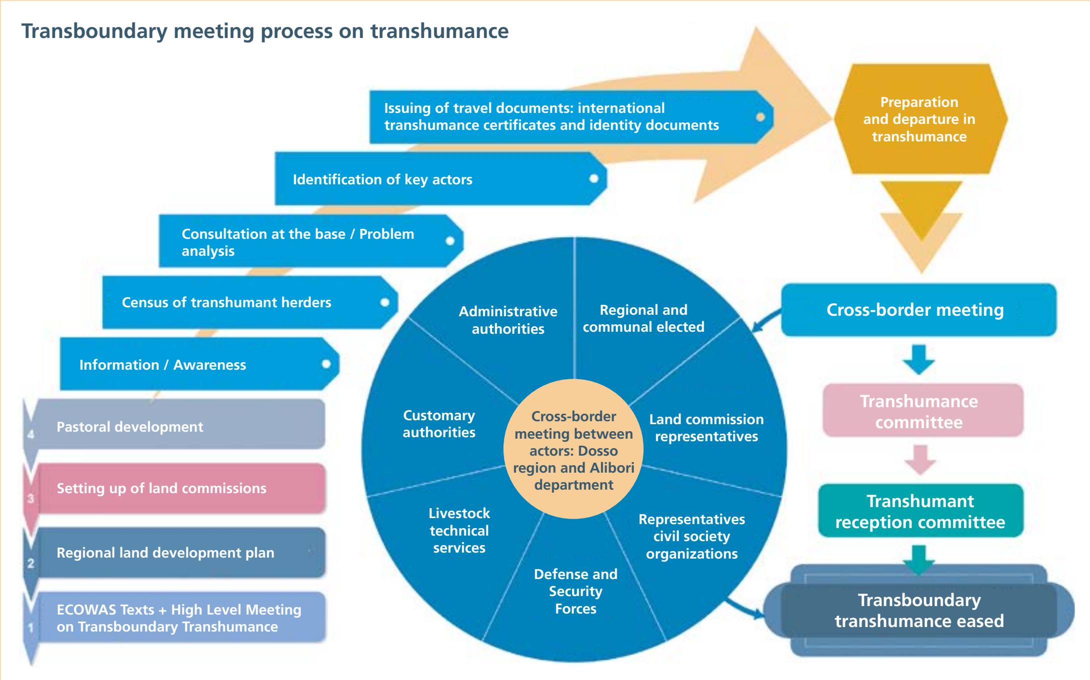


Figure: Issaka Dan Dano.

Decision-making on the selection of SLM Technology

Decisions were taken by

- ☐ land users alone (self-initiative)
- ☐ mainly land users, supported by SLM specialists
- ☑ all relevant actors, as part of a participatory approach
- ☐ mainly SLM specialists, following consultation with land users
- ☐ SLM specialists alone
- ☐ politicians/ leaders

Decisions were made based on

- ☑ evaluation of well-documented SLM knowledge (evidence-based decision-making)
- ☐ research findings
- ☐ personal experience and opinions (undocumented)

Comment: The processes to secure rangelands are defined in Niger through the provisions in the rural code. Consultation with the local population is essential to select the works to implement. The project has conducted all the processes on the ground with the participation of the farmers and the livestock keepers in all the intervention zones.

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE

The following activities or services have been part of the approach

- ☐ Capacity building/ training
- ☑ Advisory service
- ☑ Institution strengthening (organisational development)
- ☑ Monitoring and evaluation
- ☐ Research

Advisory service

Advisory service was provided

- ☐ on land users' fields
- ☑ at permanent centres
- ☑ in the encampment and grazing areas

Comment: The livestock keeping services provide useful information to the livestock keepers on transhumance and on enabling conditions. They issue the International Certificate of Transhumance to transhumant livestock keepers, after vaccinating their herd. They are present in the field to organize joint meetings to inform livestock keepers, and receive the leaders and livestock keepers who seek information in their office. The Civil Society Organisations participate in these services, especially in the field, and support the mobilization of the community.

Institution strengthening

Institutions have been strengthened/ established

- ☐ no
- ☐ yes, a little
- ☑ yes, moderately
- ☐ yes, greatly

at the following level

- ☑ local
- ☑ regional
- ☐ national
- ☑ transboundary level

Describe institution, roles and responsibilities, members, etc.
An advisory committee is established for transboundary transhumance, bringing together actors from Benin and from Niger. The committee is at regional municipalities and border region level. It includes the mayors, Civil Society Organisations of livestock keepers, the decentralized technical services, the land commissions and the leaders of the communities of livestock keepers.

Type of support

- ☑ financial
- ☐ capacity building/ training
- ☐ equipment
- ☑ guidance

Further details
The Programme to Support the Livestock Keeping Sector (PASEL7) contributes to the funding and provides guidance and support to actors in the implementation of the process.

Monitoring and evaluation
The monitoring and evaluation are integrated in the steering of the process through periodic cross-border meetings, and are operated by the regional council with the support of PASEL7.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- ☐ < 2,000
- ☐ 2,000-10,000
- ☐ 10,000-100,000
- ☑ 100,000-1,000,000
- ☐ > 1,000,000

Comment: The funding is provided by PASEL7, a programme financed by the Swiss Cooperation in Niger, and implemented under the lead of VSF-Belgium. In the long term, it is envisaged that the actors themselves will be fully in charge of financing the approach.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	no	yes, little	yes, moderately	yes greatly
Did the Approach empower local land users, improve stakeholder participation? The compliance with the procedures for transhumance, as defined by the CEDEAO, has slightly improved. Hence the number of International Certificates of Transhumance issued since the start of the approach has increased from 6 to 216.			✓	
Did the Approach enable evidence-based decision-making? The meeting takes informed decisions based on consultation with the livestock keepers and the administrative and customary authorities. Initially interviews were held to collect the needs and information from the livestock keepers.				✓
Did the Approach improve knowledge and capacities of other stakeholders? The livestock keepers have better understood the community regulations (CEDEAO) on transhumance, and the challenges of compliance.				✓
Did the Approach build/ strengthen institutions, collaboration between stakeholders? The different stakeholders collaborate regularly and exchange information, which facilitates the management of the transhumance on either side between Benin and Niger.				✓
Did the Approach mitigate conflicts? There has been a sharp decrease in conflicts between farmers and livestock keepers, as well as acts of violence towards the transhumant livestock keepers. Before the approach was implemented, there were regular arrests by the border authorities in Niger for conflicts related to transboundary transhumance; these have now become sporadic.				✓
Did the Approach improve issues of land tenure/ user rights that hindered implementation of SLM Technologies? The approach has enabled the clarification of the ownership status of certain grazing areas, and has strengthened the proportional representation of the grass-roots land commissions.				✓
Did the Approach improve access to markets? The free movement across the border of the transhumant livestock keepers facilitates the access to the livestock markets in northern Benin. As a result, livestock keepers are now well supplied with live cattle.			✓	
Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters? Transhumance is a strategy for resilience of Sahelian livestock production systems, by facilitating the access to grazing land for Sahelian livestock keepers in bordering countries.				✓

Main motivation of land users to implement SLM

- ☑ increased production
- ☑ increased profit(ability), improved cost-benefit-ratio
- ☑ reduced land degradation
- ☑ reduced risk of disasters
- ☐ reduced workload
- ☐ payments/ subsidies
- ☑ rules and regulations (fines)/ enforcement
- ☑ prestige, social pressure/ social cohesion
- ☐ affiliation to movement/ project/ group/ networks
- ☐ environmental consciousness
- ☑ customs and beliefs, morals
- ☐ enhanced SLM knowledge and skills
- ☐ aesthetic improvement
- ☑ conflict mitigation

Sustainability of Approach activities
Can the land users sustain what had been implemented through the Approach (without external support)?

- ☐ no
- ☑ yes
- ☐ uncertain

Comment: The approach has fostered contacts between the actors involved; they only need to ensure their continued accountability. The results which have already been achieved will enable actors to sustain the approach in the long term. Considerations will be made on how to secure funding by the actors themselves. The Land Management Scheme will serve to guide such an approach to manage the mobility of livestock keeping.

CONCLUSIONS AND LESSONS LEARNT

Strengths

Land user's view
- Flexibility in the acquisition of civil status documents and of the International Certificate of Transhumance.
- Effective involvement of the authorities of Niger and Benin.
- Reconciliation of the leaders of livestock keepers, the Civil Society Organisations and the border authorities of the two countries.

Weaknesses/ disadvantages/ risks → how to overcome

Land user's view
- Weak feedback of recommendations in Benin.→ Informe the established monitoring committee in writing.
- Insufficient information on the boundaries of the protected and listed areas in Benin.

Key resource person's view
- There is a high risk that the approach will be abandoned or become irregular after the end of the PASEL7 project. → Support to the mobilization of other partners is ongoing.
- The lack of supplies in the forms for the International Certificate of Transhumance frequently slows down their issuance. → The Regional Directorate for Livestock Keeping makes arrangements to ensure the availability of forms in the period of preparation for the transhumance.

REFERENCES

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Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/approaches/view/approaches_2850/

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Key references

Guide Méthodologique: Processus d'élaboration du schéma d'aménagement foncier (SAF), Secrétariat permanent du code rural Niger, avril 2011: Ministry of Agriculture and Livestock Keeping, Permanent secretary of the rural code in Niger

Conflits fonciers ruraux au Niger: les mécanismes de prévention et de gestion, Secrétariat permanent du code rural Niger, édition 2014: Ministry of Agriculture and Livestock Keeping, Permanent secretary of the rural code in Niger

Recueil des textes sur le pastoralisme, Secrétariat permanent du code rural Niger, mai 2014: Ministry of Agriculture and Livestock Keeping, Permanent secretary of the rural code in Niger

Sécurisation des Espaces Pastoraux, Programme d'Appui au secteur de l'élevage phase 6 (PASEL6), 2015: VSF-Belgium in Niger

Capitalisation sur les stratégies et adaptation aux évolutions du contexte, PASEL6, 2015: VSF-Belgium in Niger

Opérationnalité des structures du code rural, PASEL6, 2015: VSF-Belgium in Niger

Accompagnement des acteurs sur le SAF, PASEL6, 2015: VSF-Belgium in Niger

A farmer transporting hay to Tera weekly market (©FAO/Giulio Napolitano).

Community participation in large-scale land restoration for Africa's Great Green Wall programme (Niger)

DESCRIPTION

The Food and Agriculture Organization of the United Nations (FAO) has been using a participatory approach to implement large-scale restoration of degraded land in the Sahel. Communities have been central to the programme. In the framework of the Great Green Wall initiative, adapted and useful native tree species, shrubs, and fodder grasses are planted in agro-sylvo-pastoral land. This is response to community needs and preferences while ensuring that the species and varieties are all ecologically suitable.

The approach is implemented under FAO's Action against Desertification (AAD) programme in the Great Green Wall for the Sahara and the Sahel Initiative (GGWSSI). This is Africa's flagship initiative to combat the effects of climate change and desertification, and to address food insecurity and poverty. It brings together more than 20 African countries with international agencies, research institutes, civil society and grassroots organisations. Through the GGWSSI, the vision is a mosaic of sustainable land use practices and productive landscapes stretching across North Africa, the Sahel and the Horn.

Community participation in the Great Green Wall restoration initiative is through a people-centred approach to rangeland management that puts communities at the heart of efforts. It focusses on plant species that support their livelihoods. Specifically these are a selection of well-adapted indigenous trees, shrubs and fodder grasses with proven resilience to drought and usefulness in restoration. Village communities decide on which areas to plant and on the species that they can utilise for food, for fodder, and for medicines. There are also plants that produce economically valuable goods for local, national and even international markets, such as gum arabic (from Acacia senegal) for example.

Technically, AAD supports the implementation of land restoration activities through provision of equipment, and by strengthening the technical and functional capacities of individuals, communities, and organisations in restoration techniques and sustainable land management.

The three main objectives of this approach are:
a) Poverty alleviation;
b) Ending hunger; and
c) Improving resilience to climate change.

The restoration approach is based on a five-step model:

– Communities: needs and requirements for restoration are determined through in-depth consultations with communities.

– Research: good quality seed is made available for the propagation of economically viable, locally adapted and biodiverse vegetation.

– Operational procedure: efficient operational restoration processes are ensured, including land preparation and management, assisted natural regeneration and planting.

LOCATION

Location: In Niger, the GGWSSI covers all the eight regions of the country. Currently FAO's Action Against Desertification project works in the three regions of Tillabery, Dosso and Tahoua, though the approach is expanding to the remaining five regions. Tillabery, Dosso and Tahoua, Niger

Geo-reference of selected sites
- 0.7552, 14.00527

Initiation date: 2013

Type of Approach
- ☐ traditional/ indigenous
- ☐ recent local initiative/ innovative
- ☑ project/ programme based

A woman sows a 'half-moon' after its construction in Tera, Niger. (©FAO/Giulio Napolitano).

Farmers harvesting hay in Tera, Douma, Niger (©FAO/Giulio Napolitano).

– Monitoring: field performance of species are evaluated, as well as communal activities such as maintenance and management of restored areas.

– Capacity development: village technicians' capacities are upgraded in forest seed collecting and nursery techniques, planting, maintenance and management of restored areas, and development of plant products, marketing, and local business management.

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims/ objectives of the approach

Key elements and aims of this approach include:

- Planting the right species in the right place.
- Promoting the use of quality native forest and fodder seeds for restoration.
- Ensuring that a wide range of useful plant species is made available.
- Managing natural regeneration of species and planted areas through village management committees.
- Updating a species database for gene-pool traceability, monitoring, reporting and for future uses of data and information.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** The approach is people-centred, and builds on traditional management of land, traditional ecological knowledge and techniques such as 'half-moons' (demi-lunes in French) for rainwater harvesting that facilitate improved plant establishment.
- **Availability/ access to financial resources and services:** Individuals can acquire finance to buy seeds. On community land, finance may be needed to lease land for production of plant varieties, or for hiring labour to take care of seedlings.
- **Institutional setting:** Better organisation at local level enhances community participation and commitment to achieve interventions at large-scale/community level.
- **Collaboration/ coordination of actors:** There are various levels of collaboration needed for example in establishing which land should/ can be used, in seed selection based on defined needs, and also for the provision of labour. Fundamentally, collaboration is key to agreements to achieve the desired objectives.
- **Legal framework (land tenure, land and water use rights):** Securing access rights to land and water resources is a motivation for investing in reforestation.
- **Policies:** National level policies can protect and ensure supply of seeds as well facilitate access to natural resources such as land. Additionally, policies such as those in support of Great Green Wall activities create an enabling environment within which these activities can be supported.
- **Land governance (decision-making, implementation and enforcement):** Similar to legal framework above.
- **Knowledge about SLM, access to technical support:** Knowledge around SLM contributes to maintenance and management of restored areas, thus ensuring sustainability of activities. The programme has integrated existing/traditional SLM activities such as zaï (wide planting pits)/half-moons in capturing, concentrating and storing water thus keeping soils moist and improving the chances of good plant growth in a very dry environment.
- **Markets (to purchase inputs, sell products) and prices:** Market access and increasing economic capacities of communities can enable active involvement in restoration especially when plant products can earn income thus facilitating local business.
- **Workload, availability of manpower:** Availability of labour facilitates activities such as forest seed collecting, nursery activities, planting, maintenance and management of restored areas. Most of the work is done by women who prepare the land and take the lead in planting.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

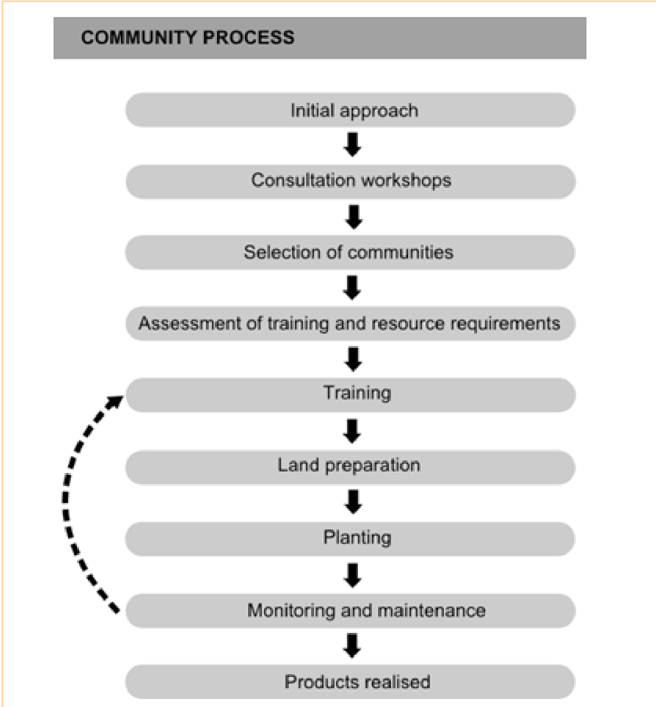
What stakeholders/ implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Total project beneficiaries are currently 116,000 people (over half are women) Age varies from 15 to 70 years. Participants are villagers including farmers, herders, traditional healers and herbalists. Each intervention village has a village management committee set up for GGW implementation. They contribute land and labour, and village technicians are trained in large-scale degraded land restoration techniques so that they can be self-sufficient at the end of the funding.	1. Defining needs, preferences of species and objectives for land restoration in degraded areas. 2. Trained in the collection of seeds and in how to produce seedlings in village nurseries. 3. The communities involved also participated in the regular monitoring and evaluation of plots. 4. Participating in workshops including agreeing on work plans 5. Communities were also a source of rich traditional ecological knowledge 6. Supporting projects through in-kind contributions of labour and land 7. Representation in the steering committee.
community-based organisations	Each intervention village has a village management committee set up for GGWSSI activities.	Contributed land, labour and village technicians to be trained in large-scale land restoration techniques geared to self-sufficiency at the end of project life. Managing intervention sites including products such as fodder. Collaborating with national and local administrations.
SLM specialists/ agricultural advisers	Support in identification of land needed for restoration, seeds, and management of restoration.	
researcher	National seed centres.	1. Address the availability of good quality seeds for collection. 2. Ensure genetic diversity reflecting varieties of native species.
NGO	Local and National NGOs.	Local NGO's were trained in land restoration activities. NGOs were also instrumental in discussions on scaling up the approaches and policy support for mainstreaming sustainable land management.
private sector	Supplies of equipment and materials needed for restoration activities.	Mainly business related to procurement of goods and services.
local government	Local administration and national governments in the respective countries.	1. Provide technical management and management of the operational team. 2. Mobilization of communities. 3. Part of the steering committee.
national government (planners, decision-makers)	1. Ministry of Environment and Sustainable Development. 2. National Agency of the Great Green Wall. 3. National Forestry Seed Centre. 4. Local authorities (i.e.Town halls/ Mairies in French) involved in Tillabery, Dosso and Tahoua regions.	
international organisation	Royal Botanical Garden, Kew.	Technical support; botanical knowledge and information resources, and identifying priority species for the Great Green Wall.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	Specify who was involved and describe activities
initiation/ motivation				✓		Communities' local knowledge, needs and aspirations were the backbone of the project. Communities were extensively consulted on species identification and prioritization based on needs, including speed of production, personal knowledge and aspirations. This was through questionnaires and village workshops. Commitment and buy-in from the community was also a prerequisite for activities to start, as they had to commit to contribute land and in-kind labour. Selection of villages for restoration was based on, amongst other things, motivation and commitment by communities to participate in restoration activities, and community-based structures and organisations.
planning				✓		Extensive planning was done with communities before implementation, e.g. to agree on planting times, use of traditional techniques and land preparation.
implementation				✓		Implementation was done actively with communities who volunteered traditional knowledge as well as labour to the activities. This built on the initial procedures where species were selected and prioritized; planning of activities; and later labour in preparation of land, setting-up nurseries and transplanting.
monitoring/ evaluation				✓		Monitoring and field data collection of survival and growth of seedlings were carried out by trained village technicians in collaboration with the communities and technical institutions.

Flow chart

Community process.



Author: AAD Project.

Decision-making on the selection of SLM Technology

Decisions were taken by

- ☐ land users alone (self-initiative)
- ☐ mainly land users, supported by SLM specialists
- ✓ all relevant actors, as part of a participatory approach
- ☐ mainly SLM specialists, following consultation with land users
- ☐ SLM specialists alone
- ☐ politicians/ leaders

Decisions were made based on

- ✓ evaluation of well-documented SLM knowledge (evidence-based decision-making)
- ✓ research findings
- ✓ personal experience and opinions (undocumented)

Comment: This is a local initiative that uses traditional ecological knowledge and multi-purpose plant species (of known benefits to the local communities) for restoration. Community participation, lifestyles and preferences and a careful analysis of ecological landscapes are carefully considered and then matched to suitable interventions. This similar approach has been applied by other projects in the GGWSSI region however although has not often been formally disseminated to wider audiences.

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE

The following activities or services have been part of the approach
- ✓ Capacity building/ training
- ✓ Advisory service
- ✓ Institution strengthening (organisational development)
- ✓ Monitoring and evaluation
- ✓ Research

Capacity building/ training

Training was provided to the following stakeholders
- ✓ land users
- ✓ field staff/ advisers

Form of training
- on-the-job
- farmer-to-farmer
- demonstration areas
- public meetings
- ✓ courses

Subjects covered

Technical training was provided to villages through formal modules in how to collect quality seeds in defined seed zones. The training was provided by the national forest seed centres. The training was in seedling production and participatory forest management. Other areas covered included; added-value and the development of plant products (non-timber forest products), marketing and local business management to support income generation.

Advisory service

Advisory service was provided
- ✓ on land users' fields
- ✓ at permanent centres
- ✓ workshops

Comment: To re-introduce plants for large-scale restoration, effective use of seeds of wild species demands sufficient biological and technical knowledge about a large number of species to allow for collection, storage and germination of seeds and establishment of seedlings. In this approach therefore, use was made of the technical know-how of RBG Kew and their partnership with forest seed centres that guided collection of quality seeds.

Institution strengthening

Institutions have been strengthened/ established
- no
- yes, a little
- yes, moderately
- ✓ yes, greatly

at the following level
- ✓ local
- ✓ regional
- ✓ national

Describe institution, roles and responsibilities, members, etc.

Institutions: National government; NGOs, CBOs.

Support to the national government which is the national agency for the GGW is the entry point. Through them and based on national objectives, the project progresses to a decentralized level. At the national level, capacities have been improved on monitoring and evaluation techniques; seed identification and selection and handling.

Local level: these are the implementing partners and work on the ground. Their capacities have been improved on seed selection and restoration techniques, and on data collection

Regional level: more collaboration, coordination and knowledge sharing on the GGW initiatives as well as peer-to-peer learning.

Type of support
- ✓ financial
- ✓ capacity building/ training
- ✓ equipment

Further details

Equipment: mainly for land preparation for planting and non-timber forest product processing.

Monitoring and evaluation

Regular monitoring is carried out by village communities involved in the restoration exercise. The activities include assessing seedling survival and growth, and the area planted.

Research

Research treated the following topics
- ✓ sociology
- ✓ economics/ marketing
- ✓ ecology
- technology

Through a questionnaire, communities define their needs and preferences for species, and the objectives of land restoration in their selected agro-sylvo-pastoral degraded lands. Results of this consultation are fed back to them after analyses by the project team (researchers, plant experts, seed centres) for the feasibility, suitability and availability of the requested species. This creates common agreement on interventions, priorities and implementation plans, with roles and responsibilities from the communities as well as from the technical teams.

1. Sociology: prior research was done on social diversity of village communities in areas such as gender, age, and professions to decide on village selection, but also to ensure balance.
2. Economics/ marketing: this was multi-faceted – on the one hand looking at community economic needs and priorities, but also on how to add value to non-timber forest products. The plant-use data received from respondents were classified according to the Economic Botany Data Collection. These helped in deciding and prioritizing species according to community needs.
3. Ecology: the GGW initiative is typically aimed at drylands with challenges of aridity. Thus the ecology was studied to identify suitable plant species that would thrive under these conditions – in combination with traditional SLM/ water harvesting technologies that have been developed to overcome moisture deficits.

The selected species was further examined in laboratories to check their suitability for dryland environments and thereafter to ensure good quality and genetically diverse seeds are used.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- ☐ < 2,000
- ☐ 2,000-10,000
- ☐ 10,000-100,000
- ☑ 100,000-1,000,000
- ☐ > 1,000,000

Comment: Action Against Desertification is implemented by FAO and partners with funding from the European Union in the framework of the 10th European Development Fund (EDF). The GGWI under AAD in Niger is funded up to around 1.5 m USD for the four years of the project.

The following services or incentives have been provided to land users

- ☑ financial/ material support provided to land users
- ☑ subsidies for specific inputs
- ☐ credit
- ☑ other incentives or instruments

Financial/ material support provided to land users
Finances are needed for purchasing equipment; seeds were also provided; seed testing was carried out to establish appropriate type/ species of those chosen by the communities.

	partly financed	fully financed
labour Local communities shared some tasks such as during planting period the project provided lunch.	✓	
equipment: machinery Provided such as hand tools, and carts for transportation.	✓	
equipment: tools Tools for SLM/WH structures and planting.	✓	
agricultural: seeds Training was provided in a collection of native forest seeds that were then bought from them (communities thus earning an income).	✓	
agricultural: organic manure Training to do and collect composts.	✓	
construction: stone For storage facilities.	✓	

Labour by land users was

- ☐ voluntary
- ☐ food-for-work
- ☐ paid in cash
- ☑ rewarded with other material support

Comment: In partnership with WFP there was collaboration on food for assets and incentives from the project such as trainings on preparation of vegetable gardens.

Other incentives or instruments
Functional capacity building village communities for example in management of restoration sites and development of forest products.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	no	yes, little	yes, moderately	yes greatly
Did the Approach empower local land users, improve stakeholder participation? The project supports communities to improve the productivity of their land in direct consultation with them while benefiting from training on recording changes in the diversity of biomass in community plots and lands.				✓
Did the Approach enable evidence-based decision-making? Substantial improvement has already been recorded with respect to the state of land in the last two years.				✓
Did the Approach help land users to implement and maintain SLM Technologies? Training was provided in various aspects such as seed selection and collection.				✓
Did the Approach improve coordination and cost-effective implementation of SLM? The project is not funding all aspects, though building sustainability through the direct capacity development and participation of communities.				✓

Did the Approach mobilize/ improve access to financial resources for SLM implementation?
1. Village technicians have been used by other projects in the area in SLM and also by the government while receiving remuneration. 2. Communities are able to sell indigenous seeds for restoration to other projects in the region, and to the government.

Did the Approach improve knowledge and capacities of land users to implement SLM?
Through trainings and capacity development e.g. on large-scale land preparation for planting and seed selection.

Did the Approach improve knowledge and capacities of other stakeholders?
1. Governments; training of technicians in specialized tools, training in monitoring and evaluation of SLM and in restoration impacts. 2. CBOs and local administrations: regional organisations such as CILSS-Agryhmet were also trained in the above.

Did the Approach build/ strengthen institutions, collaboration between stakeholders?
The village technicians and trained seed collectors have now been organized into a regional union for supply of restoration seed.

Did the Approach mitigate conflicts?
With the increasing of fodder production, pressures on other grazing areas have gone slightly down. Disadvantaged groups not present at village level.

Did the Approach improve gender equality and empower women and girls?
Yes; gender equality is taken into consideration – for example, women are represented in each village management community.

Did the Approach encourage young people/ the next generation of land users to engage in SLM?
As income comes in from restoration activities, it has encouraged young people to consider SLM as an income generating opportunity.

Did the Approach improve issues of land tenure/ user rights that hindered implementation of SLM Technologies?
Communities now see more value in restoring degraded land previously neglected and there are tenure agreements with local administration. Land tenure had been insecure for local communities, but now rights of access and use have been delivered by local administrations to local communities, guaranteeing that restoration areas belong to communities – thus ensuring sustainability, as a community perceives ownership of the investments.

Did the Approach lead to improved food security/ improved nutrition?
1. Farming in restored areas allows for more crop production. 2. Fodder production is feeding livestock better improving production of milk and meat.

Did the Approach improve access to markets?
Seeds and fodder are being sold by local communities to other projects, governments and communities.

Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters?
The project's aim is to increase the resilience of natural capital and people living in the drylands while being able to adapt to climate change.

Did the Approach lead to employment, income opportunities?
In seed sales, crop production, income earning from employment of technicians.

Main motivation of land users to implement SLM
- [x] increased production
- [x] increased profit(ability), improved cost-benefit-ratio
- [x] reduced land degradation
- [ ] reduced risk of disasters
- [ ] reduced workload
- [ ] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [x] prestige, social pressure/ social cohesion
- [x] affiliation to movement/ project/ group/ networks
- [x] environmental consciousness
- [x] customs and beliefs, morals
- [x] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [x] conflict mitigation

Sustainability of Approach activities
Can the land users sustain what had been implemented through the Approach (without external support)?
- [ ] no
- [x] yes
- [ ] uncertain

Comment: The capacity being developed should help farmers continue without external intervention e.g. training in collecting planting material, planting techniques and in managing the plots enables continuity, and the capacities developed stay within the community – for example: the trained village technicians.

CONCLUSIONS AND LESSONS LEARNT

Strengths

Land user's view
- Builds on existing knowledge such as the use of zaï (pit planting).
- Income generation e.g. from selling of seeds to governments and other land users.
- Helping achieve communities specifics objectives such as increasing tree cover.

Key resource person's view
- The consultation process and the mutual trust built over time, which helps people 'buy into' the programme and feel ownership of the activities on the ground.
- The technical and scientific feedback answers to priorities and preoccupation of land users in terms of restoration objectives.
- The involvement of people in monitoring and management of their planted sites as they contribute their lands and labour.

Weaknesses/ disadvantages/ risks → how to overcome

Land user's view
- Inability to adequately influence donor plans. → Frequent consultations.

Key resource person's view
- Inability to address all the needs of the beneficiaries: for example demand for water supply in dry seasons while the project focusses on rainfed restoration. → Increased dialogue on interventions across sectors, such as with donors for a more systematic and integrated approach.
- Lack of flexibility in implementation to consider some of the upcoming demands of communities.

REFERENCES

Compiler: Vivian Onyango (Vivian.Onyango@fao.org)
Resource persons: Vivian Onyango (Vivian.Onyango@fao.org) - SLM specialist; Moctar Sacande (moctar.sacande@fao.org) - SLM specialist
Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/approaches/view/approaches_2909/
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Date of documentation: July 5, 2017; **Last update:** April 26, 2018

Key references

FAO. 2015. Global guidelines for the restoration of degraded forests and landscapes in drylands: building resilience and benefitting livelihoods. Forestry Paper No. 175. Rome, Food and Agriculture Organization of the United Nations.: UN-FAO

Community participation at the heart of Africa's Great Green Wall Restoration model. Authors: M. Sacande, N. Berahmouni and S. Hargreaves. In Unasylva. Volume 66 2015/3: UN-FAO

Links to relevant information which is available online

Action Against Desertification (FAO): http://www.fao.org/in-action/action-against-desertification/en/

Building Africa's Great Green Wall: Restoring degraded drylands for stronger and more resilient communities: http://www.fao.org/3/a-i6476e.pdf

Forest and Landscape Restoration Approach: http://www.fao.org/3/a-i5212e.pdf

Participatory resource mapping under solar panels in Merti (Caroline King Okumu).

Participatory mapping, database building, and monitoring of rangeland resources (Kenya)

Resource Mapping

DESCRIPTION

Participatory mapping and monitoring of vegetation types and other natural resources in the rangelands. This involves convening stakeholder groups, reviewing conditions of rangeland, water and other resources under changing climatic conditions.

Participatory digital mapping using satellite imagery and digital earth and other open source Geographic Information Systems (GIS) is a practical tool that can bridge knowledge and communication gaps between pastoral communities and county government planners. It offers an effective 'tool' for participatory planning and decision-making in support of climate change adaptation efforts in the drylands of Kenya. The use of participatory mapping is not new in seeking to capture communities' understanding and use of natural resources. These maps are typically drawn on the ground using stones, sticks and other locally available materials to depict key features such as schools, water points, and forest areas, etc. However the process used in Isiolo County combines digital mapping with community-drawn perception maps. This offers a number of extra benefits. While fully capturing the wealth of local knowledge, they contain an in-built coordinate system which corresponds to a global reference grid, enabling their linkage to maps used in formal systems. Furthermore, the coordinate system provides a geographically precise basis from which to discuss natural resource management, making outputs of participatory mapping more universally usable. These benefits, however, need to be carefully balanced to avoid the risk that through this process, pastoral resources – which are highly dynamic – are 'frozen' in time and space. The participatory mapping process has adopted GIS workflows within community workshops, enabling the creation of integrated, consistent and standardized geospatial information. The process follows seven steps: Step 1: Community level meetings to develop perception maps drawn on the ground and/or on paper. The product is a community perception map of those resources that are important for their livelihood systems. This map should be created in a community setting to enable the participation of a large group. Several maps may be produced by smaller sub-groups (women, the youth, elders etc.) and then amalgamated. The final map is then copied onto paper. Step 2. Digital mapping is introduced. This step takes place in a workshop setting with a smaller group of key informants chosen by the community – as well as county government planners and technical staff. The presence of the latter is critical to the process of 'legitimizing' community knowledge. Following a quick explanation of satellite imagery, Google Earth is projected onto a wall alongside the perception maps developed under step 1. The use of Google Earth is only for orientation, and to enable participants to navigate the imagery and to cross-reference their paper-mapped key resources against the satellite imagery. Features that participants feel are important (e.g. water points, wet and dry season grazing areas, drought reserves, wildlife routes) are then captured digitally using open source applications: Quantum GIS (QGIS) and JOSM, the Open Street Map ed-

LOCATION

Location: Pasturalist areas, Isiolo, Kenya

Geo-reference of selected sites
- 38.4583, 0.49844

Initiation date: 2012

Year of termination: 2015

Comment: The mapping process needs to be continuous as new community resources are identified and added.

Type of Approach
- [ ] traditional/ indigenous
- [ ] recent local initiative/ innovative
- [x] project/ programme based

Participatory resource mapping in Dadacha Bassa (Caroline King Okumu).

Facilitating the identification of features on the GIS platform in Oldonyiro village (Omar Jattani).

iting platform. This produces the coordinates that pinpoint the locations of natural resources in a manner that can be independently and objectively verified. The highly interactive process of geo-referencing local knowledge to a coordinate reference system allows resource maps to be produced to any scale, and in real-time, with the community. Step 3. Qualitative and quantitative attributes describing the key resources are collected. As participants add features to the map, they also describe their specified characteristics or attributes. Attribution data includes a fuller description of the physical characteristics of the resource (e.g. soil type, waterquantity and quality, pasture species) as well as issues concerning their management (e.g. under customary or modern management, land tenure status, negotiated or paid access, area of conflict). Updating this data on a regular basis adds temporal and trend data to the spatial database. This underlines the need to structure data systems well to manage time-based data and to record updates. Steps 4-6: Data verification cycles are integrated into the mapping process in order to capture community feedback and verify the records in the geospatial data and their attribute values against the specification. The mapping includes a series of validation, cross-checking and verification cycles, run with the community – and in a few instances on-the-ground verification termed 'groundtruthing'. Step 7: Field validation. Field validation is carried out where the verification stages highlight gaps in information. Verification consists of targeted field visits to take GPS markers, or holding meetings with the local community to clarify particular issues.

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims/ objectives of the approach

To allow participation for community groups to inform planners.

- To provide the necessary precision for planners to use local knowledge effectively.
- To make a 'bridge' for information to flow between customary and formal institutions.
- To better share ideas through communication tools using powerful visual language.
- To demonstrate the depth of local knowledge about natural resources and with that, demonstrate the importance of these resources.
- To identify gaps and risks in the system being mapped.
- To compare one plan with another to see how complimentary/contradictory they are.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** Communities are awed by the technology that allows them to see their resources while seated in a single specific location. The approach doesn't conflict with any community social, cultural, religious norms and values.
- **Availability/ access to financial resources and services:** A brief GIS training of four weeks can allow county government staff to develop, add and update the database.
- **Institutional setting:** The approach helps in improving planning at community and government levels, and is accepted by all stakeholders.
- **Collaboration/ coordination of actors:** The product of the participatory mapping process is beneficial to all actors and many are willing to engage in implementation of the approach.
- **Legal framework (land tenure, land and water use rights):** The approach helps in land use planning and supports regulations meant to improve land governance such as a customary natural resource management bill.
- **Policies:** Many policies and laws (including the national constitution) support the mapping of resources to improve land use planning.
- **Land governance (decision-making, implementation and enforcement):** The approach allows communities to develop their land use plans for resource utilisation, and digitize them – making the work of land governance easier.

- **Knowledge about SLM, access to technical support:** New graduates in dryland resource management, and communities' reception of the new technologies, help in acceptance and implementation of the technology.
- **Markets (to purchase inputs, sell products) and prices:** Free open source programmes are available to digitize local knowledge to geo-referenced products.
- **Workload, availability of manpower:** The technology makes the process simpler and reduces the workload.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** Minimal local capacity is required to use the technology.
- **Availability/ access to financial resources and services:** Short GIS training courses costs around $850 and facilitation of community engagement meetings may be costly to undertake.
- **Institutional setting:** Poor capacity and financial resources can be a challenge.
- **Collaboration/ coordination of actors:** Different mapping initiatives are undertaken by actors with various objectives.
- **Legal framework (land tenure, land and water use rights):** County governments can develop their own spatial plans, but there are only few initiatives underway to map county resources.
- **Policies:** Conflicts over land undermines political will.
- **Land governance (decision-making, implementation and enforcement):** Competing claims over land and land-based resources in community lands means enforcement of the approach is often challenged. Resources along administrative boundaries are claimed by different communities.
- **Knowledge about SLM, access to technical support:** 58% of the residents of the county (according to the Kenya National Bureau of Statistics socio-economic survey report of 2016) are illiterate and may have difficulties engaging properly with the technology.
- **Markets (to purchase inputs, sell products) and prices:** Good programmes for mapping are expensive.
- **Workload, availability of manpower:** The processes can be tedious because of the paper maps involved, series of validation and verification of features.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders/ implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Jarsa Dedha (customary natural resource management institutions) Community Members (i.e. pastoralists).	Jarsa Dedha identify the most knowledgeable elders from different grazing areas to help in identifying features and providing grazing land management plans that are in place. Community members identify features and contribute to the attributes of the features.
community-based organisations	Kinna Integrated community based initiative (KICBI) Ward Adaptation Planning Committees.	They identify features and also contribute to attributes of the features.
SLM specialists/ agricultural advisers	Ibrahim Jarso.	Support mapping process and also add new features supporting updates to the products.
NGO	Resource Advocacy Program (RAP) Merti Integrated Development Program (MID-P) Adaptation Consortium.	Support the mapping process and mobilize communities and stakeholders for the approach to be implemented properly.
local government	Isiolo County Government.	Support the mapping process with intention to use product for planning purpose and own the product.
national government (planners, decision-makers)	Kenya's National Government.	Support the planning process – also with the intention of using the product for planning.
international organisation	International Institute for Environment and Development (IIED) and the University of Southampton (Geodata Institute).	Support with funding to implement the approach and also provide technical expertise to undertake GIS processing of data.

Lead agency
WAPC, ADA and IIED.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization
initiation/ motivation		✓			
planning				✓	
implementation				✓	
monitoring/ evaluation		✓			

Specify who was involved and describe activities

Resource Advocacy Programme (RAP) undertook discussions with the local community and also with the county and national government in shaping the idea for the approach.

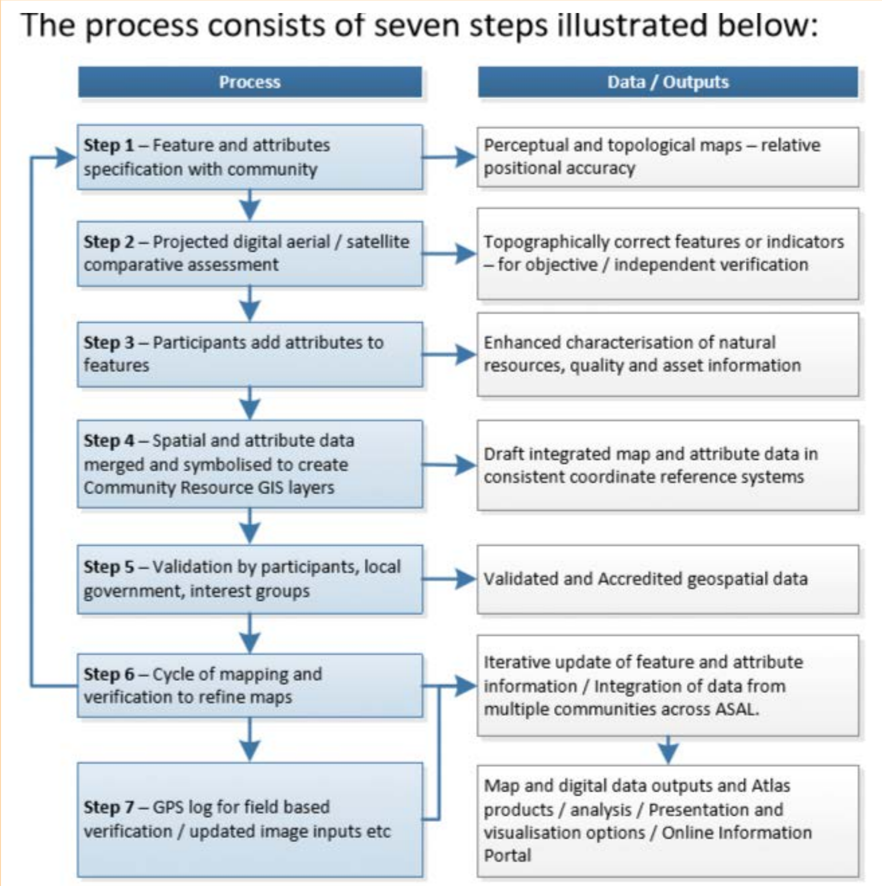
All stakeholders (community, RAP, ADA, IIED, Geodata and Governments) were engaged in the planning for the implementation of the Approach.

Community members and all stakeholders were involved in the implementation of the participatory mapping.

The county government and the actors (RAP, ADA and IIED) monitor the participatory mapping database and improves it.

Flow chart

Participatory mapping of community resources has seven steps, which can be summarised under the main groupings of: consultations with the community where key features are identified and mapped on paper; digitization of community identified points by GIS specialists; processing of the data where community identified attributes are incorporated into the data; and feedback sessions for community validation and verification.



Author: Ibrahim Jarso.

Decision-making on the selection of SLM Technology

Decisions were taken by

- ☐ land users alone (self-initiative)
- ☐ mainly land users, supported by SLM specialists
- ☑ all relevant actors, as part of a participatory approach
- ☐ mainly SLM specialists, following consultation with land users
- ☐ SLM specialists alone
- ☐ politicians/ leaders

Decisions were made based on

- ☐ evaluation of well-documented SLM knowledge (evidence-based decision-making)
- ☐ research findings
- ☑ personal experience and opinions (undocumented)

Comment: The process requires inputs from all the relevant stakeholders. The community provide local knowledge of the features, GIS specialists provide technical expertise and the other local stakeholders provide their knowledge and experience of working in the communities for many years.

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE

LUP

The following activities or services have been part of the approach
- ✓ Capacity building/ training
- ✓ Advisory service
- ✓ Institution strengthening (organisational development)
- ✓ Monitoring and evaluation
- ✓ Research

Capacity building/ training

Training was provided to the following stakeholders
- ✓ land users
- ✓ field staff/ advisers

Comment: 5 persons trained- One from County Government (Planning Unit), Two from National government (National Drought Management Authority and Kenya Meteorological Department (KMD)) and Two representative of Local NGOs (RAP and MID-P).

Form of training
- ✓ on-the-job
- farmer-to-farmer
- demonstration areas
- public meetings
- ✓ courses

Subjects covered

Participatory GIS mapping techniques.

Input of data using different platforms.

Use of GPS devices.

Validation of data.

Data management.

Advisory service

Advisory service was provided
- ✓ on land users' fields
- at permanent centres

Comment: Practical sessions were provided in the field and with communities.

Institution strengthening

Institutions have been strengthened/ established
- no
- yes, a little
- ✓ yes, moderately
- yes, greatly

at the following level
- ✓ local
- regional
- national
- transboundary level

Describe institution, roles and responsibilities, members, etc.
Local institutions were able to use the maps to advocate for improved planning.

Type of support
- financial
- ✓ capacity building/ training
- equipment

Further details
Courses/ trainings were provided.

Monitoring and evaluation

Inputs were monitored.

Research

Research treated the following topics
- sociology
- economics/ marketing
- ✓ ecology
- technology

Comment: Research on vegetation patterns in Isiolo's rangelands were conducted by the University of Nairobi's Department of Land and Resource Management.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
- < 2,000
- 2,000-10,000
- ✓ 10,000-100,000
- 100,000-1,000,000
- > 1,000,000

Comment: The approach was supported by RAP and IIED under the Adaptation Consortium with funding from UK's Department for International Development (DfID). The budget is used to convene sub-county level meetings and trainings sessions. Many of the participants costs and preparation costs are not covered.

The following services or incentives have been provided to land users
- financial/ material support provided to land users
- ✓ subsidies for specific inputs
- credit
- other incentives or instruments

	partly financed	fully financed
labour Community meetings were supported by the actors in the project (RAP, IIED and Adaptation Consortium).		✓
equipment: machinery Machinery used in the approach was purchased by the actors involved.		✓

Labour by land users was

- [x] voluntary
- [ ] food-for-work
- [ ] paid in cash
- [ ] rewarded with other material support

Comment: Communities provided the local knowledge to support the approach.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	no	yes, little	yes, moderately	yes greatly
Did the Approach empower local land users, improve stakeholder participation? Yes, the approach strengthens community rights and management of resources.				✓
Did the Approach enable evidence-based decision-making? Yes greatly – provided databases that did not previously exist.				✓
Did the Approach help land users to implement and maintain SLM Technologies? Strengthened the traditional system of management of land.				✓
Did the Approach improve coordination and cost-effective implementation of SLM? Improved coordination among the partners and enabled monitoring of resource conditions.				✓
Did the Approach improve knowledge and capacities of land users to implement SLM? The technology provided digitized observation of resources, and communities realised their wealth of their resources.				✓
Did the Approach improve knowledge and capacities of other stakeholders? The Community resource atlas of Isiolo County has been online since July 2015. Yes greatly, the Approach made local institutions stronger and enhanced their collaboration and data sharing.				✓
Did the Approach mitigate conflicts? The Approach mapped conflict hotspots and improved the process of conflict resolution and analysis.			✓	
Did the Approach improve gender equality and empower women and girls? The process also engaged women in gathering local knowledge of resources and they made a very considerable contribution to the work.			✓	
Did the Approach encourage young people/ the next generation of land users to engage in SLM? The use of GIS fascinated young people and they felt attracted to the process.				✓
Did the Approach improve issues of land tenure/ user rights that hindered implementation of SLM Technologies? The approach guided use of land and also strengthened communities ownership and rights over their land and their available resources.				✓
Did the Approach lead to improved access to water and sanitation? The approach guided water investments in the community lands and improved placement of water infrastructure.				✓
Did the Approach lead to more sustainable use/ sources of energy? The approach mapped boreholes, and the energy used to extract water from them, as well as encouraging use of clean and green energy.				✓
Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters? The approach concreted the community land use plans and guided proper use of their pasture and water – enhancing the community's capacity to adapt to climate related disasters of drought and floods.				✓

Main motivation of land users to implement SLM

- ✓ increased production
- increased profit(ability), improved cost-benefit-ratio
- ✓ reduced land degradation
- ✓ reduced risk of disasters
- reduced workload
- payments/ subsidies
- ✓ rules and regulations (fines)/ enforcement
- prestige, social pressure/ social cohesion
- affiliation to movement/ project/ group/ networks
- ✓ environmental consciousness
- customs and beliefs, morals
- ✓ enhanced SLM knowledge and skills
- aesthetic improvement
- ✓ conflict mitigation

Sustainability of Approach activities

Can the land users sustain what had been implemented through the Approach (without external support)?

- no
- yes
- ✓ uncertain

Comment: The approach was implemented with support from donors and county government. Although in theory, it could be possible for resource users to auto-finance the Approach, this has not ever happened previously, and many of the resource users are not wealthy. Support is available for devolved development planning and mapping, but as yet this has not been assigned to participatory resource mapping.

CONCLUSIONS AND LESSONS LEARNT

Strengths

Land user's view

- It is a promising new approach that builds on the legitimacy of local/indigenous knowledge, and enables the county government to fulfil its mandate of undertaking participatory planning with communities.
- GIS technology helps in the acceptance of the approach by many land users.
- The mobility of the technology can provide an opportunity for all community members to add features as they come up.

Key resource person's view

- It is a user friendly approach accepted and recognized by Isiolo pastoralists for mapping their rangeland resources.
- IIt provides an opportunity to map all investments of development partners in the county and avoid duplication of projects.
- IIt is a powerful tool for communication and advocacy for community land rights.

Weaknesses/ disadvantages/ risks → how to overcome

Land user's view

- It requires time and commitment from community members and county officers. → Systematic use of media (e.g. radio, websites, etc.) to publicize the approach and its importance to the community.
- It is difficult for illiterate community members to fully engage with the approach and make meaningful contributions. → Provide local translations and interpretation as well as producing good visual maps.

Key resource person's view

- There is a need for continuous updating. → Engage local universities and students.
- Observation of key features and resources are sometimes obscured by clouds and thus mapping precision is affected. → Ground truthing visits and observations need to be undertaken to improve precision.
- Lack of legislation to support and enforce the use of the approach. → Formulate legislation to support enforcement.

REFERENCES

Compiler: Ibrahim Jarso (jarsoibra@gmail.com)

Resource persons: Ibrahim Jarso(jarsoibra@gmail.com) - SLM specialist; Hussein Konsole (saritehussein@yahoo.com) - land user; Shandey Abdullahi (midp2003@gmail.com) - Non-State Actor; Caroline King (caroline.king@ouce.ox.ac.uk) - SLM specialist

Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/approaches/view/approaches_3439/

Linked SLM data: SLM Technology: Dedha grazing system as a natural resource management technology https://qcat.wocat.net/en/wocat/technologies/view/technologies_3403/

Documentation was facilitated by: Institution: Resource Advocacy Programme (RAP) - Kenya. Project: Strengthening Adaptation and Resilience to Climate Change in Kenya Plus (StARCK+)

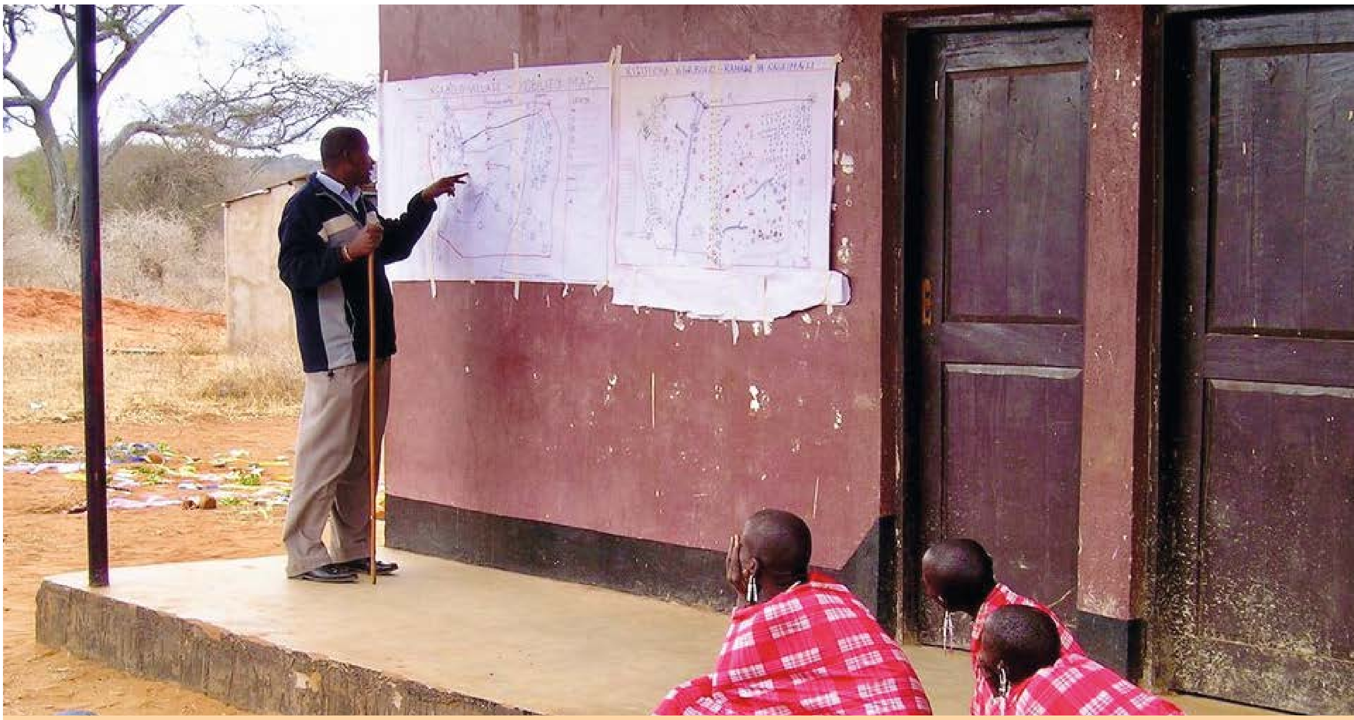
Date of documentation: March 13, 2018; **Last update:** May 22, 2018

Key references

Participatory Mapping using Digital Earth Tools, Imagery and Open Source GIS in the drylands of Kenya and Tanzania by Chris Hill, Tom Rowley, Homme Zwaagstra, Andrew Harfoot and Mike Clark: Ada Consortium Website

Key references

Resource Atlas of Isiolo County, Kenya: pubs.iied.org/pdfs/G03984.pdf



Participatory mapping of shared resources is the first step in the joint village land use planning approach (Fiona Flintan).

Joint village land use planning (United Republic of Tanzania)

DESCRIPTION

Joint village land use planning is a process facilitated by Tanzania's land policy and legislation. It supports the planning, protection and management of shared resources across village boundaries. It is an important tool towards land use planning and better rangeland management. This case study provides an example from a cluster of villages in Kiteto District, Tanzania.

The Sustainable Rangeland Management Project (SRMP) is an initiative led by Tanzania's Ministry of Livestock and Fisheries (MoLF), the International Livestock Research Institute (ILRI) and the National Land Use Planning Commission (NLUPC), with support from International Fund for Agricultural Development (IFAD), Irish Aid and the International Land Coalition (ILC). A key innovation of the project has been the development of joint village land use planning (JVLUP). The JVLUP process in Kiteto District, Manyara Region began in November 2013, and included the villages of Lerug, Ngapapa, and Orkitikiti. The three villages share boundaries and grazing resources, and in order to illustrate a single shared identity across the boundaries, the name OLENGAPA was chosen – incorporating part of each village's name.

The total area of the three villages is (approx.) 59,000 hectares. The majority of inhabitants are Maasai pastoralists with some Ndorobo hunter-gatherers, and some farmers – most of whom are seasonal migrants. Mobility is central to the survival of the pastoralists and takes place across the three villages, as well as to locations in Kilindi, Gairo, and Bagamoyo Districts.

Average annual rainfall is between 800-1,000 mm per annum. There are no perennial rivers flowing through the OLENGAPA villages. The only permanent surface water source is Orkitikiti Dam, constructed in 1954.

In order to understand the different resources such as grazing areas, water points, cropping areas, livestock routes, and cultural places, SRMP supported participatory mapping. This assisted in developing a base map for the village land use planning process: it showed which resources were shared by the villages and where they were situated.

SRMP then helped village members to agree the individual village land use maps and plans – which zoned the village land into priority land uses – as well as the joint village land use map and plan, and the joint village land use agreement (JVLUA). These specified the grazing areas, water points, livestock routes and other shared resources. Reaching agreement was a protracted negotiation process between the villages, and within villages also – between different interest groups. It involved numerous community meetings and considerable investment of resources. Finally, each Village Assembly approved the JVLUA, which allocated approx. 20,700 ha of land for shared grazing –around 40% of the total village area. By-laws for management of the resources were developed and adopted.

Following approval of the JVLUA, the three OLENGAPA Village Councils established a Joint Grazing Land Committee made up of members from all three villages. This Committee is responsible for planning, management, enforcement of by-laws applicable to the OLENGAPA, and coordination of the implementation of both the OLENGAPA land use

LOCATION

Location: Kiteto District, Manyara Region, Tanzania, United Republic of Tanzania

Geo-reference of selected sites
- 36.5366, -5.31046

Initiation date: 2010

Year of termination: 2017

Type of Approach

☐ traditional/ indigenous
☐ recent local initiative/ innovative
☑ project/ programme based

Rangeland resources mapping is an important step in the joint village land use planning process (Fiona Flintan).

Mapping livestock routes contributed to an understanding of mobility patterns across regions and villages (Mohammed Said).

agreements and joint land use plan. In addition, a Livestock Keepers Association was established, including 53 founding members – but with most households from the three villages being associate members. A constitution was developed for the Association, which was officially registered on 11 September 2015.

In January 2016 the Ministry of Lands approved and registered the village land boundary maps and deed plans for the three villages. The District Council has issued the village land certificates, and the next step is for Village Councils to begin issuing Certificates of Customary Rights of Occupancy (CCROs). The shared grazing area will require three group CCROs to be issued to the Livestock Keepers Association – one from each village – for the part of the grazing area that falls under its jurisdiction. Signboards and beacons marking the shared grazing area are being put in place.

In November 2017 a fourth village joined OLENGAPA, expanding the shared grazing area to 30,000 ha. The villages are now working to develop a management plan to improve rangeland productivity.

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims/ objectives of the approach

To secure shared grazing areas and other rangeland resources for livestock keepers, and to improve their management.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** History of collective tenure, management and sharing of rangeland resources as part of sustainable rangeland management practices.
- **Institutional setting:** Strong local government/community institutions for leading process at local albeit their capacity may require building.
- **Legal framework (land tenure, land and water use rights):** Tanzania's legislation, if implemented well, provides an enabling environment for securing of community/village rights for both individuals and groups.
- **Policies:** Tanzania possesses facilitating national land use policy for the joint village land use planning approach, together with guidelines.
- **Land governance (decision-making, implementation and enforcement):** Decision-making has been decentralised to the lowest levels, giving local communities considerable power to decide on the uses of their village land.
- **Knowledge about SLM, access to technical support:** Good local knowledge of rangeland management based on historical practice. Communities understand need for better rangeland management.
- **Workload, availability of manpower:** Well-structured local community bodies ready to provide manpower. Local government experts in place to support VLUP process.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** Marginalisation of pastoralists from decision-making processes at local and higher levels.
- **Availability/ access to financial resources and services:** Village land use planning process is costly due to the requirement to include government experts in the process in order to gather required data and to authorise plans. Lack of government priority to village land use planning, so poor allocation of government funds to the process.
- **Collaboration/ coordination of actors:** Poor coordination of different actors supporting VLUP in the past due to previous weakness of National Land Use Planning Commission (NLUPC). However, this is now changing as NLUPC becomes stronger and takes up coordination role.

- **Legal framework (land tenure, land and water use rights):** Legislation allows village land to be transferred into public land if in the 'public' or 'national' interest – this facility confers insecurity on village land.
- **Policies:** There are conflicting policies over land coming from different sectors including land generally, together with forests, wildlife and livestock. These cause confusion at the local level. Depending on power of actors one set of policies may be stronger than another – wildlife-related policy for example can have a lot of power because there are many strong and influential tourism and conservation bodies lobbying for stronger protection of land, with potentially negative impacts for communities who want to use that land for other purposes.
- **Land governance (decision-making, implementation and enforcement):** The process of village land use planning is costly due to the requirement for having local government experts involved, and the need to follow often complex procedures and steps. Many communities and even local government do not have adequate technical skills and knowledge to complete the long process, as well as not having adequate funds. This has held up the VLUP applications. Further few VLUPs move from their production stage to implementation stage including enforcement of bylaws and, for example, land management.
- **Knowledge about SLM, access to technical support:** Lack of investment in rangeland management and the provision of technical support e.g. through government extension services. Lack of technical knowledge in rangeland rehabilitation and improving rangeland productivity at scale.
- **Markets (to purchase inputs, sell products) and prices:** Lack of local markets and coordinated operations for livestock production.
- **Workload, availability of manpower:** Lack of knowledge, skills and capacity amongst local communities and government experts to complete JVLUP adequately, including such as resolving conflicts between different land users.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders/ implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Village members (Assembly) of three villages – Orikitiki, Lerug and Ngapapa.	All village members as the Village Assembly have an opportunity to contribute to the land use planning process and to approve it.
community-based organisations	Village Council, Village Land Use Management Committee (VLUMC), Rangeland Management Committee, Livestock Keepers Association.	Village government coordinated the planning process at local level. VLUMC develops plan. Village Council approves plans and issues CCROs. Rangeland Management Committee oversees development in rangelands. Livestock Keepers Association established made-up of all members of the villages that have livestock (nearly all village members) -they will be issued with CCROs as 'owners' of the grazing land.
SLM specialists/ agricultural advisers	Land use planning consultants.	Provision of advice to the project team, local government and villagers on the JVLUP approach.
researchers	International Livestock Research Institute (ILRI).	Identification of good practice in village land use planning in Tanzania and ways to adapt and incorporate good practice into joint village land use planning to improve the approach. Research on role of and impact on pastoral women. Undertaking of baseline studies.
NGO	KINNAPA Development Association (supported originally by CARE and Tanzania Natural Resource Forum).	KINNAPA is the local CSO partner working as part of the project to implement the JVLUP with local communities.
local government	District Council including the PLUM (participatory land use management planning experts).	The District Council provides local government oversight of the planning process and approves the plan before submitting to national government body. The PLUM technically supports the development of the JVLUP working with the village government(s) and village committees.
national government (planners, decision-makers)	Ministry of Livestock and Fisheries, National Land Use Planning Commission (NLUPC), Ministry of Lands, Housing and Human Settlements Development,	Ministry of Livestock and Fisheries leading the planning process with a sectoral interest in protecting rangelands. NLUPC provides technical oversight and guidance. Ministry of Lands is the national body that approves the final plan.

international organisation	International Land Coalition (ILC).	ILC is the grant recipient for the funds from the donors. The project is implemented through ILC members such as ILRI. ILC coordinates its members work in Tanzania on land issues including the JVLUP through a national engagement strategy (NES). ILC also provides technical support to the process through its global/ Africa programme – the ILC Rangelands Initiative. The ILC Rangelands Initiative is a platform for learning, sharing, influencing, and connecting on rangeland issues with the objective of making rangelands more secure.
Donors	IFAD and Irish Aid.	Provide funds for the project. IFAD also provides technical support on land tenure issues.

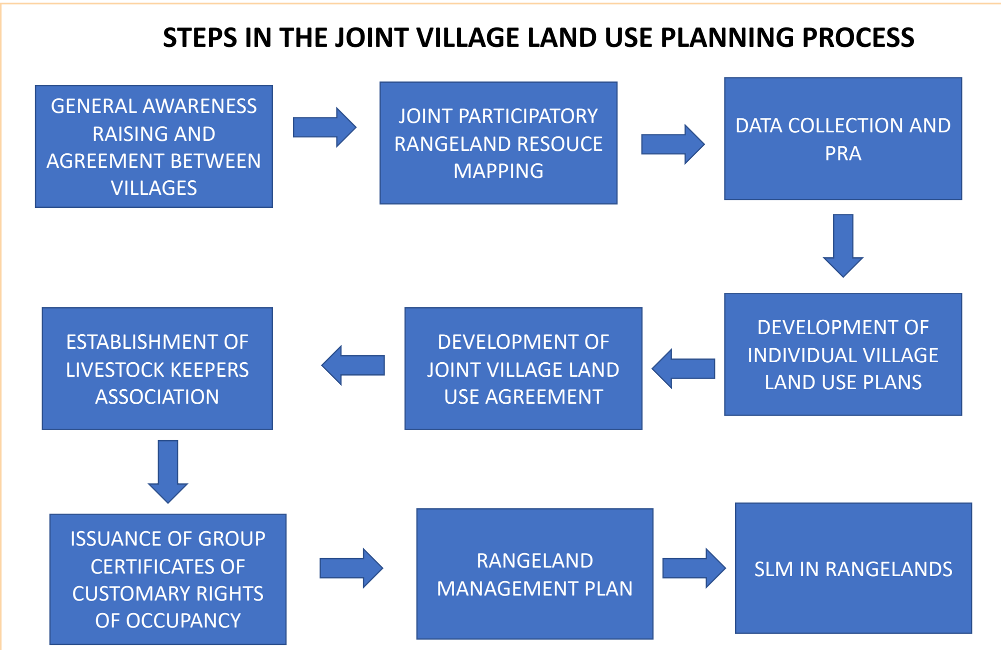
Lead agency
The lead agency is the International Land Coalition (ILC) working through its members including ILRI. In country, the main implementer is the Ministry of Livestock and Fisheries.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	Specify who was involved and describe activities
initiation/ motivation			✓			The project supported communities to initiate the first steps taken to reach agreement on the need for planning and how this would be done.
planning				✓		Communities were centrally involved in the planning of the VLUP process, with support from local NGO and government.
implementation				✓		Village government and community in general is responsible for the implementation of the planning process, with the support of local government.
monitoring/ evaluation			✓			The community is responsible for monitoring and evaluation, but lack skills and capacity in this regard requiring external support.
research			✓			Research on information required for planning processes collected and generated by communities with the assistance of technical support from local NGO, local government and researchers.

Flow chart

Steps in the Joint Village Land Use Planning Process.



Author: Fiona Flintan.

Decision-making on the selection of SLM Technology

Decisions were taken by
- [ ] land users alone (self-initiative)
- [ ] mainly land users, supported by SLM specialists
- [x] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders

Comment: The policy and legislation lays down the steps to be followed for the VLUP/JVLUP process. However there is room to adapt these processes to local context – and here all stakeholders were involved to develop the process of JVLUP through its first piloting. This included communities, local and national government, local NGOs, researchers and development organizations.

Decisions were made based on
- [x] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [ ] personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE

The following activities or services have been part of the approach
- [x] Capacity building/ training
- [ ] Advisory service
- [x] Institution strengthening (organizational development)
- [x] Monitoring and evaluation
- [x] Research

Capacity building/ training

Training was provided to the following stakeholders
- [x] land users
- [x] field staff/ advisers
- [x] forum

Form of training
- [x] on-the-job
- [ ] farmer-to-farmer
- [ ] demonstration areas
- [x] public meetings
- [x] courses

Subjects covered

Land users were trained in land related and other relevant laws and the JVLUP process. Field staff/advisers were trained in land laws, the JVLUP process, gender, and conflict resolution. Local government were trained in the JVLUP process, gender and conflict resolution.

Institution strengthening

Institutions have been strengthened/ established
- [ ] no
- [ ] yes, a little
- [ ] yes, moderately
- [x] yes, greatly

at the following level
- [x] local
- [ ] regional
- [x] national

Type of support
- [x] financial
- [x] capacity building/ training
- [x] equipment
- [x] data collected and
- [x] database set up

Describe institution, roles and responsibilities, members, etc. Local government bodies including Village Council, VLUMC (village land use management committee) and Livestock Keepers Association have all had capacity strengthened, but more is required (particularly for the latter). Capacity of the Ministry of Livestock and Fisheries and the National Land Use Planning Commission to implement JVLUP has been built.

Monitoring and evaluation

M&E has not been strong in previous phases, but now is central with baselines being carried out in all new clusters of villages where the project will work so that impact can be fully assessed.

Research

Research treated the following topics
- [x] sociology
- [x] economics/ marketing
- [x] ecology
- [ ] technology

Comment: Research was carried out to identify good practice (in terms of social, economic and environmental impacts) from which the JVLUP process was developed. In future phases the full impacts of this JVLUP in terms of social, economic and ecological impact are being researched.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
- [ ] < 2,000
- [ ] 2,000-10,000
- [x] 10,000-100,000
- [ ] 100,000-1,000,000
- [ ] > 1,000,000

IFAD, Irish Aid

The following services or incentives have been provided to land users
- [ ] financial/ material support provided to land users
- [ ] subsidies for specific inputs
- [ ] credit
- [x] other incentives or instruments

Other incentives or instruments

Tanzanian policy and legislation states that all village should have a VLUP, therefore this was an incentive for stakeholders to invest in the process. In addition conflicts over land use are increasingly a problem in Tanzania – so the resolution of these was also an important incentive.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	no	yes, little	yes, moderately	yes greatly
Did the Approach empower local land users, improve stakeholder participation? Local village communities now feel strongly empowered in protecting and managing their land. The process has brought different stakeholders together and strengthened commitment to make the process work.				✓
Did the Approach enable evidence-based decision-making? The piloting of the JVLUP showed what is possible and the positive impacts realised (albeit they could have been better documented). On these results the process is being scaled-up.			✓	
Did the Approach help land users to implement and maintain SLM Technologies? The planning process has laid the foundations for improved rangeland management – what is now required is investment in that management.			✓	
Did the Approach improve coordination and cost-effective implementation of SLM? The JVLUP established the structures for coordination of management across the village boundaries – what is now required is investment in that management. It is believed that the approach of planning across village boundaries and jointly is more cost-effective than planning separately – but the evidence of this needs to be fully documented.				✓
Did the Approach mobilize/ improve access to financial resources for SLM implementation? By helping communities to establish a Livestock Keepers Association there is potential there for the Association to access funds for development through government structures, but this has not happened yet.		✓		
Did the Approach improve knowledge and capacities of land users to implement SLM? Land users have greater knowledge of the potential and need for rangeland management based on a better understanding of their land and resources gained through the JVLUP process, but they still need skills and resources to put this knowledge into action.			✓	
Did the Approach improve knowledge and capacities of other stakeholders? National and local government have seen the potential of the JVLUP to resolve conflicts over land use, and their capacities to implement the JVLUP in this regard has been improved.				✓
Did the Approach build/ strengthen institutions, collaboration between stakeholders? The approach is helping build relations between the Ministry Livestock and Fisheries and the NLUPC together with NGO(s) at national level, as well as between different stakeholders involved in JVLUP at local levels.				✓
Did the Approach mitigate conflicts? Through the process of JVLUP the roots of land use conflicts come to the surface and must be resolved before agreement is reached. This may cause tensions and even conflict along the way – but the outcome should be positive.			✓	
Did the Approach empower socially and economically disadvantaged groups? Pastoralists are often left out of village land use planning processes. This approach when implemented well gives greater opportunity for them to be involved. However this is still a challenge.			✓	
Did the Approach improve gender equality and empower women and girls? Women can be left out of village land use planning processes. This approach when implemented well gives greater opportunity for them to be involved. However this is still a challenge.			✓	
Did the Approach encourage young people/ the next generation of land users to engage in SLM? Youth can be left out of village land use planning processes. This approach when implemented well gives greater opportunity for them to be involved. However this is still a challenge.			✓	
Did the Approach improve issues of land tenure/ user rights that hindered implementation of SLM Technologies? By following the JVLUP process village land has been certified and secured, as well as the rights of access and use of livestock keepers to the grazing land.				✓
Did the Approach lead to improved food security/ improved nutrition? This has not been specifically monitored but it assumed by having stronger security to land and resources, food security and nutrition will be improved.		✓		
Did the Approach improve access to markets? This has not been specifically monitored but it assumed by having stronger security to land and resources, access to markets will be improved.		✓		
Did the Approach lead to improved access to water and sanitation? In terms of water for livestock the JVLUP process has secured rights for the three villages to shared water resources.				✓
Did the Approach lead to more sustainable use/ sources of energy?	✓			
Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters? By having stronger security to land and resources local land users are better placed to adapt to climate change etc.			✓	
Did the Approach lead to employment, income opportunities? This has not been specifically monitored but it assumed by having stronger security to land and resources, income opportunities will be improved.		✓		

Main motivation of land users to implement SLM

- ✓ increased production
- increased profit(ability), improved cost-benefit-ratio
- ✓ reduced land degradation
- ✓ reduced risk of disasters
- reduced workload
- payments/ subsidies
- ✓ rules and regulations (fines)/ enforcement
- ✓ prestige, social pressure/ social cohesion
- affiliation to movement/ project/ group/ networks
- environmental consciousness
- customs and beliefs, morals
- enhanced SLM knowledge and skills
- aesthetic improvement
- ✓ conflict mitigation

Sustainability of Approach activities

Can the land users sustain what had been implemented through the Approach (without external support)?

- no
- yes
- ✓ uncertain

Comment: The community requires support from local government to protect their village lands including grazing lands from outsiders wanting to settle on the land – this is a constant problem to be addressed (despite the securing of village boundaries etc.). The community also needs capacity building and resources to improve the productivity of the land including the grazing areas. If they get these supports then they can sustain what has been implemented.

CONCLUSIONS AND LESSONS LEARNT

Strengths

Land user's view

- Improved the security of access and use to village land including grazing.
- Brought attention to the challenges faced by land users in the area in protecting and using their village land, and the need for more investment and support for this.
- Pastoralists are now more central to decision-making processes than they were before.

Key resource person's view

- Collaboration of different stakeholders in implementing the approach has supported a new way of working.
- Capacity of different stakeholders has been built along the way through joint problem-solving and learning-by-doing.
- The approach – with adaptation – has application in other contexts/countries and shows that even if a rangeland is split by administrative boundaries there is opportunity to work across those village boundaries in order to maintain the functionality of the rangeland and land use systems such as pastoralism that depend upon this.

Weaknesses/ disadvantages/ risks → how to overcome

Land user's view

- Despite village land being theoretically protected, in practice it can still be encroached upon. → Greater support provided from government to enforce protection of land.
- Time-consuming process which became more expensive than anticipated resulting in some gaps in funding. → Process needs to be refined through practice, and adequate funds allocated from beginning.

Key resource person's view

- The selection of villages for JVLUP needs more care to ensure that enabling conditions for JVLUP exist. → In future selection of villages for JVLUP a set of criteria should be used that enable more enabling conditions to exist.
- Information has not been methodologically collected on social, environmental and economic impacts of the approach. → In future the impacts of the approach need to be fully monitored and evaluated.
- The VLUP is an expensive process to follow. → National government needs to identify ways to reduce the cost of the VLUP so that more villages can undertake it. Government needs to allocate more funds to VLUP. The VLUP is an expensive process to follow.
- Need for an enabling environment. → The policy and legislation in Tanzania enables this process – it is not the case in the majority of other African countries.

REFERENCES

Compiler: Fiona Flintan (f.flintan@cgiar.org)
Resource persons: Fiona Flintan (f.flintan@cgiar.org) - SLM specialist
Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/approaches/view/approaches_3336
Documentation was facilitated by: Institution: International Livestock Research Institute (ILRI) - Kenya. Project: Sustainable Rangeland Management Project (ILC / ILRI)
Date of documentation: Jan. 4, 2018; **Last update:** Feb. 26, 2018

Links to relevant information which is available online

Kalenzi, D. 2016. Improving the implementation of land policy and legislation in pastoral areas of Tanzania: Experiences of joint village land use agreements and planning. Rangelands 7. Rome, Italy: International Land Coalition.: https://cgspace.cgiar.org/handle/10568/79796

Daley, E., Kisambu, N. and Flintan, F. 2017. Rangelands: Securing pastoral women's land rights in Tanzania. Rangelands Research Report 1. Nairobi, Kenya: ILRI.: https://cgspace.cgiar.org/handle/10568/89483

International Livestock Research Institute. 2017. Sustainable Rangeland Management Project, Tanzania. ILRI Project Brochure. Nairobi, Kenya: ILRI.: https://cgspace.cgiar.org/handle/10568/80673

International Land Coalition. 2014. Participatory rangeland resource mapping in Tanzania: A eld manual to support planning and management in rangelands including in village land use planning. Rome: International Land Coalition: https://cgspace.cgiar.org/handle/10568/51348

Flintan, F., Mashingo, M., Said, M. and Kifugo, S.C. 2014. Developing a national map of livestock routes in Tanzania in order to value service and protect them. Poster prepared for the ILRI@40 Workshop, Addis Ababa, 7 November 2014. Nairobi, Kenya: ILRI.: https://cgspace.cgiar.org/handle/10568/64964 Village land use planning in rangelands in Tanzania, F. Flintan 2012: http://www.landcoalition.org/en/regions/africa/resources/no-3-village-land-use-planning-rangelands-tanzania

Protecting shared grazing through joint village land use planning: http://www.landcoalition.org/en/regions/africa/resources/protecting-shared-grazing-through-joint-village-land-use-planning

Celebration of the 4th Lola Commune Jango Pastoril (Pastoral Management Forum), hosting Commune Administrators and technicians, traditional leaders, veterinarians and herders for discussions on land and animal management (Projecto RETESA 2017).

Restoration of traditional pastoral management forums (Angola)

Jangos Pastoris

DESCRIPTION

The transhumance pastoral communities of Southern Angola traditionally held gatherings of chieftains and community leaders to discuss management of commonly held pastoral resources. However, the conflicts of the last century led to the breakdown in traditional governance and the majority of the traditional management systems were abandoned. The RETESA Project has supported their recovery as a way to reduce land degradation and improve local livelihoods.

The Approach was developed and implemented through the RETESA Project 'Land rehabilitation and rangelands management in smallholder agropastoral production systems in south western Angola'. RETESA is a project owned and implemented by the Ministry of Environment of the Government of Angola with technical and methodological assistance from The Food and Agriculture Organization of the United Nations (FAO), and financed by the Global Environment Facility (GEF).

From an early stage, RETESA identified management itself as the most effective tool to improve pastoral livelihoods and to reduce land degradation over large areas of land. However, the management terms and concepts used in conventional western cultures were difficult to convey to the pastoral communities. Thus communication of the needs and methods of appropriate grazing management were not fully understood and this led to confusion. After struggling initially with these challenges, the project technicians responsible for rangeland improvement and rehabilitation began to investigate the traditional management systems that were in place before the armed conflicts occurred. It was found that they adapted to modern rangeland management theory and practice and had a rich vocabulary which described in detail the timing and movements of the herds. Rather than teach a new way of viewing the natural world, the project's objective became one of resurrecting these lost systems and recuperating what was, in the communities' words, 'the ways of our elders'. In order to provide an underlying methodological basis which guided the process, the 'Green Negotiated Territorial Development' (GreenNTD) methodology was introduced and used to negotiate the terms and agreements of the six management plans created and implemented during the process.

In essence, the role of the traditional management systems was to keep the animals in more remote, mountainous areas during the rainy season, the only time of year when water is available in these areas, and gradually bring them back to the lowland, river plains during the dry season. This simple system allowed for rangeland recovery and rest – and for agriculture to be practiced in the lowlands during the rainy season without the threat of intrusion by livestock, something which has become a constant source of conflict within the communities. The periods of 'recovery and rest' of the different areas also meant that important grasses and forage plants could grow, produce seed and multiply,

LOCATION

Location: Municipalities of Bibala, Virei and Quilengues, Province of Namibe and Huila, Angola

Geo-reference of selected sites

- 12.94833, -15.72548
- 12.9085, -15.04789
- 13.60459, -14.3042
- 13.6721, -13.89884
- 13.16547, -15.72713
- 13.55423, -14.44119

Initiation date: 2015

Comment: The Project held its first Jango in December of 2015 and a total of 14 Jangos had been celebrated by the end of the project in April 2018.

Type of Approach

- ☐ traditional/ indigenous
- ☐ recent local initiative/ innovative
- ☐ project/ programme based
- ☑ the approach relies on a combination of Traditional Inputs and the RETESA Project support

Presentation of the final grazing management plan for the Commune of Impulo (Projecto RETESA 2017).

Celebration of a a Jango pastoril in the Community of Cavelocamue, Virei (Projecto RETESA 2017).

something which was not occurring any longer, where the animals were now free to roam where they wished, returning to the same areas day after day and reducing ground cover to a bare minimum.

The modern discussion forums, or 'Jangos', are still traditional affairs run by traditional authorities and representatives from the communities. But they have adapted to include local Administrations and their technicians, as well as veterinarians, church leaders, NGOs, ranchers and farmers, so as to involve a broader range of stakeholders. The addition of these stakeholders and their involvement and approval of the decisions that come out of the forums are seen as key to the survival and effectiveness of the new management plans implemented.

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims/ objectives of the approach

To establish Jango Pastoril as institutions in strategic areas and use GreeNTD methodology to develop and implement six natural resource management plans that address the causes of land degradation, and improve production and local livelihoods.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** There is a clear understanding of the benefits of recuperating the traditional social structures and management systems.
- **Institutional setting:** Most of the Municipal governments and community leaders involved have invested in the approach and wish to continue with the forums.
- **Collaboration/ coordination of actors:** The pastoral communities are fully aware of the land degradation and challenges they face, and see the Jango Pastoril forums as a way to address these challenges.
- **Policies:** The RETESA Project has succeeded in presenting traditional livestock management and transhumance movements in a positive light and is working with the Angolan Government to improve policies directed at livestock and herder movement throughout the transhumance migration routes, at community, regional and national levels.
- **Workload, availability of manpower:** There is a vast pool of young people able to work.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** Current cultural norms and socio-political systems hinder the recuperation of the traditional systems as they originally were; therefore, adaptations need to be applied to make them viable under current conditions.
- **Availability/ access to financial resources and services:** The project ends in April 2018, at which point the Jangos must be self-sufficient and self-operating. Given the current economic crisis, this will be a challenge.
- **Institutional setting:** Pastoral, nomadic lifestyles are seen as a threat to education and prosperity by some institutions operating in the country, and the forums could be seen as a way of preserving pastoral culture.
- **Collaboration/ coordination of actors:** Communication has improved through the forum structure, though collaboration within communities for common benefit is still on the whole uncommon and could threaten the sustainability of the plans agreed by the forums. Some communities also fear that improvements in land productivity or infrastructure could lead to land being seized by more powerful actors.
- **Legal framework (land tenure, land and water use rights):** Land and water rights were not addressed during the forums and are still unclear in the majority of locations these forums are operating. The land management plans were based on maintaining the 'status quo' currently operating in the area.

- **Policies:** Pastoral cultures are still seen by many in power as a threat to education and economic prosperity.
- **Land governance (decision-making, implementation and enforcement):** There still remains much to be done in the area of land governance, from decision-making, implementation and especially enforcement.
- **Knowledge about SLM, access to technical support:** Very little is known about SLM, and technical support is lacking at community and municipal levels.
- **Markets (to purchase inputs, sell products) and prices:** The more traditional tribes rarely sell their animals to local markets, leading critics to claim that their way of life contributes little to the local or national economies.
- **Workload, availability of manpower:** Manual labour is most often carried out by the women of the family, and those under 18 years are responsible for caring for the animals and following them on their daily search for pasture and water.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders/ implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Originally it was just the community chiefs and respected livestock producers who took part in the Jango Pastoril meetings, though the modern version also includes Administrators and their staff, Administrative technicians, veterinarians, ranchers, church leaders, NGOs and farmers.	Given that it is the local land users and communities who manage the land on a daily basis, it is their role to fully understand the issues being debated and how the new management plans will affect them. This is usually done through a community Jango Pastoril forum run by the project and traditional leaders who participate in the Municipal Forums, with the support of the local Administrations. In the community Jango Pastoril, the decisions taken at a Muncipal level are presented, opinions are expressed and the plans are modified or agreed upon. Community feedback is then presented by the traditional leaders at the next Municipal Jango Pastoril where it is recorded and taken into consideration, with the necessary adaptations being introduced.
community-based organisations	Agropastoral Farmer Field School (APFS) Facilitators and Members. Representatives from the Agricultural Development Initiatives. Local Church Representatives.	The community-based organisations participate in the discussions and speak for those they represent. Many times they are the ones who support the Administrations in the communication or implementation of the decisions made in the forums.
SLM specialists/ agricultural advisers	FAO national and international consultants. Administrative agricultural and livestock technicians Veterinarians and Animal Health Workers.	Provide technical support to discussions and provide feedback on local issues.
NGO	Local and National NGOs.	Their role will most likely depend on the objectives of the participant NGO, but often lines of collaboration are easily established.
private sector	Representatives from local ranches and private holdings.	Often the owners are far from the land, and send their local managers to participate, though they have often have little decision-making capacity. However, their presence and opinion should be sought.
local government	Municipal and Communal Administrations and their representatives.	Co-coordinate the organisation and logistics of the Jango Pastoril forums. Participate as a stakeholder in the meetings and give feedback and administrative approval of the decisions taken. The Municipal and Communal Administrations usually have the final word on any decisions made so they must actively participate in the meetings.
international organisation	Project 'RETESA', FAO Angola.	FAO Angola was responsible for supporting the Angolan Government in its design and execution of the Global Environment Funded 'Project RETESA'.

Lead agency
Project 'RETESA', FAO Angola was the lead agency, though plans are for the Municipal Forums to be self-sufficient in 2018.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization
initiation/ motivation				✓	
planning				✓	
implementation				✓	
monitoring/ evaluation			✓		

Specify who was involved and describe activities

The first meetings and forums were organised by the Municipal Administrations and the Retesa Project, picking up from previous attempts at organising discussion forums to manage commonly held natural resources.

Once Jango Pastoril were well established, the decision-making process was transferred to them, with technical support being provided by the SLM specialists and with the Municipal Administrators having final word.

The implementation of the decisions made was based on their type and complexity and often depended on input and action from various stakeholders. Where possible, external support in the form of technical knowledge, materials, food, machinery, etc. were organised to support the agreed upon activities and works.

At the current stage, monitoring and evaluation is being carried out by the RETESA Project and the supporting Administrations. In the best case scenario, monitoring and evaluation would be carried out by the Jango Pastoril themselves, though external support would most likely be needed, at least until the process is well understood by the forum participants.

Flow chart

As the initial processes had different entry points and acted at different administrative levels, a graphic representation of the process can be seen in the flow chart provided. Readers are asked to focus on the entry points and how each situation developed, rather than focus on the specific names of the areas.

The Approach has overseen the creation of five Jango Pastoril, each with their own contexts and stakeholders, which are highlighted in the flow chart in green. By introducing and implementing the GreenNTD methodology, the five Jango Pastoril also debated and approved land management plans with administrative and community support, which in some cases allowed for the creation of large grazing reserves. The sixth and final plan is the combination of the 5 plans into an encompassing plan which serves a large part of the principal transhumance migration route.

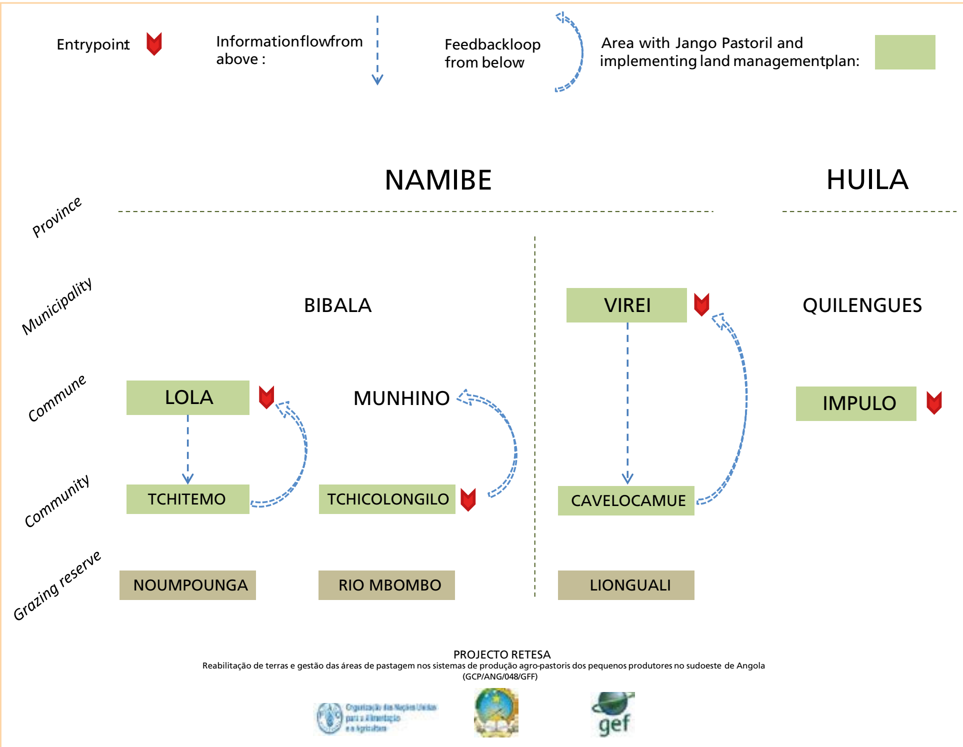


Figure: Projecto RETESA 2018.

Decision-making on the selection of SLM Technology

Decisions were taken by

- ☐ land users alone (self-initiative)
- ☐ mainly land users, supported by SLM specialists
- ☑ all relevant actors, as part of a participatory approach
- ☐ mainly SLM specialists, following consultation with land users
- ☐ SLM specialists alone
- ☐ politicians/ leaders

Comment: FAO representatives facilitated the Forums, though decision-making and proposals came largely from the Forum participants themselves. SLM specialists did make clear their opinions and helped the group reach viable decisions on the use and adequacy of the technologies to be implemented.

Decisions were made based on

- ☐ evaluation of well-documented SLM knowledge (evidence-based decision-making)
- ☐ research findings
- ☑ personal experience and opinions (undocumented)
- ☑ the traditional management system used before the conflicts of the XX century provided important inputs to the final lands management plan.

LUP

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE

The following activities or services have been part of the approach

- ☑ Capacity building/ training
- ☑ Advisory service
- ☑ Institution strengthening (organisational development)
- ☑ Monitoring and evaluation
- ☐ Research

Capacity building/ training

Training was provided to the following stakeholders

- ☐ land users
- ☐ field staff/ advisers
- ☑ forum participants

Form of training

- ☐ on-the-job
- ☐ farmer-to-farmer
- ☐ demonstration areas
- ☑ public meetings
- ☐ courses

Subjects covered

Animal health and nutrition; native pasture and rangeland management; water management & illnesses (both human and animal); integrated landscape design and planning; development and governance of Community Management Forums.

Comment: If relevant, specify gender, age, status, ethnicity, etc. Principally male (livestock is male centred enterprise in the area, except for chickens and pigs), 40 to 60 years of age, leader/authority within the community and their is generally a mix of tribal backgrounds. Administrative representatives were more variable in gender, background and ethnicity.

Advisory service

Advisory service was provided

- ☑ on land users' fields
- ☐ at permanent centres

Comment: The Jango Pastoril have limited ability to provide advisory services, but they can be used by participants to find and meet those who can provide assistance.

Institution strengthening

Institutions have been strengthened/ established

- ☐ no
- ☐ yes, a little
- ☑ yes, moderately
- ☐ yes, greatly

at the following level

- ☑ local
- ☐ regional
- ☐ national
- ☐ transboundary level

Describe institution, roles and responsibilities, members, etc.
Creation of the Jango Pastoril as an institution in its own right has led to important benefits. Local, communal and municipal institutions have also been strengthened and provided with a direct link to the pastoral communities.

Type of support

- ☐ financial
- ☑ capacity building/ training
- ☐ equipment

Further details
The Jango Pastoril approach, underpinned by the GreeNTD Methodology, stands as an example of involving local people in decision-making processes around commonly held natural resources. Local and Municipal authorities have benefited by experiencing and overseeing much of the process.

Monitoring and evaluation

The idea is that the regularly scheduled Jango Pastoril are to act as monitoring bodies for the land management plans, evaluating results and taking action to correct mistakes or adapt to new conditions. However, for the most part it will be the Municipal authorities who decide whether the process is working and whether to continue with them or not.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- ☑ < 2,000
- ☐ 2,000-10,000
- ☐ 10,000-100,000
- ☐ 100,000-1,000,000
- ☐ > 1,000,000

Precise annual budget: 2,200

Comment: It costs about US $500 to organise and fund a Municipal Forum, about US $200 for a Community Forum. Theoretically, there should be around 2 Muncipal Forums and 6 Community Forums per year per municipality.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	no	yes, little	yes, moderately	yes greatly
Did the Approach empower local land users, improve stakeholder participation? In most cases, there are no community forums or public spaces for locals to voice their opinions. By creating the Jango Pastoril forums, participant land users and their representatives were able to voice their concerns and propose solutions.				✓
Did the Approach enable evidence-based decision-making? Experience in the area has shown that presenting 'scientific evidence' to communities with little formal education can produce interesting interpretations and consequences. Most decisions in pastoral communities are based on past experience, social conventions and emotions. However there is significant collective memory that has allowed for the evidence of land degradation and climate change to become clear and better decisions are being made.		✓		
Did the Approach help land users to implement and maintain SLM Technologies? Yes, the approach did help land users implement and improve upon current practices. However, the Jango Pastoril forums were not created as a purely educational environment and they depended on the participants having enough experience and knowledge to provide adequate feedback and make proper decisions.			✓	
Did the Approach improve coordination and cost-effective implementation of SLM? Coordination was improved at various public and administrative levels, though the forums as an institution are still in their early stage.		✓		
Did the Approach mobilize/ improve access to financial resources for SLM implementation? Funding has been sought for water point improvement works yet none has materialised to date.	✓			
Did the Approach improve knowledge and capacities of land users to implement SLM? As the first Jango Pastoril forums in each area did include 2 hours of education on proper rangeland and natural resource management, some knowledge and capacity building was part of the process.		✓		
Did the Approach improve knowledge and capacities of other stakeholders? The exchange of points of view and communication between the different stakeholders improved the collective knowledge of traditional production systems and the challenges each group faces.			✓	
Did the Approach build/ strengthen institutions, collaboration between stakeholders? The Jango Pastoril forums were the first organised events that brought these different stakeholders to the table to discuss key issues surrounding commonly held natural resources.				✓
Did the Approach mitigate conflicts? The Jango Pastoril discussed and dealt with various sources of conflict in the local areas where they were held. In some cases, solutions were found and agreed upon; however, some conflicts were best left in the hands of the relevant authorities, though suggestions and proposals were gathered and presented to Administrative authorities present.			✓	
Did the Approach empower socially and economically disadvantaged groups? Pastoral herders often enjoy a certain amount of standing within their communities, and the majority of the participants were elder male members of the communities. Women farmers and widows were often invited but were overall under-represented in the forums. This is clearly an area of improvement for future interventions.	✓			
Did the Approach improve gender equality and empower women and girls? Although a number of women hold high positions within the Provincial and Municipal governments and took part in the forum discussions as administrative representatives, for the most part the participants in the forums were elderly men of standing.	✓			
Did the Approach encourage young people/ the next generation of land users to engage in SLM? A small percentage of young males took part in the forums. As they mostly care for the livestock, it would be good to improve their participation rates in future events.	✓			
Did the Approach improve issues of land tenure/ user rights that hindered implementation of SLM Technologies? Land rights and tenure were not addressed either by the forums or the Project. The land management plans created and implemented maintained the 'status quo' currently operating in the area.	✓			
Did the Approach lead to improved food security/ improved nutrition? The land management plans should produce improved animal production rates and reduce livestock invasions of crops, leading to improved food security and nutrition.		✓		
Did the Approach improve access to markets? Sales of livestock is still a sensitive issue in the area and this topic did not form part of the discussions.	✓			
Did the Approach lead to improved access to water and sanitation? Water harvesting and access was a common topic and a list of priority areas and works was prepared and presented to Communal and Municipal Administrations, leading to a number of access and storage improvement activities.		✓		
Did the Approach lead to more sustainable use/ sources of energy? Charcoal production and its effects on the area was raised and debated a number of times but no agreements or solutions were found.	✓			

Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters? ✓ (3rd of 4)

The creation of large-scale grazing reserves and institutions that allow for debate and adaptation of management to increasing changes should lead to an improved capacity to adapt to changes in the climate.

Did the Approach lead to employment, income opportunities? ✓ (1st of 4)

Main motivation of land users to implement SLM

- ✓ increased production
- increased profit(ability), improved cost-benefit-ratio
- ✓ reduced land degradation
- reduced risk of disasters
- reduced workload
- payments/ subsidies
- rules and regulations (fines)/ enforcement
- prestige, social pressure/ social cohesion
- affiliation to movement/ project/ group/ networks
- environmental consciousness
- ✓ customs and beliefs, morals
- enhanced SLM knowledge and skills
- aesthetic improvement
- ✓ conflict mitigation

Sustainability of Approach activities

Can the land users sustain what had been implemented through the Approach (without external support)?

- no
- ✓ yes
- uncertain

Comment: Given coordination and willingness, the communities and Administrations have the resources needed to continue on with Approach as it has been, albeit without the technical and logistical support given by the project until this point. In any case, the process has shown to be well accepted.

CONCLUSIONS AND LESSONS LEARNT

Strengths

Land user's view

- Through the Jango Pastoril, land users now have available an instrument to voice opinions and bring attention to issues affecting pastoral communities and the natural resources they depend on.
- It brings people in contact with decision-makers and others who play important roles in community affairs.
- The Jango Pastoril also serve as a source of information, for example, information on water and pasture availability, on livestock theft, on the Administrations point of view on key issues and priorities, on new projects or programmes.

Key resource person's view

- The Jango Pastoril brings together a diverse and important group of stakeholders who normally wouldn't meet with the objective of addressing rangeland management and livestock issues. In doing so, it brings attention to a number of serious problems affecting the base of local livelihoods and promotes understanding and collaboration between those present and the communities they represent.
- It is one of the few ways to directly deal with the root cause of land degradation, which in this case is the cause is poor land management. It was management processes which drove the land degradation, and land management should equally be the tool used to address the problems. The land management plans created through the Jango Pastoril hopefully return things to a process by which the land was productive and supported a wide array of life.
- It creates an institution whose formalities and objectives are easily understood and appropriated by locals. This institution deals with issues that are of a common concern and that should be receiving more attention than they are.
- The Jango Pastoril and the commonly agreed land management plans they produced add weight to the argument for maintaining the commons for public use and grazing. By entering into agreements and producing management plans that improve local resources, the communities can show unity and argue against those that want to divide and privatise land in the area.

Weaknesses/ disadvantages/ risks → how to overcome

Land user's view

- It can require a lengthy trip and an overnight stay for participants who have to travel from isolated communities. → The Jangos were scheduled at the same time as other key events and meetings, so as to reduce costs and travel. The Municipal and Communal Administrations usually found accommodation for those that had to stay the night.
- The issues discussed and decisions made will have outcomes that will affect some land users. Obviously, there are those that are benefiting from the current situation and they will try and ensure that things remain as they are. → The GreeNTD methodology discussed earlier has a well-established system for involving all stakeholders, assessing their motivations and publically producing a viable plan that addresses key issues.
- The withdrawal of logistical and technical support by the RETESA Project will affect the Jango Pastoril forums. → Approach other projects coming into the area and find other funding opportunities to continue to support the growth of the forums.

Key resource person's view

- The Jango Pastoril do little to improve the situation of the disadvantaged members of the population, or to improve gender equality. In other words, they perpetuate current cultural power bases. → Explore ways with the Jangos of bringing in more farmers and women into the discussions. Or create 'Jango Campones' which deal with cropping issues and land rights.
- The Jango Pastoril do little to address land ownership issues or land rights. → t should be the Jango that ask for help on this issue, but the Jango Pastoril have proven to be in favour of the rangelands being open and available for community grazing.
- Enforcement of laws and regulations is not always easy in such isolated territory. → Establish protocols and systems for dealing with offenders that are known to the local authorities and support all attempts to communicate the plans to land users and invite their feedback.

REFERENCES

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Date of documentation: Sept. 8, 2017; **Last update:** Feb. 16, 2018

Links to relevant information which is available online
FAO in Action: Using indigenous knowledge to reverse land degradation in Angola.: http://www.fao.org/in-action/using-indigenous-knowledge-to-reverse-land-degradation-in-angola/en/

MARKETING & ALTERNATIVE INCOME (AG3)

Training in animal husbandry at the Mugie rangeland and pastoralist show, Laikipia, Kenya (Henry Bailey).

In a nutshell

Short description

This approach group covers the promotion of improved marketing to adapt the products and sales according to market information, through value chain development. The shift is towards (1) high-value (and origin-specific) labelled products (e.g. for 'naturally produced' grass-fed beef or game), (2) improved abattoirs and value of the meat, (3) promotion of non-livestock rangeland products (NLRP) (e.g. legally produce charcoal, firewood, grass for thatching, fruits, nuts (e.g. shea nut butter), gum arabic, medicinal plants, milk, and payment for ecosystem services (ESS). For rangelands, marketing of livestock is a major source of income. Livestock perform multiple functions in the African economy by providing food, inputs for crop production and soil fertility management, raw material for industry, cash income as well as promoting savings, being central to social functions, and providing employment opportunities.

Principles

– Improve market infrastructure and access.
– Improve marketing of livestock: healthy and high quality livestock; high-end products, branding and origin labelling.
– Explore non-livestock rangeland products: medicines, cosmetics etc.
– Establish functioning carbon credit and payment for ecosystem services (PES) schemes for rangelands.

Most common approaches

Improved marketing (livestock, meat and milk):

– Livestock to market programmes: where cattle markets are held in conservancies that have demonstrated efforts to rehabilitate rangelands and implement grass management. Cattle are bought directly from pastoralists on their doorstep, and priced per kilo to ensure fair prices.
– Special high value beef/ grass-fed meat label rearing: guarantees customers high animal
– welfare standards and good products[1].
– Livestock insurance: livestock market information and measurement of forage conditions made via satellite data on vegetation cover help track changes, support decisions and legitimise insurance programmes.
– Improved abattoirs in terms of location and hygiene management: continual improvement is critical to ensure that the abattoirs remain relevant, efficient and effective over time.

Value chain development: adding value to pastoral products – livestock and non-livestock products – e.g. by processing milk and dairy products, supplementary feeding, manure for fertility or fuel, firewood or processed into compressed firewood or pellets,

[1] https://www.farmersweekly.co.za/bottomline/grass-fed-association-of-sa-launched/

Improved water availability	
food security/ self-sufficiency	++
SRM knowledge	+++
conflict mitigation	+++
empower disadvantaged groups	+
Improve gender	++
equality	++
governance	++
CC adaptation	+

Importance: +++ high, ++ medium, + low, +/– neutral, n/ap: not applicable

A women's group that is supported by the MWCT (Maasai Wilderness Conservation Trust) who make traditional Maasai jewellery to be sold: at their boma in the Chyulu Hills, Kenya (© Charlie Shoemaker).

deBushing-Value Addition 'I used to be an invader tree' (GIZ).

charcoal production, use of medicinal, aromatic and cosmetic plants (devil's claw, shea/ karité, gum arabic, etc.), grass for thatching/ roof building and for weaving baskets, other handicrafts such as bead jewellery and wood carvings.

Payment for ecosystem services (PES): provides incentives to land users to supply environmental services that benefit society (e.g. carbon sequestration, upstream/ downstream water availability and quality)[2]. Those who benefit pay those who provide the services.

(Eco)tourism: promoted as environmentally sound and locally beneficial tourism. Its growth in Africa is exceptional because of landscape, wildlife diversity and abundance of charismatic wildlife species. Community-based initiatives have emerged from ecotourism with both ecological and socio-economic benefits to rural communities and nations.

Rangeland use system (RUS)
Reported from 'bounded without wildlife' and to a lesser extent from 'agropastoral' system.

Main benefits
- Creating a shift towards increased livestock quality, and the underlying rangeland productivity.
- New opportunities for generation of income.
- Strengthening institutions to implement sustainable rangeland management.
- Creating resilience in the area and rehabilitating degraded land through financial market based incentives.
- Financial viability through the introduction of value chains.
- Involvement of private sector to facilitate implementation.

Main disadvantages
- Market fluctuations and lack of guaranteed prices. Unfair or inequitable pricing of livestock especially during droughts.
- Shortage of high quality livestock especially cattle.
- Administrative burden.
- When livestock is perceived as symbol of wealth, there is reluctance to sell.
- Private sector, especially insurance companies are profit oriented and might not be fully motivated to venture into remote areas with higher risks.
- Carbon benefit funding channels not sufficiently established.

Applicability and adoption
Pastoralism and livestock production and markets are of significant importance to the economies of many countries in SSA. Therefore, improving livestock value, markets and value chains are of high priority in all the rangelands. In addition, further marketing of non-livestock products and ecosystem services has a high applicability and potential for adoption. Factors that can affect adoption are available infrastructure, access to markets, proximity to specialized clientele (e.g. tourist lodges, along busy roads), arrangements with industries, continuous adaptation to market fluctuations and changes.

Potential of camel milk – the experience of Tiviski dairy, Mauritania
This small dairy is a positive example of: (a) appropriate technologies for "good" camel milk production; (b) collecting, processing and preserving camel milk and dairy products to ensure safety and quality; and (c) develop standards to facilitate trade and export to the rest of the world.

The mini dairy started up in 1989, when camels were used almost exclusively as a means of transport. In 2002, milk deliveries reached 20,000 litres a day, but a drought dealt a severe blow to the sector. Over the years, herders have found that the regular income from milk sales has improved their living standards and enabled them to feed their livestock in dry periods (Rota and Sperandini 2009).

Tiviski camel-milk collection center in Mauritania (Courtesy Photo).

Bush control and biomass utilisation, Namibia
In line with national development plans, which promote domestic value addition for local resources, the bush control programme strengthens the restoration of productive rangeland piloting various value chains, including modernised charcoal production, bush based animal feed and household cooking fuel. It triggers and drives large-scale bush thinning activities. The programme is implemented through a collaboration of public and private stakeholders. Coordination is ensured through a cross-sector steering committee, which includes the Ministries of National Planning (chair), Agriculture, Environment, Energy, and Industrialisation.
https://qcat.wocat.net/en/summary/3396/


Charcoal production (GIZ).

[2] https://qcat.wocat.net/en/summary/4264/

Pastoralists undergoing Index Based Livestock Insurance (IBLI) training in Loyiangalani, Marsabit County (Credits to ILRI).

Kenya Livestock Insurance Program (KLIP) (Kenya)

KLIP

DESCRIPTION

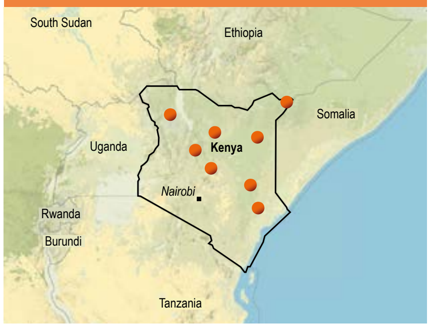
Government of Kenya (GoK) is implementing the Kenya Livestock Insurance Program (KLIP). KLIP is a GoK funded drought insurance program for vulnerable pastoralists located in the Arid and Semi-Arid Lands (ASALs) of Kenya. KLIP's overall objective is to reduce the risk of livestock mortality emanating from drought. This is intended to help to build resilience of vulnerable pastoralists for enhanced and sustainable food security.

Currently, under KLIP, GoK pays insurance premiums for a maximum of 5 Tropical Livestock Units to over 18,000 selected households that are considered vulnerable (i.e. own less than 5 TLUs). (0.1 of 1TLU is equivalent to 1 goat or sheep,therefore 10 goats/sheep = 1 cow (TLU) and 1.7 of TLU is equivalent to a camel or 17 goat/sheep or 1 cow + 7 goats/sheep = 1 camel). The program is currently being implemented in 8 Arid and Semi-Arid counties in Northern Kenya. In case of severe forage scarcity because of drought, the households enrolled on KLIP receive pay-outs to enable them purchase fodder, veterinary drugs and water to keep their animals alive during the drought season. The expected impact of KLIP on pastoralists' livelihoods protected assets and improved resilience due to better recovery mechanisms from drought shocks. At national level, reduced expenditure on humanitarian emergencies during severe droughts and sustained contribution of the livestock sub sector to the national economy is expected. As a Sustainable Land Management (SLM) solution, the KLIP approach can contribute to reduced pressure on grazing lands by providing pay-outs which are used by pastoralists to purchase animal feeds from outside the KLIP counties during drought periods, leading to reduced land degradation.

KLIP was first piloted in 2014 in 2 counties in the ASALs of Kenya i.e. Wajir and Turkana counties. 2,500 households from each county were enrolled to the program, each receiving insurance worth 5TLUs for 1-year renewable period. In August 2016, 275 households in Wajir County received a total of Ksh. 3.5 million pay-out as a result of the failed long rain season of the same year. KLIP later expanded to cover 4 more counties in 2017 which included Isiolo, Marsabit, Mandera and Turkana raising the total number of beneficiary households to 14,000. In February 2017, a payout worth Ksh. 214 million was triggered to 10,000 pastoralists households across the six counties at the end of the failed short rainy season of 2016 (October to December). In 2017 KLIP added to more Counties Samburu and Tana River on its scope. Later in August of the same year, another payout worth Ksh. 319 million triggered across 7 counties leading to 12,000 beneficiaries receiving compensation. Currently KLIP is operational in the 8 counties, with plans underway for expansion to reach all the 14 ASAL counties of Kenya.

KLIP pay-outs are pegged to measurements of forage conditions made via satellite data on vegetation cover to derive an index of seasonal forage availability/scarcity, called the Normalized Differenced Vegetative Index (NDVI). The index can be defined as a measure comparing the total amount of forage available across the contract season with the his-

LOCATION



Location: Counties, Isiolo, Mandera, Wajir, Tana river, Marsabit, Turkana, Kenya, Samburu, Garissa, Kenya

Geo-reference of selected sites
- 37.58298, 0.35658
- 40.03627, -1.49811
- 35.61016, 3.12285
- 40.104, 1.97421
- 41.62012, 3.79555
- 38.04956, 2.20477
- 39.64649, -0.45551
- 37.17888, 1.25667

Initiation date: 2014

Type of Approach
- ☐ traditional/ indigenous
- ☐ recent local initiative/ innovative
- ☑ project/ programme based

Ashok Shah (centre), CEO of APA insurance company presenting the National KLIP payout cheque for all the 6 counties under KLIP. He is flunked by representatives of various insurance companies from the KLIP risk underwriting consortium (ILRI).

Cabinets Secretary for the Ministry of Livestock Agriculture and Fisheries, issuing cheques to beneficiaries in Wajir County in March 2017. Looking on is the Wajir County governor, Ahmed Abdullahi (ILRI).

toric average forage availability of that season. When the index signals that forage conditions have deteriorated to the point that animals are likely to die, KLIP compensates pastoralists in cash pay-outs immediately after a failed rainy season(s) and just before the start of subsequent dry season to help pastoralists buy fodder, drugs and water to sustain their livestock through the drought period.

The use of a satellite based Index eliminates the need for insurance companies to carryout loss verification, which would be logistically and financially impossible to implement if they were to provide livestock insurance in such vast and remote areas as Kenya's ASALs. Satellite data (NDVI) is used to calculate forage conditions in a specific area over a specific season in order to determine whether the index could trigger a pay-out. Once pay-outs are triggered pastoralists registered under the affected areas are automatically eligible for compensation. Payouts are immediately disbursed via either M-Pesa or bank accounts depending on the beneficiaries preferred means as specified during registration.

The implementation of KLIP is done through a Public Private Partnership approach (PPP) spearheaded by the State Department of Livestock (SDL) under the Ministry of Agriculture, Livestock and Fisheries (MOALF). The GoK purchases KLIP policies on behalf of the pastoralists targeted under the KLIP program. However, in case of an insurance payout, indemnified households receive their respective share of the payout directly from the underwriting insurance company/ies. Private Insurance companies registered in Kenya provide underwriting services for KLIP. The World Bank Group provides financial and technical support while ILRI provides awareness and capacity development support together with KLIP contract design. Various capacity development and awareness creation tools e.g. radio programs, posters, flyers, cartoon booklets, videos and training manuals have been used by KLIP to target pastoralists, partners and policy makers. A contract design tool has also been developed for KLIP with the support of ILRI and the WBG for insurance firms to use in determining their KLIP pricing options.

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims/ objectives of the approach

The overall objective of KLIP is to reduce the risk of livestock mortality emanating from drought and to build the resilience of vulnerable pastoralists for enhanced and sustainable food security. KLIP is intended to enhance the capacity of pastoral communities to minimize weather related risks through provision of index based livestock insurance.

KLIP's specific objectives are:

i) To build the resilience of vulnerable pastoralists in Kenya's ASALs against the consequences of drought by developing and applying index based insurance products in the provision of livestock insurance services to the pastoralists.

ii) To build capacities of the pastoral communities and stakeholders in the use of insurance for the reduction of weather related risks and rebuilding of livelihood support systems.

iii) To increase Public-Private-Partnerships (PPP) in the provision of index based livestock insurance to the vulnerable pastoralists whose livelihoods are dependent on livestock.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** Apart from being the main source of livelihoods for many of the communities living in Kenya's ASALs, pastoralism is a cultural practice that has been passed on from generation to generation. Pastoralists aspire to protect their herds from all manner of perils, including drought related livestock losses.
- **Availability/ access to financial resources and services:** Financial support for KLIP mainly from GoK and the World Bank Group. This has been a great enabling factor as huge financial investment is required for premium subsidies, awareness creation, operations etc.
- **Collaboration/ coordination of actors:** KLIP has leveraged academic research, advocacy, private sector partnerships, NGOs and other stakeholders working to improve the livelihoods in the pastoralist rangelands of Kenya. It has managed to tap into emerging innovations and insights from past work done for instance by ILRI and her partners such as AUSAID, DFID, USAID, Cornell University, European Union in the implementation of Index Based Livestock Insurance (IBLI), managing to further draw on both the knowledge generated and lessons learned (see references below).
- **Policies:** KLIP enjoys the goodwill of various partners including the Insurance Regulatory Authority (IRA), county governments, the national treasury, National Parliament, the Presidency and other key stakeholders who are willing to support the program in policy formulation and advocacy to create an enabling environment for the scaling-up of KLIP and further commercialization of index insurance by private local insurance companies and other financial sector players.
- **Knowledge about SLM, access to technical support:** Access to technical support by the GoK from both ILRI and the World Bank, especially for KLIP contract design and index monitoring – together with requisite capacity development and awareness creation – have enabled effective roll out and implementation.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** The belief that rainfall or drought are both God's fate upon man is common both as a traditional and religious belief among pastoralist communities. Most of them hold that human beings should not try to control/ mitigate against such. There is also the concern of whether insurance is 'halal' in the context of Islamic Shariah. Both of these challenges have been widely addressed in the implementation of KLIP, through awareness creation and sensitization efforts done in consultation and involvement of national and local religious leaders together with insurance companies and the local communities.
- **Availability/ access to financial resources and services:** Bureaucratic processes involved in the steps towards policy formulation puts at risk the guarantee for continued funding from the government of Kenya, especially in case of regime change. Efforts are being made to influence and initiate policy formulation at the national level. The SDL has also approached county governments where KLIP is being implemented to encourage them to contribute towards the scheme, in order to cover their local communities.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

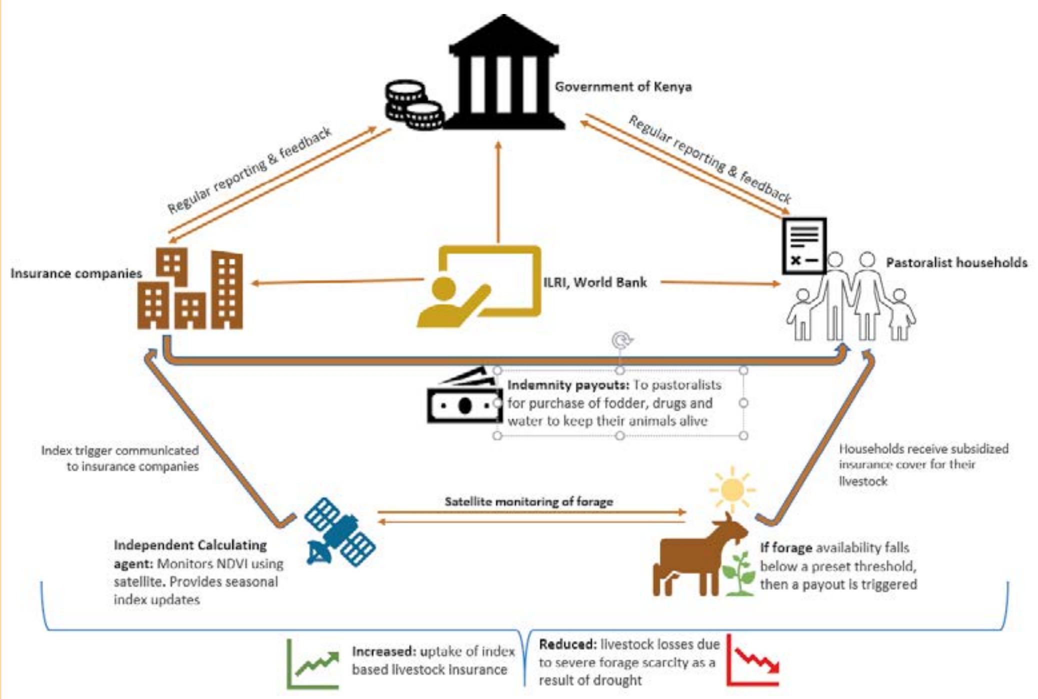
What stakeholders/ implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Pastoralists, also known as KLIP beneficiaries.	Pastoralists households who are vulnerable to drought shocks are the primary beneficiaries in the implementation of KLIP. They receive timely cash payouts at the onset of drought in order to keep their livestock alive throughout the season.
private sector	Insurance companies.	Private insurance companies underwrite the KLIP product either individually or as a consortium. The underwriting insurer is expected to underwrite and distribute pay-outs whenever the index is triggered to beneficiaries listed on KLIP. The selection of the insurer is based on its capacity to underwrite the risk, develop new or strengthen existing products in line with government policy and provide livestock insurance capacity building and awareness creation services. Underwriting insurers are also in charge of marketing the product and explaining its features to (potential) policyholders.
local government	County governments in the target ASAL areas.	The national government utilizes county governments infrastructure for the implementation of KLIP. Counties provide support to the national government in sensitization, mobilization and selection of benefiting pastoralists for the fully subsidized KLIP component. The county governments also provide support during payouts and monitoring and evaluation activities. Some county governments are exploring the possibility of contributing to the public financial support to premiums to match that which is currently provided by the national government.

national government (planners, decision-makers)	The government of Kenya, the State Department of Livestock (SDL) under the Ministry of Agriculture Livestock and Fisheries.	The GoK purchases KLIP policies on behalf of the pastoralists targeted under the KLIP program.
international organisation	Development partners such as the World Bank and ILRI.	The World Bank Group provides KLIP funding to the GoK and is the principal technical adviser to SDL on KLIP. ILRI is responsible for providing technical assistance to SDL on all issues relating to insurance product design, management and improvement, as well as training and awareness creation. ILRI's contributions are based on their experience developing, implementing and assessing an Index-Based Livestock Insurance (IBLI) program since 2008 (http://ibli.ilri.org/).

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	**Specify who was involved and describe activities**
initiation/ motivation				✓		GoK was motivated to implement KLIP in order to protect vulnerable communities from livestock losses due to drought, and also accelerate further uptake of livestock insurance by pastoralists, by experiencing how the product works.
planning				✓		KLIP exemplifies the case of a multi-stakeholder participatory approach linking scientific analysis with local knowledge, while facilitating the awareness, understanding and acceptance of the product by local communities. Activities such as; delineation of geographic areas that constitute an insurable unit and selection of KLIP beneficiaries are conducted through transparent and participatory means.
implementation				✓		KLIP is implemented by the SDL with support from World Bank and ILRI in collaboration with local private insurance companies which underwrite the product either individually or as a consortium. County governments and local NGOs are also involved in the implementation of KLIP.
monitoring/ evaluation				✓		M & E under KLIP, largely relies on acquiring information from management and project records that reflect program resource use and implementation. Primary data collection from key stakeholders is also used. Outcome measurement uses a combination of both qualitative and quantitative methods. Data collection for high level outcomes, for instance the impact of KLIP on household welfare, will require the use of official country level data or relying on countrywide surveys, since these outcomes are normally outside the full control of the program.

Flow chart



Author: Duncan C. Khalai.

KLIP beneficiaries are pastoralist households whose livelihoods are highly dependent on livestock and are susceptible to climate uncertainties and recurrent droughts. They are considered to have limited alternative sources of livelihoods and any disruptions to livestock assets lead to destitution. The beneficiaries are selected through participatory community meetings convened by local chiefs and opinion leaders with the support of county government agricultural extension officers. The main criteria for selection is that each household must own less than 5 Tropical Livestock Units (TLU), which is approximately 5 cows (1TLU = 1 cow). A calculating agent is an independent company or organisation responsible for: (i) accessing eModis NDVI data during the Cover Period and (ii) for processing this data to calculate the index value in accordance with the agreed methodology for each Insured Unit in each county during the cover period and (iii) for reporting this data to the Author: Duncan C. Khalai Insurer and the Insured on a timely basis. Once the index is triggered, the calculating agent notifies the insurance company and the SDL. Cash pay-outs are prepared by the insurance company and disbursed to the registered beneficiary households through mobile money transfers e.g. M-Pesa (available in Kenya), bank transfers and cheques.

Decision-making on the selection of SLM Technology

Decisions were taken by

- ☐ land users alone (self-initiative)
- ☐ mainly land users, supported by SLM specialists
- ☑ all relevant actors, as part of a participatory approach
- ☐ mainly SLM specialists, following consultation with land users
- ☐ SLM specialists alone
- ☐ politicians/ leaders

Decisions were made based on

- ☑ evaluation of well-documented SLM knowledge (evidence-based decision-making)
- ☐ research findings
- ☐ personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE

The following activities or services have been part of the approach

- ☑ Capacity building/ training
- ☑ Advisory service
- ☑ Institution strengthening (organisational development)
- ☑ Monitoring and evaluation
- ☑ Research

Capacity building/ training

Training was provided to the following stakeholders

- ☑ land users
- ☑ field staff/ advisers

Form of training

- ☐ on-the-job
- ☑ farmer-to-farmer
- ☐ demonstration areas
- ☑ public meetings
- ☑ courses

Subjects covered

1. Introduction to KLIP and its key features.
   a. Contract features
   b. KLIP coverage
2. Beneficiary selection & registration.
3. KLIP communication and awareness creation – Managing interactions with other programs.
4. KLIP Voluntary and fully subsidized products – features and differences.
5. County governments and State Department of Livestock coordination.

Advisory service

Advisory service was provided

- ☐ on land users' fields
- ☑ at permanent centres

Comment: A Program Coordination Unit (PCU) comprising of a program coordinator and 2 technical officers i.e. an M&E specialist and a Networking and Capacity development specialist were constituted under the SDL. The PCU is responsible for implementing the program and its day-to-day operations. Each technical officer is responsible for specific components of the program. Advisory communication via phone and email are frequently conducted between the KLIP implementation counties and the PCU. The PCU also supports recruitment of beneficiaries, training, awareness, M&E and communication for KLIP beneficiaries, various stakeholders and partners. ILRI provides support to these activities through its Markets and Capacity development unit. The PCU also provides reports to county governments on all KLIP related aspects including; the status of the index, number and identity of beneficiaries and the amount of indemnities paid.

Institution strengthening

Institutions have been strengthened/ established

- ☐ no
- ☐ yes, a little
- ☑ yes, moderately
- ☐ yes, greatly

at the following level

- ☑ local
- ☑ regional
- ☑ national

Type of support

- ☑ financial
- ☑ capacity building/ training
- ☐ equipment

Describe institution, roles and responsibilities, members, etc.

At the National level; the KLIP coordination unit under the Ministry of Agriculture, Livestock and Fisheries is responsible for the following:

- To develop, and institutionalize a large-scale sustainable livestock insurance program for the Arid and Semi-Arid Lands
- Efficient and effective engagement of relevant stakeholders.
- Influencing policy.
- Develop and maintain Public Private Partnerships.
- To institutionalizing provision of livestock insurance at national and county government levels for increased resilience of vulnerable pastoralists.
- Sustained demand of livestock insurance.

Regional governments (Counties) are responsible for the following:

- Support access to appropriate livestock insurance products – registration of beneficiaries, extension and awareness creation International NGOs i.e. The World Bank Group (WBG) provides funding to the GoK and is also the principal technical adviser to the SDL on KLIP. ILRI is also funded by the World Bank Group to provide technical support around KLIP contract design, awareness creation and capacity development.

Monitoring and evaluation

A monitoring and evaluation framework is in place to ensure that the program is constantly improved and that it can respond to challenges and opportunities arising in the field. The M&E framework is a tool for continuous program planning, implementation and reflection and also used for day-to-day reporting and tracking of progress towards outcomes and long-term impacts. The M&E framework's principle purposes are summarized as follows:

- Tracking progress on program implementation
- Identifying gaps and weaknesses in the implementation process
- Planning, prioritizing, allocating and managing resources during the entire program timeline
- Providing lessons for program management Regular technical reports are generated by the PCU to be submitted to the KLIP technical committee for their technical inputs.

Research

Research treated the following topics

- ☑ sociology
- ☑ economics/ marketing
- ☐ ecology
- ☑ technology

Comment: A livestock insurance service for Kenya's ASALs was tested with remarkable success on a pilot basis by the International Livestock Research Institute (ILRI's) Index Based Livestock Insurance (IBLI) from 2010 –2015 supported by DfID, AUSAID, USAID and other development partners. The lessons drawn from this experience were incorporated in the inception and implementation of KLIP.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component

- ☐ < 2,000
- ☐ 2,000-10,000
- ☐ 10,000-100,000
- ☐ 100,000-1,000,000
- ☑ > 1,000,000

The main source of funding for the KLIP project is from the government of Kenya and the World Bank.

The following services or incentives have been provided to land users

- ☑ financial/ material support provided to land users
- ☑ subsidies for specific inputs
- ☐ credit
- ☑ other incentives or instruments

Financial/ material support provided to land users
Over 14,000 households currently under KLIP receive fully subsidized livestock insurance cover where the government of Kenya fully funds the premiums at an average rate of Ksh. 3000 per TLU, based on the cost of feeding 1 TLU during the months affected with severe drought during in a year. Each pastoralist receives cover for a maximum of 5 cows (5 TLU). However the SDL plans to provide for a partially subsidized KLIP cover, which can be purchased by any interested pastoralist, for as long as they are willing to pay for a partial cost of the premium. Further considerations are underway to assess the possibility of making voluntary insurance more accessible and affordable to pastoralists by partial premium subsidies.

	partly financed	fully financed
Insurance Premiums The government pays premiums on behalf of the pastoralists but is the policy holder. However, in-case a payout is triggered, the pastoralists receive the indemnity directly. Over time, the GoK plans to reduce the size of public support by transitioning into voluntary type of insurance.		✓

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	no	yes, little	yes, moderately	yes greatly
Did the Approach empower local land users, improve stakeholder participation? KLIP has facilitated regular stakeholder interactions leveraging various partnerships forged within its PPP framework. Local communities, county governments, national government and NGOs are all engaged in the quest to find solutions for the pastoralists, who face repetitive cycles of devastating droughts.				✓
Did the Approach enable evidence-based decision-making? KLIP has largely enabled evidence-based decision making within the National treasury and Parliament as both entities have been considerably increasing annual financial allocations for KLIP. Other donors e.g. the World Bank continue to support KLIP implementation as well as there being increased interest from county governments to provide additional funding towards the program. Also more pastoralists are beginning to voluntarily purchase livestock insurance as they have experienced ho the product works through KLIP.				✓
Did the Approach help land users to implement and maintain SLM Technologies? The impact of KLIP on the target population with regards to land use and maintenance of SLM technologies is not yet observable as KLIP is only 3 years into implementation. Rigorous impact analysis may need to be conducted to establish such impacts. However, the rising demand for the KLIP product both from the insurance companies (supply side) and the pastoralists (demand side) is an indication of implementation and maintenance of the SLM (KLIP).		✓		
Did the Approach mobilize/ improve access to financial resources for SLM implementation? Advocacy efforts have been directed at raising decision makers' awareness on the benefits of KLIP is having and the potential it holds for pastoralist communities country-wide. County governments and donors need to appreciate and be motivated towards playing a key role in the implementation KLIP.			✓	
Did the Approach improve knowledge and capacities of land users to implement SLM? Insurance as a concept is complex and regulated entities in the sector seldom commit resources for awareness creation other than marketing of their individual products. KLIP implementation takes into account this situation and has continuously undertaken publicity and awareness creation about insurance with the aim of ensuring that consumers know about and understand the concept of insurance, and can make informed judgments and to take effective decisions in an insurance transaction.			✓	
Did the Approach improve knowledge and capacities of other stakeholders? KLIP implementation has capacity development as one of its key components, which entails developing tools and materials that help support training, extension and awareness creation on KLIP's agenda. Various government, Insurance, County and Community members have undergone KLIP training at distinct levels. Despite all this, there is still room for more to be achieved with regards to capacity development.			✓	
Did the Approach build/ strengthen institutions, collaboration between stakeholders? Since its inception in 2014, KLIP has thrived on collaboration among various state and non-state actors. The State Department of World Bank Group, the International Livestock Research Institute (ILRI) and the Financial Sector Deepening Kenya (FSD), private local insurers (APA Insurance Ltd., UAP Insurance, CIC Insurance, Jubilee Insurance, Amaco Insurance, Heritage Insurance, Kenya Orient) and one global reinsurer (Swiss Re)).				✓
Did the Approach empower socially and economically disadvantaged groups? ILRI conducted a phone survey in 2017, where 643 phone numbers registered to beneficiaries under the KLIP program were selected out of the total 14,000 beneficiaries. Out of the 643, 337 beneficiaries were reached and out of these 300 were surveyed (37 either had no time or did not consent). Questions were asked about the Short Rain Short Dry 2016 and Long Rain Long Dry 2017 seasons. Of the 300 surveyed, 129 reported receiving KLIP payments associated with the SRSD 2016 drought. Out of these 58% indicated having spent the money on food. Based on this therefore, it can be noted that KLIP has moderately contributed to social and economic empowerment of disadvantaged groups.			✓	

Did the Approach lead to improved food security/ improved nutrition? ✓

Under the same study described above, out of 300 beneficiaries surveyed, 129 reported receiving KLIP payments associated with the SRSD 2016 drought, 75 (58%) of these, reported having spent the cash on food stuff for their households. The KLIP study above also indicated increased access to markets as respondents were asked how they changed their response to the drought once they knew that the KLIP payouts were coming. Out of the 63 respondents to this question, more than 50% indicated that they increased purchase of, veterinary drugs & services together with forage and water for their animals.

Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters? ✓

KLIP has so far been able to enhance the capacity of pastoral communities to minimize weather related risks through provision of index based livestock insurance build the resilience of vulnerable pastoralists in Kenya's ASALs.

Main motivation of land users to implement SLM

- [ ] increased production
- [ ] increased profit(ability), improved cost-benefit-ratio
- [ ] reduced land degradation
- [x] reduced risk of disasters
- [ ] reduced workload
- [x] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [ ] environmental consciousness
- [ ] customs and beliefs, morals
- [x] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [ ] conflict mitigation

Sustainability of Approach activities

Can the land users sustain what had been implemented through the Approach (without external support)?

- [ ] no
- [ ] yes
- [x] uncertain

Comment: KLIP is structured in a double pronged approach meant to ensure scale up and sustainability, however uncertainty over the program's sustainability emanates from the lack of government policies that can guarantee continuity. Efforts are still ongoing to ensure such policies are in place.

CONCLUSIONS AND LESSONS LEARNT

Strengths

Land user's view

- High level support from the government and development partners is a strength for KLIP as it continues to attract goodwill from key stakeholders within and outside government.
- KLIP is anchored in a reliable, simple and trusted technology -index based livestock insurance, which is a product of rigorous research.
- KLIP's impacts and lessons are replicable and scalable in other geographical locations.

Weaknesses/ disadvantages/ risks → how to overcome

Land user's view

- Full commercialization of livestock insurance might be a challenge to achieve considering that the private sector, especially insurance companies are profit oriented and might not be fully motivated to venture into the hard to reach, remote and poorly infrastructured ASALs of Kenya where KLIP is implemented. → Continuous capacity development and proper policy environment should be created to enable the private sector's desire to venture into the target regions and fully commercialize the product.
- Sustainability – There is no government policy or legislative Act on KLIP. Its therefore not a guaranteed possibility that the government will support this in the long term. → Continued advocacy, lobbying and sensitization need to be done targeting the key policy makers. Also a proper exit strategy should be designed and put into action.

REFERENCES

Compiler: Duncan Collins Khalai (d.khalai@cgiar.org)
Resource persons: Duncan Collins Khalai (d.khalai@cgiar.org) - Market & Capacity Development Specialist, IBLI, ILRI
Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/approaches/view/approaches_3283/
Video: https://player.vimeo.com/video/246931535
Documentation was facilitated by: Institution: International Livestock Research Institute (ILRI) - Kenya. Project: Index Based Livestock Insurance, Kenya (IBLI)
Date of documentation: Nov. 21, 2017; **Last update:** May 23, 2018

Links to relevant information which is available online

Successful Kenya Livestock Insurance Program scheme scales up: http://www.swissre.com/reinsurance/successful_Kenya_livestock_insurance_program_scheme_scales_up.html

Govt to release record cash payout in livestock insurance program: https://www.capitalfm.co.ke/business/2017/03/govt-to-release-record-cash-payout-inlivestock-insurance-program/

APA Pay The First Major Claim To The Kenya Livestock Insurance Program (KLIP) Farmers: http://www.apainsurance.org/news/apa-pay-the-first-majorclaim-to-the-kenya-livestock-insurance-program-klip-farmers/

SATELLITE, MOBILE TECHNOLOGIES UNDERPIN INSURANCE PAYOUT TO HERDERS IN KENYA: https://www.iii.org/insuranceindustryblog/?tag=kenyalivestock- insurance-program

Record payouts being made by Kenya Government and insurers to protect herders facing historic drought: https://ibli.ilri.org/2017/02/22/record-payoutsbeing-made-by-kenya-government-and-insurers-to-protect-herders-facing-historic-drought/

Mara Beef (Lippa Wood (2017).

Mara Beef: value added beef for for improved rangeland management, livelihoods,and conservation (Kenya)

DESCRIPTION

Mara Beef provides a new direct to market sales approach for pastoralist's in Kenya, in an effort to make livestock production more viable to local landowners. This livestock production model is combined with rangeland management and training in an effort to improve pastoral livlihoods, restore rangelands and prevent degradation, and support biodiversity conservation.

Mara Beef is a limited company that raises top quality beef on the edge of the Maasai Mara, Kenya. The Mara Beef company uses their own private land – Naretoi farm – as well as partnering with the Enonkishu Conservancy, to introduce high quality beef breeds to local herds, and sell the beef onto high end supermarkets and restaurants through their own abattoir. There is a large gap in the prime beef market in Kenya, and Mara Beef is trying to fill this gap. Other cuts, not prime cuts, are sold to other less expensive restaurants. The beef is slaughtered and butchered on site. Mara Beef is engaged in many facets of improved rangeland management; the management of Enonkishu Conservancy and Naretoi farms; through the Mara Training Centre, a training hub for rangeland management; and using the Mara Beef network to link pastoral communities with higher value market.

The Enokishu Conservancy is a conservancy created on the edge of the Maasai Mara ecosystem, and is registered under the Maasai Mara Wildlife Conservancies association. The conservancy is 6,000 acres in size, and is owned by 34 landowners who are Maasai pastoralists. Mara Beef has worked with the conservancy to develop a grazing plan for the conservancy. This plan encourages seasonal rotational grazing that allows grasslands to be heavily grazed for short periods, and allowed to recover over long periods. Conflict between predators and cattle is minimised through the use of mobile bomas (enclosures), to protect cattle at night. Integrating wildlife and livestock management into this conservancy aims to i) provide financial benefits through livestock sales from community cattle to build resilience to stochastic events, such as droughts; ii) to increase food security through supplementary income generation; iii) establish sustainable livestock production, to reduce rangeland degradation in an effort to restore and protect ecosystem functioning. This includes the improvement of soils, watershed protection, carbon sequestration and biodiversity conservation. The conservancy pays each land owner to use the land for cattle fattening, and the average land rent paid to each landowner per year is $20 per acre, spending roughly $119,680 per year. Community members also receive conservancy fees from tourists visiting the area.

The Mara Training Centre was established within the Enonkishu training centre to work with communities to help them create and manage the future they desire. The programs build on three principles: building social participation, governance and participation; creating locally implemented and led planned grazing; and stimulating growth in livestock and wildlife based enterprises. The centre runs a variety of training courses including: boot-camps on rangeland management; extension services; and ecological monitoring.

LOCATION

Location: Maasai Mara, Narok, Kenya

Geo-reference of selected sites
- 15.98915, -25.00452

Initiation date: 2013

Type of Approach
- [ ] traditional/ indigenous
- [x] recent local initiative/ innovative
- [ ] project/ programme based

Enonkishu conservancy (Lippa Wood (2017).

Mara Training Centre; (Lippa Wood (2017).

Finally Mara Beef also provides market linkages for the broader pastoral community to premium beef markets. This service lets pastoral communities from across the region to sell beef at a guaranteed price based on both weight and grade at the animals. This price is often significantly higher, on average around $50, than any price offered by local markets, and the lower transport costs and less weight loss on transport also benefit the seller. The emphasis on high quality beef, with high weight requirements, should have a broader affect on pastoral communities, encouraging improved rangeland management for improved livestock productivity. Although this process will be slow. Mara Beef, for example, was granted a loan from the Agricultural Finance Corporation in January 2017 to purchase malnourished cattle during the drought – where Mara Beef bought 1,000 animals from 105 individuals at an average of $250 per cow.

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims/ objectives of the approach

- Establish sustainable livestock production and premium market for pastoralists.
- Improve grazing management systems through implementation and training.
- Conserve and restore biodiversity through an integrate wildlife-livestock approach.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** Cultural and traditional ecological knowledge complements the teaching of the Mara Training Centre and the holistic management of Enonkishu conservancy.
- **Availability/ access to financial resources and services:** Provision of a grant (and loan) through the African Enterprise Challenge Fund allowed for the improvement of the slaughter house; livestock purchases from community members; the establishment of Enonkishu conservation area; and the building of the Mara Training Centre Support has also been provided by WWF to help establish the conservation area.
- **Institutional setting:** Enonkishu is a community onwned conservancy which operates as a legal entity and acts as the interaction point between Mara Beef and the local community.
- **Legal framework (land tenure, land and water use rights):** Enonkishu conservancy has formed under the provisions of the Wildlife Act 2013 to form a conservancy, bringing together private landowners.
- **Knowledge about SLM, access to technical support:** The creation of the Mara Training Centre acts as a hub of knowledge for information sharing and technical support in rangeland management, offering courses and extension services to communities. This is supported by the Kenya Wildlife Conservancies Association and the Savory Institute.
- **Markets (to purchase inputs, sell products) and prices:** The creation of the Mara Beef premium market ensures that pastoralists receive improved prices on their livestock compared to normal markets.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders/ implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	33 landowning families established the Enonkishu Conservancy.	They are the landowners and receive benefits from land rents provided by the conservancy. They receive benefits from sale of Enonkishu cattle to Mara Beef, receiving financial returns on the investment. They also receive benefits of conservancy fees from visiting tourists.
SLM specialists/ agricultural advisers	Savory Insitute.	Act as advisers for the Mara Training Centre programs.
NGO	Maasai Mara Wildlife Conservancies Association.	Acts as the umbrella body for wildlife conservancies in the region, including Enonkishu. They are also responsible for encouraging sustainable rangeland management practices and livestock production within the Mara conservancies.
international organisation	African Enterprise Challenge Fund (AECF).	Provided funding for the establishment of the conservancy; construction of the mara training centre; and the improvement of the slaughterhouse.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	Specify who was involved and describe activities
initiation/ motivation				✓		Mara Beef began the process of developing Enonkishu conservancy with the local community members, and found funding and technical capacity to develop the project.
planning		✓				The fundraising and planning of the Mara Beef business model, the Mara Training Centre, and Enonkishu was largely supported by members external to the local Maasai community.
implementation			✓			Enonkishu conservancy has a manager supported by Mara Beef that controls grazing management across the conservation area. Mara Beef is owned an operated by non community members. Mara Training Centre involves local communities in the development of the training curriculum – to incorporate traditional knowledge – and during teaching of courses.
monitoring/ evaluation		✓				Monitoring and evaluation of grazing management, beef prices and community benefits is conducted by Mara Beef staff.

Decision-making on the selection of SLM Technology

Decisions were taken by

- ☐ land users alone (self-initiative)
- ☐ mainly land users, supported by SLM specialists
- ☐ all relevant actors, as part of a participatory approach
- ☑ mainly SLM specialists, following consultation with land users
- ☐ SLM specialists alone
- ☐ politicians/ leaders

Comment: The farm manager has a long history of working with rangeland management. They consulted with specialists from the region to help advise on the best way to manage grazing on Enonkishu, as well as including community dialogue on best practice. Mara Beef was set up with advise from business experts to build a sustainable and profitable beef business. The Mara Training Centre was developed in consultation with landowners and with experts from the fields of conservation and rangeland management.

Decisions were made based on

- ☑ evaluation of well-documented SLM knowledge (evidence-based decision-making)
- ☐ research findings
- ☑ personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE

The following activities or services have been part of the approach
- ✓ Capacity building/ training
- ✓ Advisory service
- ✓ Institution strengthening (organisational development)
- ✓ Monitoring and evaluation
- Research

Capacity building/ training

Training was provided to the following stakeholders
- ✓ land users
- ✓ field staff/ advisers

Form of training
- ✓ on-the-job
- ✓ farmer-to-farmer
- ✓ demonstration areas
- ✓ public meetings
- courses

Comment: In 2015, 40 members of the Enonkishu Conservancy community, went on a training trip to Ol Maisor, Sosian, NRT, LEWA, Il Ngwesi and Westgate Conservancy, to learn about community conservation and rangeland management. Training is provided on a continual basis to both local land owners and pastoralists from across the region through the Mara Training Centre. In the first 6 months of operation, over 600 people attended training courses.

Advisory service

Advisory service was provided
- ✓ on land users' fields
- ✓ at permanent centres

Comment: Mara Training Centre provides advise and courses both at the training centre, located in the Mara, and through outreach programs to pastoralists across the region.

Institution strengthening

Institutions have been strengthened/ established
- no
- yes, a little
- yes, moderately
- ✓ yes, greatly

at the following level
- ✓ local
- regional
- national
- transboundary level

Describe institution, roles and responsibilities, members, etc.
The Enoonkishu conservancy was established with 50 landowners to protect and manage their land in a more sustainable and profitable way.

Type of support
- ✓ financial
- ✓ capacity building/ training
- equipment

Further details
Support was provided by several conservation NGOs, including the African Conservation Centre and WWF to support the initial costs of motorbikes and wildlife rangers within the Enonkishu conservation area. Further funding from African Enterpise Challenge Fund was used to pay lease fees to the Enonkishu community and further equip the wildlife rangers and managers.

Monitoring and evaluation
Mara Beef monitors its purchase and sales records, as well as purchase weight and sale weight.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
- < 2,000
- 2,000-10,000
- 10,000-100,000
- 100,000-1,000,000
- ✓ > 1,000,000

Precise annual budget: 2,000

Comment: The initial budget for this project was large (>$500,000). This large amount of funding was needed to establish Enonkishu conservation area through payment of land rent, the purchasing of equipment for the Mara Beef slaughterhouse and distribution network, and the construction of the Mara Training Centre. The company has a large turnover each year, purchasing over $850,000 of cattle in 2017.

The following services or incentives have been provided to land users
- ✓ financial/ material support provided to land users
- ✓ subsidies for specific inputs
- credit
- other incentives or instruments

Comment: Landowners of Enonkishu conservancy are provided with land rent, roughly $3,390 per landowner per year.

Financial/ material support provided to land users
Finances are needed for purchasing equipment; seeds were also provided; seed testing was carried out to establish appropriate type/ species of those chosen by the communities.

	partly financed	fully financed
Slaughter house improvement Grant from AECF		✓
Mara Training Centre Grant from AECF		✓

Comment: The Enonkishu conservancy land rent was also paid by an AECF grant for the first two years of establishment.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	no	yes, little	yes, moderately	yes greatly
Did the Approach empower local land users, improve stakeholder participation? The approach established the Enonkishu conservancy, providing them with a platform for better land management, conservation and revenue generation.				✓
Did the Approach help land users to implement and maintain SLM Technologies? The approach provides training and outreach through the Mara Training Centre				✓
Did the Approach mobilize/ improve access to financial resources for SLM implementation? The approach improved access for funding to the Enonkishu conservation area.			✓	
Did the Approach improve knowledge and capacities of land users to implement SLM? Over 600 pastoralists trained in rangeland management and livestock production in the first 6 months of the establishment of the Mara Training Centre.				✓
Did the Approach improve knowledge and capacities of other stakeholders? Mara Beef organised a conference in Nariobi, called Grazing for Change, with other 300 delegates debating the role of livestock production in conservation and development.				✓
Did the Approach build/ strengthen institutions, collaboration between stakeholders? The approach established the Enonkishu conservancy, and its links with Mara Beef.				✓
Did the Approach empower socially and economically disadvantaged groups? In 2017 Mara Beef provided an estimated benefit of $103,600 to livestock owners (estimated at at a $50 increase in value per cattle sold to Mara Beef as opposed to other markets). In 2017 Mara Beef also bought cattle from an Agricultural Finance Corporation drought contingency fund. Mara Beef bought 1,000 animals off 105 farmers at an average of $250 each cow. These cattle would have certainly died due to lack of food. Therefore, a net Benefit of $250 per (cow) multiplied by 1,000 cows spread over 105 farmers. So, a net benefit of $250,000 divided by 105 farmers. $2,380 for 105 farmers. The approach allows pastoralists to sell directly to market, rather than losing value through several steps of brokers before it reaches a point of sale in Nairobi.				✓

Main motivation of land users to implement SLM
- [x] increased production
- [x] increased profit(ability), improved cost-benefit-ratio
- [x] reduced land degradation
- [ ] reduced risk of disasters
- [ ] reduced workload
- [x] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [ ] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [ ] environmental consciousness
- [ ] customs and beliefs, morals
- [x] enhanced SLM knowledge and skills
- [ ] aesthetic improvement
- [ ] conflict mitigation

Sustainability of Approach activities
Can the land users sustain what had been implemented through the Approach (without external support)?
- [ ] no
- [ ] yes
- [x] uncertain

Comment: The Mara Beef model is supported by large captial investment and is not landowner run. The Enonkishu conservancy is heading towards creating a self sustaining model of operations, without external support.

CONCLUSIONS AND LESSONS LEARNT

Strengths

Land user's view
- Provision of knowledge on improved livestock production and rangeland management.
- Provision of an improved market for cattle.

Key resource person's view
- Creation of a production oriented approach provides the potential for improved rangeland management across the region. With pastoralists beginning to produce fewer, higher quality cattle for sale, through efforts to improve grazing management across the region.
- This approach has a huge potential to be up-scaled to support community conservation through a sustainable and well managed livestock production and rangeland management model.
- Mara Beef has also been a key catalyst of conversation across SSA relating to sustainable rangeland management, livestock production, and mixed livestock-wildlife ecosytems.

Weaknesses/ disadvantages/ risks → how to overcome

Land user's view
- Lack of ability to practice individual herding within the conservation area. → Use of tradtional Maasai community structures to enforce grazing rules.

Key resource person's view
- The focus on cattle present a great opportunity, but sheep and goats also need a better, readily available market to increase off-take. → Building of a pack-house in Nairobi for goat meat for the export market, to compete with other markets.
- Lack of impact on improved rangeland management beyond the Enonkishu area, especially when livestock is purchased from all over the country. There is also a lack of high quality cattle. → Establish links with other conservancies and landowner groups to encourage improved grazing management, producing higher quality cows.

REFERENCES

Compiler: Peter Tyrrell (peterdavidtyrrell@gmail.com)
Resource persons: Peter Tyrrell (peterdavidtyrrell@gmail.com)
Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/approaches/view/approaches_3425
Documentation was facilitated by: Book project: Guidelines to Rangeland Management in Sub-Saharan Africa (Rangeland Management
Date of documentation: Feb. 28, 2018; **Last update:** April 28, 2018

Pastoralists undergoing Index Based Livestock Insurance (IBLI) training in Loyiangalani, Marsabit County (Credits to ILRI).

Northern Rangelands Trust – Livestock to Markets (Kenya)

DESCRIPTION

Northern Rangeland Trust works across the rangelands of northern Kenya to improve market access to pastoral communities across 20,000 km$_2$. The program improves local revenue generation, incentives to reduce herd size, and channels funding into improved rangeland management across the conservancies.

The Northern Rangelands Trust (NRT) is a non profit organisation established in 2004. It works with communities to develop community conservancies, to transform peoples lives, secure peace and conserves natural resources in northern Kenya. NRT works cross 20,000 km$_2$, with 33 conservancies.

NRT established NRT Trading to identify, incubate, and pilot, and scale sustainable business across the NRT conservancies. The help to incubate and run business that encourages conservation ethics, while improving livelihoods.

The Livestock to Market Program (LTM) was established in 2006 as a partnership between NRT, NRT affiliated conservancies, and two private conservancies – Ol Pejeta and Lewa. The program was funded by Flora and Fauna International and The Nature Conservancy. The program was designed to: to build resilient livelihoods for local pastoralists through providing a local, equitable, reliable, fair market for a large number of cattle; provide incentives to increase production viability of cattle, reduce herd size and avoid losses during droughts; build conservation momentum; directly benefit individual conservancies through sale levies.

The model works to first buy cattle from NRT affiliated conservancies, these cattle are sold on weight and grade, and tries to embrace a more market-driven approach. Once bough cattle is quarantined and vaccinated on Lewa. They are then fattened and sold on to different markets depending on size and age.

The program aims to benefit local people through providing an equitable market with similar or better rates than available and through revenue generation for each conservancy - to provide health and education benefit. A key goal of this benefit system is through channelling conservancy levies and behavioural change into improved rangeland management. Improved management, implemented by conservancies, will lead to improved productivity of the rangelands, increased livestock quality, increased revenue for pastoralists, and ultimately contribute to the goals of NRT – Peace and security; resilient livelihoods; productive rangelands; stable wildlife; and growing enterprise.

NRT has a fully fledged grazing management team working across the conservancies to enhance pasture and land management is upheld by all members, this working by involving alienation of dry season and wet season grazing corridors in order to guarantee animal –wildlife sustainable grazing. Several technologies are implemented under this approach to improve rangeland management. Strategic destocking and cattle bunching in conservancies is one method. Supplementary feed is also provided to increase the weight gain of cattle before sale.

LOCATION

Location: Baringo, Garissa, Isiolo, Laiikipia, Meru, Samburu, Turkana and Lamu Counties, Kenya

Geo-reference of selected sites
- 37.487, 0.2439

Initiation date: 2006

Comment: In 2014 NRT spun off its commercial activities into a stand alone social enterprise, Northern Rangelands Trading Ltd (NRT Trading).

Type of Approach
- [ ] traditional/ indigenous
- [ ] recent local initiative/ innovative
- [x] project/ programme based

Investing in Conservations and Communities (NRT – LTM).

Investing in Conservations and Communities (NRT – LTM).

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims/ objectives of the approach

Assist pastoralists and families in the NRT Conservancies to build resilient livelihoods by providing a local, equitable, reliable, fair market for large numbers of cattle.

Provide incentives to pastoralists to manage cattle for ready markets and over time reduce herd sizes to avoid loses due to drought among other factors, in an effort to improve rangeland health and productivity.

Gain conservation leverage by linking market access to conservation outcomes.

Directly benefit Conservancies through purchase and sale levies.

Involve a complete value chain model i.e. involving pastoralist producers, disease control actors & quarantine, designated fattening ranches, slaughter, and marketing.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** The spread of Mpesa (Mobile Money) is helping to improve the ability for people to share money across the region.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** Pastoral societies do not necessarily have cattle for revenue generation, and they currently do not manage cattle for weight and the beef market.
- **Availability/ access to financial resources and services:** Lack of funding to support disease control in the conservancies, especially those which may hinder the movement and sale of livestock. e.g FMD.
- **Collaboration/ coordination of actors:** Certain value chain operations are hindered by the lack of cohesion between country and national government. This includes disease control and taxes.
- **Land governance (decision-making, implementation and enforcement):** There are challenges in implementing improved grazing management across many of the conservancies due to a lack of ability to enforce.
- **Knowledge about SLM, access to technical support:** High costs of technical expertise needed to upscale grazing and land management.
- **Other:** The region is insecure and hinders the impact and effectiveness of the program.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

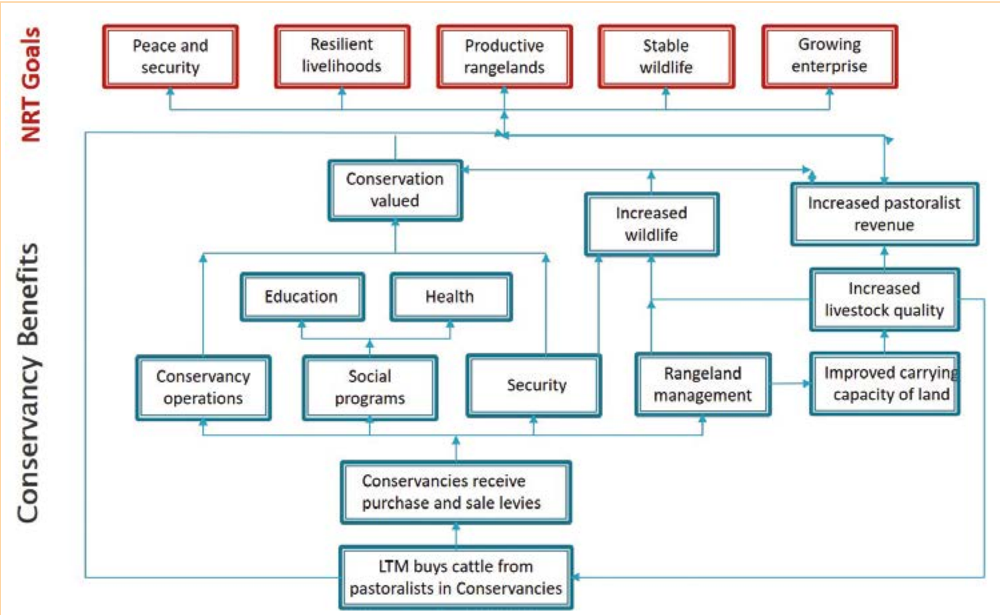
What stakeholders/ implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	27 community conservancies.	Land-owners and managers of cattle. They benefit from the sale of cattle through LTM and implement the grazing management plans.
SLM specialists/ agricultural advisers	NRT – Grazing management team.	Provide technical advise to conservancies to improve grazing management.
NGO	Sidai.	Sidai is working with community conservancies by selling drugs. LTM purchases some basic veterinary drugs from Sidai outlets.
local government	County Government.	Extension services for livestock management and disease control. Beneficiaries of county levies.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	Specify who was involved and describe activities
initiation/ motivation				✓		NRT conservancy model creates independent units that have strong leadership and governance structures. These conservancy boards and management are involved and are the drivers at each stage.
planning				✓		Conservancies are involved in planning stages.
implementation			✓			NRT-LTM runs the markets and livestock fattening with support from both local and private conservancies.
monitoring/ evaluation		✓				Monitoring is done through the NRT monitoring systems.

Flow chart

Livestock to Market Benefit Systems.



Author: NRT.

Decision-making on the selection of SLM Technology

Decisions were taken by
- [ ] land users alone (self-initiative)
- [ ] mainly land users, supported by SLM specialists
- [x] all relevant actors, as part of a participatory approach
- [ ] mainly SLM specialists, following consultation with land users
- [ ] SLM specialists alone
- [ ] politicians/ leaders

Comment: The NRT grazing management teams work with the community conservancies officials and board to establish grazing management plans and implement restoration of degraded range-lands.

Decisions were made based on
- [x] evaluation of well-documented SLM knowledge (evidence-based decision-making)
- [ ] research findings
- [x] personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE

The following activities or services have been part of the approach
- [x] Capacity building/ training
- [x] Advisory service
- [x] Institution strengthening (organisational development)
- [x] Monitoring and evaluation
- [x] Research

Capacity building/ training

Training was provided to the following stakeholders
- [x] land users
- [ ] field staff/ advisers

Form of training
- [ ] on-the-job
- [ ] farmer-to-farmer
- [ ] demonstration areas
- [x] public meetings
- [ ] courses

Comment: NRT governance department conducts effective leadership and management training to conservancy leadership across the board.

Advisory service

Advisory service was provided
- [x] on land users' fields
- [ ] at permanent centres

Comment: Some support is provided by county government extensions services. NRT also provides support.

Institution strengthening

Institutions have been strengthened/ established
- [ ] no
- [ ] yes, a little
- [ ] yes, moderately
- [x] yes, greatly

at the following level
- [x] local
- [ ] regional
- [ ] national
- [ ] transboundary level

Describe institution, roles and responsibilities, members, etc.

Community conservancies have gained funding to implement projects and strengthened their knowledge on livestock production systems and rangeland management.

Type of support
- [x] financial
- [x] capacity building/ training
- [ ] equipment

Monitoring and evaluation

Monitoring and evaluation are annually conducted through the mandatory annual statutory audit by contracted reputable audit firms. Internal production monitoring is done through the monthly internal tracking systems.

Research

Research treated the following topics
- [ ] sociology
- [x] economics/ marketing
- [ ] ecology
- [ ] technology

Comment: The research formed the basis of choosing to scale up the programme and recommendations to run the programme as a business.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
The program is supported by a loan from The Nature Conservancy, that is repayable in 10 years.

The following services or incentives have been provided to land users
- ✓ financial/ material support provided to land users
- subsidies for specific inputs
- credit
- other incentives or instruments

Financial/ material support provided to land users
Financial support comes in the form of improved livestock markets.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	no	yes, little	yes, moderately	yes greatly
Did the Approach empower local land users, improve stakeholder participation? Through the strengthening of community conservation.		✓		
Did the Approach help land users to implement and maintain SLM Technologies? Provide financial incentives and technical support from NRT.			✓	
Did the Approach mobilize/ improve access to financial resources for SLM implementation? Through financing of conservancy operation which supports governance, security and conservation programs ($80,000 over 4 years).				✓
Did the Approach improve knowledge and capacities of land users to implement SLM? Yes through the outreach from NRT grazing management team.			✓	
Did the Approach build/ strengthen institutions, collaboration between stakeholders? Strengthen ties between community conservancies, NRT and private conservancies.		✓		
Did the Approach empower socially and economically disadvantaged groups? Empower marginalized pastoralists through the provision of $1,982,210 over 4 years in income to 14,864 families.				✓
Did the Approach lead to improved food security/ improved nutrition? Through financial provision to pastoral people.			✓	
Did the Approach improve access to markets? This created regional livestock markets with 5,630 cattle bought over 4 years.				✓

Main motivation of land users to implement SLM
- ✓ increased production
- ✓ increased profit(ability), improved cost-benefit-ratio
- ✓ reduced land degradation
- reduced risk of disasters
- reduced workload
- payments/ subsidies
- rules and regulations (fines)/ enforcement
- prestige, social pressure/ social cohesion
- affiliation to movement/ project/ group/ networks
- environmental consciousness
- customs and beliefs, morals
- enhanced SLM knowledge and skills
- aesthetic improvement
- conflict mitigation

Sustainability of Approach activities
Can the land users sustain what had been implemented through the Approach (without external support)?
- ✓ no
- yes
- uncertain

Comment: NRT – Trading is a central actor in the LTM system, and controls the purchasing and movement of cattle, and manages the finances of the sales. The landowners do not purchase, fatten or sell livestock, they rely on NRT.

CONCLUSIONS AND LESSONS LEARNT

Strengths

Land user's view
- Access to a reliable, close, and equitable weight and grade based market for cattle.
- Opportunities to restore and prevent landscape degradation through funding provided to communities, support from NRT, and through the shift towards higher quality beef, which requires improved rangeland management to meet demands.
- Funding for community projects through conservancies.

Key resource person's view
- Strengthening institutions of grazing management, which should improve the ability to implement sustainable rangeland management technologies.
- Creating a shift to a production based focus on livestock management, which should increase livestock quality, and the underlying rangeland productivity.

Weaknesses/ disadvantages/ risks → how to overcome

Land user's view
- Unfair or inequitable pricing of livestock. → Clarity on revenue sharing from NRT – Trading. Prices per weight and grade clear and fair.
- Some pastoralists do not want to sell cattle, and are not motivated by increasing revenue through market-based systems.

Key resource person's view
- Lack of ownership and participation in the NRT LTM may isolate community members and create friction over finances and project ownership.
- Land and resources on the fattening ranches are limited and land invasions have complicated this.

REFERENCES

Compiler: Peter Tyrrell (peterdavidtyrrell@gmail.com)
Resource persons: Patrick Ekodere - SLM specialist
Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/approaches/view/approaches_3435/
Documentation was facilitated by: Book project: Guidelines to Rangeland Management in Sub-Saharan Africa (Rangeland Management)
Date of documentation: March 13, 2018; **Last update:** June 5, 2018

Links to relevant information which is available online
NRT - LTM Website: http://www.nrt-kenya.org/livestock/

WILDLIFE & NATURE TOURISM (AG4)

An environmental education tour in Namib Rand Nature Reserve (Samuel Fernadez-Diekert).

In a nutshell

Short description

Wildlife & nature tourism involves the use and management of the "value of nature and wildlife" in parks, reserves, protected areas and conservancies by providing and managing tourism and collecting revenues from tourists, protecting the land and animals against poaching or interference by other land uses and users. The purpose of wildlife management is to maintain populations of wild animals at levels consistent with the best interest of wildlife, the environment and the public.

A wildlife park (national park, game reserve) is an area of parkland where wildlife can be viewed by visitors driving through. A nature reserve (natural reserve, bio-reserve, preserve, or conserve) is a protected area of importance for wildlife, flora, fauna or features of geological or other special interest, which is reserved and managed for conservation and to provide special opportunities for study or research.

Protected areas pursue wildlife conservation, in which human activities are prohibited or controlled. Wildlife-based tourism includes both non-consumptive forms of wildlife tourism, such as viewing, photography and feeding; and consumptive forms, such as hunting and recreational fishing.

(Community-based) conservancies: re-aggregate the common resource, provide biodiversity conservation, and enhance human livelihoods under increasing pressures from population growth, land use changes, and other forces. It holds as a central concept "the coexistence of people and nature, as distinct from protectionism and the segregation of people and nature" (Galvin et al. 2018).

Principles

- New opportunities seek to incorporate wildlife and protected areas to benefit local people.
- Community conservancies manage rangelands jointly with wildlife, livestock & people.
- A 3-circle approach is often promoted in and around parks: from the centre (1) conservation, to a middle ring for (2) livestock grazing and an outer ring (3) settlement/ cultivation.
- The rich biodiversity and unique attractiveness of the African rangelands provides a great asset for improved marketing and livelihoods of rangeland users.

Most common approaches

Participatory land use planning: e.g. by NamibRand Nature Reserve association with the aim to restore ecosystem function in the reserve.

Community involvement in conservancy management: e.g. Kalama Community Wildlife Conservancy. The main aims are to maintain and/or improve rangeland productivity. Continuous monitoring to guide the management plan.

Improved water availability	
Drinking water (high quality)	n/ap
Domestic use (household)	n/ap
Livestock sedentary	n/ap
Livestock pastoral	+
Rainfed agriculture	+++
Opportunistic irrigation	+++
Supplementary irrigation	+
Irrigation of backyard crops / kitchen gardens	n/ap

Importance: +++ high, ++ medium, + low, +/– neutral, n/ap: not applicable

Community-based wildlife conservation area in Tanzania

Wildlife Management Areas (WMAs) consist of multiple villages designating land for wildlife conservation, and sharing tourism revenues. Nineteen WMAs are currently operating, encompassing 7% of Tanzania's land area, with 19 more WMAs planned (Lee and Bond 2018).

In the Randilen WMA higher densities of giraffes and dik-diks were found (Derek E. Lee).

Community-based conservation (CBC): institutional arrangements to enhance human social well-being and sustain biodiversity. CBC institutions are often exemplified by non-governmental organisations (NGOs), private individuals, and layers of government that represent, facilitate, or at least support local communities in conservation governance and resource management. This offers incentives to sustainably manage natural resources. There are two major CBC organisations operating in Africa (Northern Rangelands Trust, Kenya and Namibian Association of Community Based Natural Resource Management Support Organisations).

Rangeland use system (RUS)
Reported from 'parks, wildlife & nature reserves', and from 'bounded' systems with wildlife.

Main benefits
- High incomes and profitability.
- Wildlife conservation, preservation and diversity of species and natural beauty.
- Maintenance of ecosystem.
- Soil and water conservation.
- In hyper-arid regions, tourism is more profitable and sustainable than agriculture.

Main disadvantages
- Lack of adherence to, and enforcement of, grazing rules limits the success of sustainable land management efforts.
- Wildlife poaching
- Conflict between livestock and wildlife- and diseases can be easily transmitted.
- Paying community members to undertake restoration activities may lead to a reliance on donor funding for land restoration.
- Actual and potential contributions of wildlife to rural economies are often not recognised.

Applicability and adoption
Wildlife management is recognised by governments as a viable option in the designation of land for various uses. The unique wildlife and nature of the African rangelands is a key asset and offers possibility and potential in many ways for improved management of the rangelands. National parks can be found in a large majority of African countries, being most numerous in Gabon, Kenya and Tanzania. Some nations also have considerable areas designated as private parks, game reserves, forest reserves, marine reserves, national reserves and natural parks.[1]

Sub-Saharan Africa has adopted community-based conservation institutions in the last 30 years as a means to combine rural development and conservation efforts within the context of decentralised authority over land and natural resources (Galvin et al. 2018). Community-based conservation are being rapidly adopted in diverse institutional forms across multiple countries.

In West Africa most of the endangered species and highly biodiverse habitats are confined to protected areas.[2] Wildlife parks and tourism are less common, but their potential could be further explored.

The Northern Rangelands Trust (NRT), Kenya
NRT is a group of more than 30 CBCs covering 42,000 km^2 of northern and coastal Kenya, home to around 320,000 people belonging to 18 different ethnic groups. NRT's mission is to develop resilient community conservancies, which transform people's lives, secure peace and conserve natural resources. CBCs have a vital role to play in protecting wildlife in northern Kenya.

The NRT Board is accountable to an over-arching Council of Elders, which comprises the elected chairpersons of all the member conservancies. The democratically elected chairs of the conservancies make up the majority, and are joined by institutional members representing county councils, local wildlife forums, Kenya Wildlife Service (KWS) and the private sector. The Council guides NRT policy and is responsible for drawing up the bylaws for its operation and administration.
http://www.nrt-kenya.org/

Inter-conservancy peace meeting (©2016 NRT).

Conservation Approach for Kouré Giraffes, Niger
This participatory approach – to protect the last population of white giraffes – actively involves local people in conservation activities, while simultaneously strengthening local development and promoting ecotourism. A main pillar was the transfer of responsibilities in natural resources management to local organisations. User groups, a guides' association, a project steering committee, etc. were formed and trained. Thanks to the protection of the "brousse tigré" savannah vegetation through enclosures for regeneration, prohibition of cutting and closing down of rural wood markets, the giraffe population has recovered considerably.
https://qcat.wocat.net/en/summary/2568/

Giraffes around the village of Kouré, Niger (Ahmed Oumarou and ECOPAS).

[1] https://en.wikipedia.org/wiki/List_of_national_parks_in_Africa
[2] https://eros.usgs.gov/westafrica/biodiversity-protected-areas

Characteristic hill range of Kalama Community Wildlife Conservancy, from which Kalama's name is derived (Hanspeter Liniger).

Holistic Rangeland Management combined with high-end tourism (Kenya)

'Ramat engop'

DESCRIPTION

The establishment of a community wildlife conservancy facilitates (1) 'holistic rangeland management' refering to a to the implementation of a suite of management practices aimed at sustaining and/or improving rangeland productivity such as 'bunched grazing' (livestock concentrated for short duration intensive grazing), short-term 'bomas' (livestock corrals occupied for ~7 days), clearing invasive species and reseeding with grass to assist land rehabilitation/restoration; and (2) High end tourism and monetary donations facilitated by the Northern Rangelands Trust provide funding for the implementation of improved grazing practices and additional income for the community and the reduction of livestock grazing pressure.

Kalama Community Wildlife Conservancy has been established with a hierarchical structure led by a board of 13 members (5 female, 8 male), one representing each of the 13 'zones' of the Conservancy. There are also three subcommittees for grazing, finances and tourism. The main aims are to improve the involvement of the community members in the overall management of the conservancy, the generation of additional income from high end tourism and wildlife conservation and the investment into improved land management. The main sources of funding are revenue from contracted high end tourism operation and donations (facilitated by Northern Rangelands Trust). The approximate breakdown of the funding sources is: Tourism including selling of handicrafts (60%), Donors (25%), County Government (5%), Livestock Trading (5%), Camping (5%). Improved livelihood and ownership in the management as well as shared responsibility and benefits are key incentives for the community members.

Within the conservancy an attractive site on a hill overlooking the plains has been leased to an investor for the establishment of an exclusive tourist lodge on the principle of 'invest, operate and transfer', where the investor builds the infrastructure operates is for an agreed period and then transfers it to the community. Further several comping grounds are available for lower budget tourists. The conservancy profits from the neighbouring Samburu Game Reserves. This provides regular income from the lease of the land the entrance fees into the conservancy, employment opportunities for conservancy members (for catering, kitchen, house cleaning, rangers providing security for tourists and protection for wildlife as well as guides for safaris and for entertainment) and a market for selling handicrafts and souvenirs. Another cornerstone is their relationships with two trusts (Northern Rangeland Trust and the Grevy's Zebra Trust). They have been supportive in the implementation of several holistic rangeland management practices, which include 'bunched grazing' (livestock concentrated for short duration intensive grazing), short-term 'bomas' (livestock corrals occupied for ~7 days), clearing invasive species and reseeding with grass to assist land rehabilitation/restoration. The main aims are to maintain and/or improve rangeland productivity. Regarding methods, 'bunched grazing' is implemented by a team of herders ensuring the livestock are in a tight herd. Short-term 'bomas' are established on bare ground in the traditional manor (i.e. laying cut thorny

LOCATION

Location: North of Archers Post Bordering Samburu Game Reserve. Samburu County. Kenya.

Geo-reference of selected sites
- 37.562250, 0.690056

Initiation date: 2006

Type of Approach
- traditional/ indigenous
- recent local initiative/ innovative
- ✓ project/ programme based

The wildlife and picturesque views attract high end tourists (Hanspeter Liniger).

Livestock corrals built from cut invasive plant occupied for only 7 days to aid rehabilitation (Hanspeter Liniger).

woody vegetation on the ground to encircle livestock and help protect them from depredation during the night). Invasive woody vegetation can be used to erect these 'bomas'. Invasive species (predominantly Acacia reficiens) is cleared by hand using machetes during the dry season; branches cut ~1 m above the ground to prevent regrowth. Cut branches are laid on the bare ground beneath and seeds of Cenchrus ciliaris hand-broadcasted prior to the onset of rains. Members of the Kalama Community Wildlife Conservancy carry out these activities, both paid (clearing invasive species and reseeding) and unpaid ('bunched grazing' and short-term 'bomas'). Land users and tourists enjoy and value the benefits of increased forage availability in areas successfully rehabilitated but are dissatisfied with the limited extent of the rangeland improvement.

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims/ objectives of the approach

The main objectives of the approach are to maintain and/or improve rangeland productivity.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** Established traditional practice of erecting 'bomas', particularly using less valuable woody vegetation, facilitates implementation of short-term 'bomas' that only require a change in duration of occupancy.
- **Availability/ access to financial resources and services:** Supplementary income can lead to investment in activities unrelated to livestock husbandry (e.g. setting up small businesses or educating children) rather than increasing heard size, which may prevent further increases in pressure on the rangeland.
- **Collaboration/ coordination of actors:** Clearing of invasive species and reseeding with grass undertaken by land users from all villages/zones of the Kalama Community Wildlife Conservancy.
- **Legal framework (land tenure, land and water use rights):** To some extent provides sense of ownership over the land, which may motivate involvement in sustainable land management practices.
- **Land governance (decision-making, implementation and enforcement):** Community-elected board (representative of the 13 villages/zones) and grazing committee together enable formalisation of grazing rules into by-laws.
- **Knowledge about SLM, access to technical support:** Access to technical support from NGOs such as the Northern Rangelands Trust and Grevy's Zebra Trust.
- **Markets (to purchase inputs, sell products) and prices:** Located close to livestock market in the local town, Archer's Post.
- **Workload, availability of manpower:** Casual labour easily found within the community.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** Traditional practices of herding one's own immediate family's livestock in separate herds deters land users from agreeing to combine herds into larger groups for 'bunched grazing' (also due to associated issues of disease transmission). Furthermore, lack of observation and enforcement of local grazing rules prevents necessary resting of grazing land.
- **Availability/ access to financial resources and services:** Supplementary income often leads to the purchasing of more livestock, which further increases pressure on the rangeland.
- **Collaboration/ coordination of actors:** Individual concerns are at odds with that of the wider community, leading to opportunistic breaking of grazing rules and deterioration of communally managed rangeland.
- **Legal framework (land tenure, land and water use rights):** Tenure of of the land is communal but livestock ownership is individual or at the level of immediate families, which creates tensions and conflicts regarding sustainable land management.
- **Land governance (decision-making, implementation and enforcement):** Grazing rules and by-laws not well implemented or adhered to.
- **Knowledge about SLM, access to technical support:** Lack of knowledge about SLM has lead to unsuccessful grassland rehabilitation efforts.

- **Markets (to purchase inputs, sell products) and prices:** Limited direct access to markets further afield (e.g. Nairobi or international markets), with better prices.
- **Workload, availability of manpower:** Large areas of land awaiting rehabilitation, which would require large amounts of labour.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders/ implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	Local land users selected from villages/ zones within the community of the conservancy.	Providing livestock for joint herding and boma-ing and providing labour for restoration activities (e.g. clearing invasive species and reseeding with grass). Provide services for the running of the wildlife conservancy and tourist activities.
SLM specialists/ agricultural advisers	Advisors from the two trusts: Northern Rangeland Trust and Grevy's Zebra Trust for the support in the design and the implementation of the improved rangeland management practices.	Providing technical knowhow and sharing experiences with other rangeland users where the practices have been applied.
researchers	Master students from the universities in Kenya.	Investigating into the state of the rangelands and monitoring changes.
NGO	Northern Rangelands Trust and Grevy's Zebra Trust.	Provided funds for learning visits to a ranch implementing 'Holistic Rangeland Management' in Zimbabwe and costs of implementation in Kalama Community Wildlife Conservancy. Also provided technical support.
local government	County government employees related to tourism and management of Samburu Game Reserve.	Making agreements for the use and sharing of income from tourism.
international organisation	Northern Rangeland Trust: Grevy's Zebra Trust.	Joint planning of land management across the boundaries of the Community Wildlife Conservancy. Agreement for movement across boundaries and sharing of common resources.

Lead agency

Kalama Wildlife Community Conservancy.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	Specify who was involved and describe activities
initiation/ motivation				✓		Using their experience setting up other community conservancies in Kenya, the Northern Rangelands Trust was able to assist in defining the organisational structure of Kalama Conservancy. However, conservancies are not set up without the interest of the community in question.
planning				✓		Kalama Conservancy's board, which plans the Holistic Rangeland Management activities, is composed of members of Kalama Conservancy and those elected by the members of the conservancy. The Northern Rangelands Trust, in particular, helps to plan activities. For example, the Northern Rangelands Trust raised funds to enable members of Kalama Conservancy to visit a ranch in Zimbabwe where Holistic Rangeland Management activities are practiced.
implementation				✓		Members of Kalama Conservancy carry out the Holistic Rangeland Management activities. However, 25% of the costs are covered by donations and training related to specific activities is provided by Northern Rangelands Trust and Grevy's Zebra Trust.
monitoring/ evaluation				✓		The Northern Rangelands Trust commissioned a baseline survey of rangeland health in Kalama Conservancy, which was conducted in 2013. However, the Rangeland Coordinator, Benson Lelukai, was also trained by Northern Rangelands Trust to conduct informal rangeland health monitoring. As yet, no reports are available documenting the success or otherwise of the approach.

Decision-making on the selection of SLM Technology

Decisions were taken by
- ☐ land users alone (self-initiative)
- ☐ mainly land users, supported by SLM specialists
- ☐ all relevant actors, as part of a participatory approach
- ☑ mainly SLM specialists, following consultation with land users
- ☐ SLM specialists alone
- ☐ politicians/ leaders

Comment: The Holistic Rangeland Management activities are closely modeled on those advocated by the Savory Institute. The Northern Rangelands Trust facilitated the introduction of the practices (e.g. bunched grazing and more frequently moved livestock corrals), which were implemented following consultation with Kalama Conservancy's members.

Decisions were made based on
- ☐ evaluation of well-documented SLM knowledge (evidence-based decision-making)
- ☐ research findings
- ☑ personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE

The following activities or services have been part of the approach
- ☑ Capacity building/ training
- ☑ Advisory service
- ☑ Institution strengthening (organisational development)
- ☑ Monitoring and evaluation
- ☐ Research

Capacity building/ training

Training was provided to the following stakeholders
- ☑ land users
- ☐ field staff/ advisers
- ☐ forum

Form of training
- ☐ on-the-job
- ☐ farmer-to-farmer
- ☐ demonstration areas
- ☑ public meetings
- ☐ courses

Advisory service

Advisory service was provided
- ☐ on land users' fields
- ☐ at permanent centres
- ☑ personal communication

Comment: The community work closely with Northern Rangelands Trust, which can provide advice.

Institution strengthening

Institutions have been strengthened/ established
- ☐ no
- ☐ yes, a little
- ☑ yes, moderately
- ☐ yes, greatly

at the following level
- ☑ local
- ☐ regional
- ☐ national
- ☐ transboundary level

Describe institution, roles and responsibilities, members, etc.
Establishment of board and grazing committee facilitate conservancy-level decisions.

Type of support
- ☑ financial
- ☑ capacity building/ training
- ☐ equipment

Further details
Northern Rangelands Trust provide financial assistance (USAID funding) and training together with Grevy's Zebra Trust (FAO funding).

Monitoring and evaluation
But, so far, monitoring is informal and available documentation reporting outcomes of the approach is limited.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
- ☐ < 2,000
- ☐ 2,000-10,000
- ☑ 10,000-100,000
- ☐ 100,000-1,000,000
- ☐ > 1,000,000

Precise annual budget: 24,447.00

Main sources of funding are revenue from contracted high end tourism operation and donations (facilitated by Northern Rangelands Trust). Rough breakdown: Tourism including selling of handicrafts (60%), Donors (25%), County Government (5%), Livestock Trading (5%), Camping (5%).

The following services or incentives have been provided to land users
- ☑ financial/ material support provided to land users
- ☑ subsidies for specific inputs
- ☐ credit
- ☐ other incentives or instruments

Financial/ material support provided to land users
Financial support provided to cover costs associated with activities (e.g. labour, logistics)

	partly financed	fully financed
labour		✓
logistics (fuel)		✓

Labour by land users was

- ☐ voluntary
- ☐ food-for-work
- ☑ paid in cash
- ☐ rewarded with other material support

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	no	yes, little	yes, moderately	yes greatly
Did the Approach empower local land users, improve stakeholder participation? Restoration efforts hired labour from all zones of the conservancy.			✓	
Did the Approach enable evidence-based decision-making? Some monitoring is conducted but informal and not comprehensive.		✓		
Did the Approach help land users to implement and maintain SLM Technologies? The organisational structure of the conservancy provided a framework for inter-village coordination with respect to SLM.				✓
Did the Approach improve coordination and cost-effective implementation of SLM? The organisational structure of the conservancy provided a framework for inter-village coordination with respect to SLM.			✓	
Did the Approach mobilize/ improve access to financial resources for SLM implementation? Substantial income from tourism allowed investment into improved rangeland management.				✓
Did the Approach improve knowledge and capacities of land users to implement SLM? Training provided by the conservancy's institutional partners (NRT and GZT) contributed to developing SLM capacity.			✓	
Did the Approach improve knowledge and capacities of other stakeholders? Learning visits to rangeland restoration sites invited members of other communities around the country to be exposed to restoration practices and their impacts.		✓		
Did the Approach build/ strengthen institutions, collaboration between stakeholders? The organisational structure of the conservancy provided a framework for inter-village collaboration.			✓	
Did the Approach mitigate conflicts? Job creation mitigated conflicts, particularly the jobs made available to young warrior class individuals (e.g. motorbike driver), who would otherwise be arming themselves and rustling livestock.			✓	
Did the Approach empower socially and economically disadvantaged groups? No particular measures to benefit socially disadvantaged groups was mentioned.	✓			
Did the Approach improve gender equality and empower women and girls? Bead-work markets facilitated by NRT created income opportunities for women.		✓		
Did the Approach encourage young people/ the next generation of land users to engage in SLM? Young people were also involved in the rangeland restoration efforts.			✓	
Did the Approach improve issues of land tenure/ user rights that hindered implementation of SLM Technologies? The conservancy structure provides land tenure security and increases the motivation to practice SLM.		✓		
Did the Approach lead to improved food security/ improved nutrition? The increased income through tourism and donor funding may have led to improved food security/nutrition, but difficult to judge.		✓		
Did the Approach improve access to markets? NRT create a market for their livestock by buying and selling to ranchers for fattening programmes.				✓
Did the Approach lead to improved access to water and sanitation? Donor funding enabled the establishment of a clinic, which has greatly increased access to health care.				✓
Did the Approach lead to more sustainable use/ sources of energy? No reported change in energy sources.	✓			

Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters? ☑ ☐ ☐ ☐

Over such a short period, this is difficult to make any statements about.

Did the Approach lead to employment, income opportunities? ☐ ☐ ☐ ☑

The conservancy structure creates jobs such as: managerial, committee membership, accounting, security, temporary labour.

Main motivation of land users to implement SLM

- ☑ increased production
- ☐ increased profit(ability), improved cost-benefit-ratio
- ☑ reduced land degradation
- ☐ reduced risk of disasters
- ☐ reduced workload
- ☑ payments/ subsidies
- ☐ rules and regulations (fines)/ enforcement
- ☐ prestige, social pressure/ social cohesion
- ☐ affiliation to movement/ project/ group/ networks
- ☐ environmental consciousness
- ☐ customs and beliefs, morals
- ☐ enhanced SLM knowledge and skills
- ☑ aesthetic improvement
- ☐ conflict mitigation
- ☑ improved attractiveness for tourism and fodder for wildlife

Comment: Initial costs for the establishment of the practices (e.g. cutting of invasive species are fully covered through income and resources from tourism and support from the trusts aesthetic improvement attractive landscape less degraded and monotonous due to one invasive species.

Sustainability of Approach activities

Can the land users sustain what had been implemented through the Approach (without external support)?

- ☐ no
- ☐ yes
- ☑ uncertain

Comment: Lack of funding prevents larger areas from being rehabilitated through clearing of invasive species and reseeding with grass. Moreover, inability to control grazing pressure to give adequate rest to rehabilitating areas has led to unsuccessful restoration efforts. However, restoration efforts may gradually become voluntary in the future and land users may be insentience to adhere to local grazing rules.

CONCLUSIONS AND LESSONS LEARNT

Strengths

Land user's view

- Land previously considered unproductive is now considered grazing land.
- Increased infiltration, reduced run-off and soil erosion.
- Regeneration of the grassland in the 'core conservation area' (a central area with minimised grazing pressure demarcated for tourism) attracts wildlife, which in turn benefits tourism.

Key resource person's view

- Where implemented, restoration activities and reduced grazing pressure have increased productivity and diversity or grasses and forbs for livestock and wildlife forage.
- Takes advantage of inherent capacity of the land to recover.
- Improved attractiveness for tourism.

Weaknesses/ disadvantages/ risks → *how to overcome*

Land user's view

- The expectation from the community regarding the tourism-related jobs and income are too high. → Raising awareness about the limitations of benefits from tourism.
- Increased pressure on 'Core Area' due to higher grass/ forage production. → Strictly enforce local by-laws that restrict grazing in the 'Core Area'.
- Rangers under-equipped and lack sufficient capacity. → Source more equipment and provide training/capacity building for rangers.

Key resource person's view

- Very few land users are implementing the practices (e.g. shortterm 'bomas' and 'bunched grazing'). → Although likely unfeasible, one possible solution might be for the community to manage the livestock communally and share the produce rather than individual ownership, which creates conflicts in motivation between the individual and the wider community.
- Paying community members to undertake restoration activities has limited the area rehabilitated to date and led to a reliance on donor funding for land restoration. This may also be eroding the community's social capital by placing a monetary value on land health and thus devaluing it and replacing the inherent sense of value of land health that may have existed previously. → Encouraging voluntary participation in restoration activities may not only increase the area rehabilitated but also improve long-term maintenance through cultivating a sense of ownership.
- Lack of adherence to and enforcement of grazing rules limits the success of sustainable land management efforts. → Strictly enforce local grazing rules and by-laws.

REFERENCES

Compiler: Harry Wells (harrybmwells@gmail.com)

Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/approaches/view/approaches_3399/

Linked SLM data: SLM Technology: Rangeland Restoration by cutting invasive species and grass reseeding and managing grazing https://qcat.wocat.net/en/wocat/technologies/view/technologies_3381/

Date of documentation: Feb. 19, 2018; **Last update:** May 6, 2018

Key references

Northern Rangeland Trust: Baseline assessment of rangeland health - Kalama and Namunyak conservancies, Leigh A. Winowiecki & Tor-G. Vågen2014: Available online at no cost.

Links to relevant information which is available online

Northern Rangeland Trust: Baseline assessment of rangeland health - Kalama and Namunyak conservancies: https://cgspace.cgiar.org/bitstream/handle/10568/65671/nrtReport_march2014.pdf?sequence=1

Plains zebras on fairy circles in the NamibRand Nature Reserve (George Steinmetz).

Restoration of game migration routes across the Namib Desert (Namibia)

NamibRand Nature Reserve

DESCRIPTION

Seventeen former sheep farms have been joined to form the world's largest private nature reserve aimed at regenerating biodiversity to support high-quality low-impact tourism, environmental education and research. All farm owners are members of the management association.

The NamibRand Nature Reserve is a not-for-profit organisation in south-western Namibia. It was founded in 1984 through the initiative of one farm owner, Albi Brueckner, who agreed, with 16 neighbouring farmers, to jointly manage their 215,000 ha for nature conservation and tourism. Its aims are:

- To conserve biodiversity for the benefit of future generations and protect the sensitive and fragile environment.
- To create a nature reserve with a healthy and functioning ecosystem, providing a sanctuary for flora and fauna, and to facilitate seasonal migratory routes in partnership with neighbours.
- To promote sustainable utilisation – through ecologically sustainable and high-quality tourism and other projects.
- To achieve a commercially viable operation to ensure continuity and financial independence.

The NamibRand Nature Reserve's contributions to biodiversity conservation, in accordance with the environmental management plan, include the following:

- Removal of over 2,000 km of fencing to reinstate wildlife migration routes.
- Re-introduction of giraffe and cheetah.
- Bolstering numbers of red hartebeest and plains zebra.
- Removal of alien invasive vegetation such as Prosopis species and replacing these with indigenous Acacias.
- Zonation according to land use areas, including the setting aside 15% of the reserve as a wilderness area.
- Limiting overnight visitors to an average of one bed per 1,000 ha, and 25 beds per location.
- Conducting annual game counts, with results posted on the website www.namibrand.org
- Monitoring the endemic Hartmann's mountain zebra through the use of camera traps. Results are at: http://www.nnf.org.na/project/mountain-zebra-project/13/1/12.html
- Continuous monitoring of drivers and determinants of environmental change to guide the management plan. Results are posted online at: http://www.landscapesnamibia.org/sossusvlei-namib/rainfall-monitoring

LOCATION

Location: Southwestern Namibia in the Namib Desert., Namibia

Geo-reference of selected sites
- 15.98915, -25.00452

Initiation date: 1984

Type of Approach

- ☐ traditional/ indigenous
- ☑ recent local initiative/ innovative
- ☐ project/ programme based

Comment: The first property was purchased in 1984. The reserve was registered as a Game Reserve in 1992 and registered as the NamibRand Nature Reserve, an Association Not for Gain, in 2002.


School pupils on an environmental education tour (Samuel Fernadez-Diekert).


Participants of a vulture awareness workshop (Lee Tindall).

- Hosting researchers to study game migration routes. Results of wildlife monitoring, through the use of GPS collars are at: http://www.landscapesnamibia.org/sossusvlei-namib/research
- Hosting the Namib Desert Environmental Education Trust (NaDEET), to empower and educate schoolchildren for a sustainable future. It operates an environmental education and sustainable living centre (www.nadeet.org).
- A lighting management plan to qualify as an international dark sky reserve that avoids negative consequences of light pollution on biodiversity – which can interfere with animal navigation, reduce the hunting success of predators and prevent moths from pollinating (http://www.darksky.org/idsp/reserves/namibrand)
- A water management plan, including monitoring of the impact of a water hole on the surrounding vegetation.
- Implementation of tourism and land use zonation plans.
- Capture and sale of live game for wildlife population management purposes.
- Plans to develop a horticultural project to grow indigenous medicinal plants for commercial production, creating local jobs and income for conservation.

Rangeland management is achieved largely through continual monitoring and control of animal populations, and the balance between functional groups of their species, and turning off the water supply where grasses are in need of rest. Local outreach efforts focus mainly on predator-livestock management on neighbouring farms.

Stakeholders comprise the land owners, who agree on joint management, and the tourism concessionaires who operate in the reserve under contract. The reserve employs 12 people who are responsible for day-to-day management and maintenance. Biodiversity and land management are funded from park fees collected by the concessionaires from tourists who stay at their establishments. This small management team is possible, because tourism concessionaires offer scenic game drives across the reserve, while on the lookout for required action. For example, guides report issues such as leaking water pipes, unusual wildlife sightings, injured animals, and trespassers (etc.) to reserve managers, who can then react.

Land owners who have connected their land to the reserve and are members of the NamibRand Nature Reserve Association have the option of serving as directors of the association, with joint decision making powers. Those who choose not can still contribute to the strategic mission of the reserve at annual general meetings.

APPROACH AIMS AND ENABLING ENVIRONMENT

Main aims/ objectives of the approach

The approach aims, through participatory land use planning, to restore ecosystem function in the reserve and its surroundings to support high-quality, low-impact tourism that provides the means to support environmental education and other conservation projects. The overall Strategic Vision of the NamibRand Nature Reserve is to manage the Pro-Namib area, alongside the Namib Desert, for the enhanced conservation of the landscape and its biodiversity.

Conditions enabling the implementation of the Technology/ ies applied under the Approach

- **Social/ cultural/ religious norms and values:** The area was historically visited by migrant San people and more recently by Nama people, who have settled permanently elsewhere. Since no people were living permanently in this hyper-arid ecosystem, the use of the area exclusively for nature conservation remains uncontested.
- **Availability/ access to financial resources and services:** The establishment of the reserve was initially possible through the ample financial resources of wealthy, altruistic and philanthropic investors.
- **Institutional setting:** Progressive government company laws, such as the possibility to register a Section 21 company (‘Association Not for Gain’) allow financial resources to be re-invested in conservation so as to further the objectives of the non-profit association. Section 21 companies also do not have to pay company taxes to the government.
- **Collaboration/ coordination of actors:** Articles of Association and the management plan allow for the creation of a management team that effectively coordinates all activities on the reserve.
- **Legal framework (land tenure, land and water use rights):** Rights and therefore the possibility to benefit from wildlife are enshrined in the Nature Conservation Ordinance of 1975.

- **Policies:** Progressive, enabling policies of the Ministry of Environment and Tourism, such as the tourism policy and the parks and neighbours policy ensure meaningful collaborations between the public and the private sector. See http://www.met.gov.na
- **Land governance (decision-making, implementation and enforcement):** Good governance is achieved through the adoption of Articles of Association and management plans. These guide decision-making and enable implementation. A set of rules, called the Vade Mecum, enable enforcement.
- **Knowledge about SLM, access to technical support:** Good networking, membership to various professional bodies and collaboration with universities and researchers ensure good knowledge about sustainable land management and technical support.
- **Markets (to purchase inputs, sell products) and prices:** A well-established tourism market to Namibia ensures a steady stream of visitors to the NamibRand Nature Reserve, enabling the collection of park fees and thus ensuring income for the reserve.
- **Workload, availability of manpower:** Guides from tourism concessions on the reserve allow for sharing of workloads. Availability of human resources in the region is ample.

Conditions hindering the implementation of the Technology/ ies applied under the Approach

- **Availability/ access to financial resources and services:** The properties that make up the NamibRand Nature Reserve are located in a hyper-arid ecosystem. Farmers who attempted livestock farming there in the past almost all failed to establish economically viable farms, and most of them overextended themselves financially, resulting in the foreclosure of their farms. For this reason, the area became known as the 'Bankruptcy Belt'. Banks were, in the past, extremely reluctant to extend loans to landowners in this area, due to the low value and low agricultural potential. In recent years, the successes of conservation and tourism have changed this situation and banks are now prepared to accept farms with such land use as collateral for extending loans.
- **Legal framework (land tenure, land and water use rights):** The current Nature Conservation Ordinance of 1975 does not allow for the registration of private nature reserves. The status of the land with the government thus remains as agricultural land, and law enforcement has to rely on common law such as trespassing on private property.
- **Markets (to purchase inputs, sell products) and prices:** The remoteness of the reserve, 150km from the nearest town, results in expensive transport charges for goods and inflated prices for professional services.

PARTICIPATION AND ROLES OF STAKEHOLDERS INVOLVED

Stakeholders involved in the Approach and their roles

What stakeholders/ implementing bodies were involved in the Approach?	Specify stakeholders	Describe roles of stakeholders
local land users/ local communities	17 former livestock farms owned by 12 companies, now converted to tourism enterprises.	Some of them serve as directors of the NamibRand Nature Reserve Association, for joint decision making.
SLM specialists/ agricultural advisers	12 reserve management staff.	To manage the reserve.
researchers	Visiting researchers from various academic institutions.	To conduct research to help with applied research for management and 'interest research' such as on 'fairy circles'", which can be seen in the cover photo. The origin of these circles of bare soil surrounded by grass is still being disputed among scientists (https://www.youtube.com/watch?v=2VNyo9AoA8I). There is a Wildlife monitoring programme partnership with Namibia University of Science and Technology and the Greater Sossusvlei Landscape Association.
teachers/ school children/ students	4 full-time teachers at NADEET and 10 instructors at hospitality training centre.	To expose about 1,000 visiting students per year to environmental education and to provide vocational training to about 100 trainees per year.
NGO	Cheetah Conservation Fund and Giraffe Conservation Fund.	To reintroduce predators and wild herbivore species.
private sector	Neighbouring farms.	Co-management of the larger landscape with like-minded neighbours, as indicated at: http://www.landscapesnamibia.org/sossusvleinamib/.
national government (planners, decision-makers)	Ministry of Environment and Tourism.	To assist with law enforcement and wildlife monitoring.
international organisation	Member of IUCN.	For advocacy and knowledge sharing.

Involvement of local land users/ local communities in the different phases of the Approach

	none	passive	external support	interactive	self-mobilization	Specify who was involved and describe activities
initiation/ motivation					✓	The founding farm owner approached philanthropic donors to buy neighbouring farms and invest in tourism facilities and environmental education centre.
planning			✓			In 1991, external experts provided advice for planning of the reserve. Influential persons involved included Chris Brown, Hugh Berry and Haino Rumpf of the Ministry of Environment, and Mary Seely of the Desert Research Foundation.
implementation					✓	Management staff were appointed in 1991, and paid for from the conservation levy raised from use of tourism facilities in the reserve.
monitoring/ evaluation					✓	Reserve management staff do the monitoring, paid for by the conservation levy.
research			✓			Research institutions conduct research after paying a small service fee.

Decision-making on the selection of SLM Technology

Decisions were taken by

- ☐ land users alone (self-initiative)
- ✓ mainly land users, supported by SLM specialists
- ☐ all relevant actors, as part of a participatory approach
- ☐ mainly SLM specialists, following consultation with land users
- ☐ SLM specialists alone
- ☐ politicians/ leaders

Comment: The Reserve's vision and mission were set up by its directors, who comprise farm owners willing to serve in this decision making role, at the Initiation workshop in 1991. Management actions were then Implemented under the guidance of various specialists.

Decisions were made based on

- ✓ evaluation of well-documented SLM knowledge (evidence-based decision-making)
- ✓ research findings
- ✓ personal experience and opinions (undocumented)

TECHNICAL SUPPORT, CAPACITY BUILDING, AND KNOWLEDGE

The following activities or services have been part of the approach

- ✓ Capacity building/ training
- ✓ Advisory service
- ✓ Institution strengthening (organisational development)
- ✓ Monitoring and evaluation
- ✓ Research

Capacity building/ training

Training was provided to the following stakeholders

- ✓ land users
- ✓ field staff/ advisers
- ✓ tourism concessionaires

Form of training

- ✓ on-the-job
- ☐ farmer-to-farmer
- ✓ demonstration areas
- ✓ public meetings
- ☐ courses
- ✓ exchange visits

Subjects covered

Biodiversity conservation, financial management, tourism best practices, principles of co-management, human-wildlife conflict resolution, rehabilitation.

Advisory service

Advisory service was provided

- ✓ on land users' fields
- ✓ at permanent centres

Comment: Advice is provided by the Namibia Chamber of Environment, the Namibia Nature Foundation, the Ministry of Environment and Tourism Resource Centre, the Namibia University of Science and Technology, the Giraffe Conservation Fund and other wildlife biologists on issues such as determination of wildlife carrying capacities.

Institution strengthening

Institutions have been strengthened/ established

- ☐ no
- ☐ yes, a little
- ☐ yes, moderately
- ✓ yes, greatly

at the following level

- ✓ local
- ☐ regional
- ☐ national
- ☐ transboundary level

Describe institution, roles and responsibilities, members, etc.

NamibRand Nature Reserve Association. All land owners are members, who elect the directors. They manage the reserve according to an agreed strategy.

Type of support
- [x] financial
- [ ] capacity building/ training
- [ ] equipment

Further details
Hiring of lawyers and auditors/accountants to establish the association.

Monitoring and evaluation
Impacts are monitored to feed back into management.

Research

Research treated the following topics
- [ ] sociology
- [ ] economics/ marketing
- [x] ecology
- [ ] technology

Further details
Determination of wildlife carrying capacities by wildlife biologists.

FINANCING AND EXTERNAL MATERIAL SUPPORT

Annual budget in USD for the SLM component
- [ ] < 2,000
- [ ] 2,000-10,000
- [ ] 10,000-100,000
- [x] 100,000-1,000,000
- [ ] > 1,000,000

Comment: Self funded from conservation levy collected from tourism income.

IMPACT ANALYSIS AND CONCLUDING STATEMENTS

Impacts of the Approach

	no	yes, little	yes, moderately	yes greatly
Did the Approach empower local land users, improve stakeholder participation? Interest in owning land has greatly increased. Land prices have risen and more tourism establishments were built.				✓
Did the Approach enable evidence-based decision-making? Through monitoring, to determine wildlife carrying capacity.			✓	
Did the Approach help land users to implement and maintain SLM Technologies? Research and expert advice drives appropriate management for the ecology. There are no more sheep and associated weeds, while wildlife numbers increased.				✓
Did the Approach improve coordination and cost-effective implementation of SLM? By applying economies of scale. Managed holistically by a small, effective team.				✓
Did the Approach mobilize/ improve access to financial resources for SLM implementation? Through awarding of tourism concessions and collection of park fees.				✓
Did the Approach improve knowledge and capacities of land users to implement SLM? Through various training and research activities.				✓
Did the Approach improve knowledge and capacities of other stakeholders? Through accessing information and gaining knowledge from research.				✓
Did the Approach build/ strengthen institutions, collaboration between stakeholders? Through establishment of the association, appointment of the management team and information sharing.				✓
Did the Approach mitigate conflicts? Through implantation of a joint management plan and shared vision.				✓
Did the Approach empower socially and economically disadvantaged groups? There are no local communities living within the area, but children from all over the country visit the environmental education centre.		✓		
Did the Approach improve gender equality and empower women and girls? Through policies prohibiting gender discrimination, implemented by tourism enterprises.			✓	
Did the Approach encourage young people/ the next generation of land users to engage in SLM? Through the environmental education and vocational training centres.			✓	
Did the Approach improve issues of land tenure/ user rights that hindered implementation of SLM Technologies? Through establishment of the Association for joint management and guidelines that are followed in the management plan.		✓		
Did the Approach lead to improved food security/ improved nutrition? Through the organic garden of 1 ha irrigated with borehole water and featuring in one of the Youtube videos, the improved financial status of the area and access to meat of culled animals for reserve workers and tourists.			✓	

Did the Approach improve access to markets?
Due to serving tourism needs. ✓

Did the Approach lead to improved access to water and sanitation?
Workers have access to borehole water pumped for tourism. ✓

Did the Approach lead to more sustainable use/ sources of energy?
Solar power is used to generate electricity and heat water. ✓

Did the Approach improve the capacity of the land users to adapt to climate changes/ extremes and mitigate climate related disasters?
Based on naturally adapted species that are able to migrate. ✓

Did the Approach lead to employment, income opportunities?
The current land use based on tourism supports times more employees per unit area compared with former sheep farming. ✓

National economy: Contribution to national income through higher wages in the tourism industry. ✓

Main motivation of land users to implement SLM

- [ ] increased production
- [x] increased profit(ability), improved cost-benefit-ratio
- [x] reduced land degradation
- [x] reduced risk of disasters
- [x] reduced workload
- [ ] payments/ subsidies
- [ ] rules and regulations (fines)/ enforcement
- [x] prestige, social pressure/ social cohesion
- [ ] affiliation to movement/ project/ group/ networks
- [x] environmental consciousness
- [ ] customs and beliefs, morals
- [x] enhanced SLM knowledge and skills
- [x] aesthetic improvement
- [x] conflict mitigation
- [x] philanthropic

Sustainability of Approach activities
Can the land users sustain what had been implemented through the Approach (without external support)?

- [ ] no
- [x] yes
- [ ] uncertain

Comment: Through income largely derived from tourism and partly from sale of captured game animals in accordance with the environmental management plan.

CONCLUSIONS AND LESSONS LEARNT

Strengths

Land user's view

- The reserve is centrally and holistically managed by a team.
- Resilience attained by the large unfenced ecosystem.
- Land users coming together to sign and form a legally recognised body that is more robust.
- Tourism is more profitable and sustainable than agriculture for such a hyper arid region.

Key resource person's view

- Resilience to climate change through natural resources, using the competitive advantage of nature.
- Private property excludes communal demands and allows fast and easy decision making on land use.

Weaknesses/ disadvantages/ risks → how to overcome

Land user's view

- There is currently no legislative support from government for protection of private land. → The new wildlife bill being drafted makes provision for privately protected areas.
- In the eyes of the Ministry of Lands, there are only two types of land, either urban and gazetted (e.g. parks) or agricultural (subject to land tax). → Include a third category of land for protected areas, such as the desert margin being non-agricultural.

REFERENCES

Compiler: Ibo Zimmermann (izimmermann@nust.na)
Resource persons: Nils Odendaal (nils@namibrand.org) - SLM specialist
Full description in the WOCAT database: https://qcat.wocat.net/en/wocat/approaches/view/approaches_3286/
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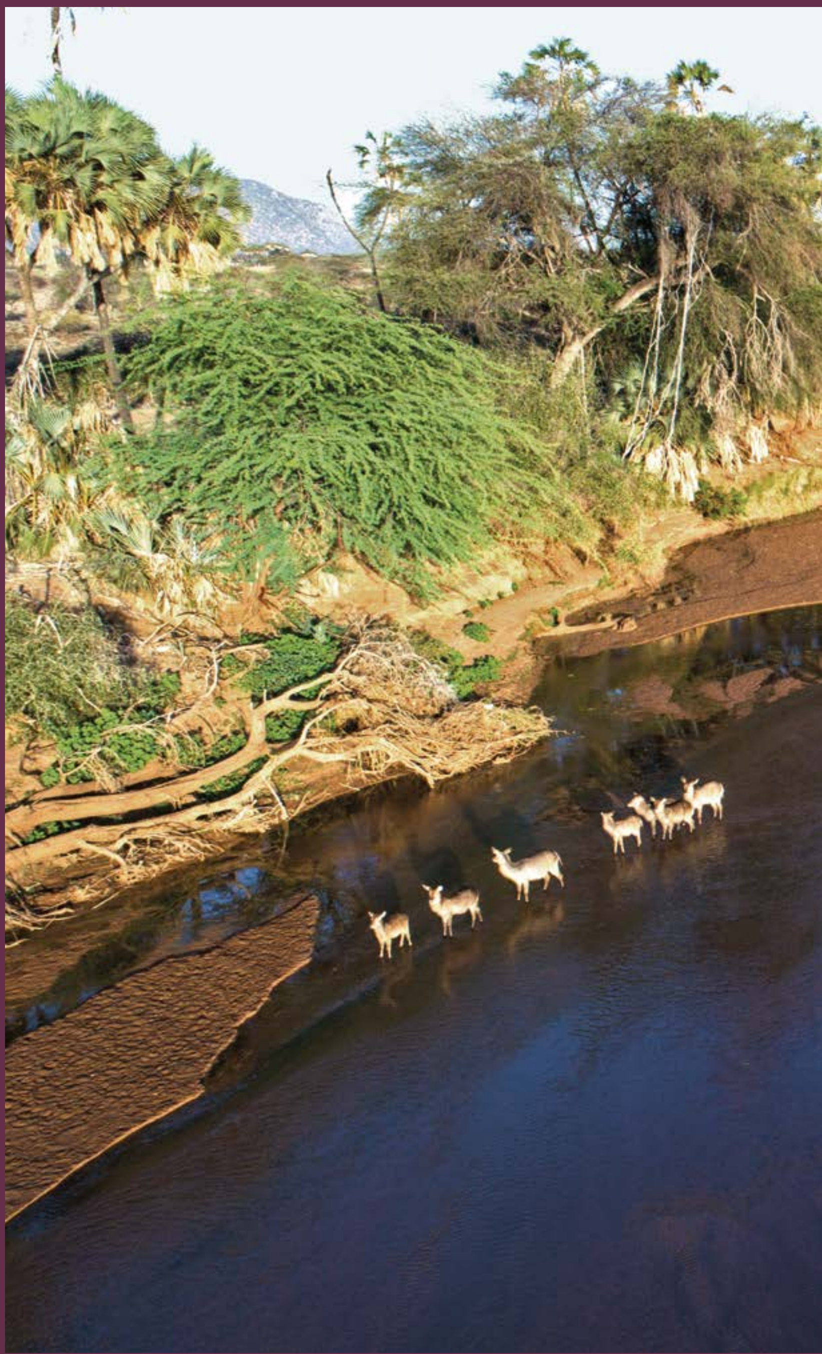
Date of documentation: Nov. 26, 2017; **Last update:** Feb. 23, 2018

Key references
A Guidebook to the NamibRand Nature Reserve, 2017, ISBN 978-99945-85-14-4: Local bookshops for approximately USD25.
Links to relevant information which is available online
Website of NamibRand Nature Reserve: www.namibrand.org
Website of Namib Desert Environmental Education Trust: www.nadeet.org

Annex



Ewaso Ng'iro river – source of water in dry rangelands, Kenya (Hanspeter Liniger).

Annex
References

Acharya, G., and Barbier, E. 2002. Using domestic water analysis to value groundwater recharge in the Hadejia-Jama' are floodplain, Northern Nigeria. American Journal of Agricultural Economics, 84, 415-426

Adjei, P.O.W., Buor, D. and Addrah, P. 2017. Ecological health effects of rural livelihood and poverty reduction strategies in the Lake Bosomtwe basin of Ghana Geo-Journal 82, 609-625

Aeschbacher, J., Liniger, H.P. and Weingartner, R. 2005. Increasing water-shortage in the Mount Kenya region – a case study of a typical highland-lowland system. Mountain Research and Development 25(2); 155-162

African Union, Department of Rural Economy and Agriculture. 2010. Policy, Framework for Pastoralism in Africa: Securing, Protecting and Improving the Lives, Livelihoods and Rights of Pastoralist Communities. https://au.int/sites/default/files/documents/30240-doc-policy_framework_for_pastoralism.pdf

African Union. 2012. https://www.oecd.org/swac/publications/41848366.pdf

African Union. 2013. Policy framework for pastoralism in Africa: Securing, protecting and improving the lives, livelihoods and rights of pastoralist communities

African Union. 2015. http://www.un.org/en/africa/osaa/pdf/au/au-handbook-2015.pdf

Ahuya, C. O., Okeyo, A. M., and Peacock, C. 2005. Developmental challenges and opportunities in the goat industry: the Kenyan experience. Small Ruminant Research, 60(1), 197-206

Aich, V., Koné, B., Hattermann, F.F. and Paton, E.N. 2016. Time series analysis of floods across the Niger River Basin Water (Switzerland), 8, 165

Aklilu, Y. 2002. Critical issues impacting livestock trade in Kenya, Ethiopia and Sudan. In Y. Jobre and G. Gebru (Eds.), Challenges and Opportunities of Livestock Marketing in Ethiopia. Proc. 10th Annual conference of the Ethiopian Society of Animal Production (ESAP), August 2002, 35-48. Addis Ababa, Ethiopia

Alidou, S.M. 2016. Cross-border transhumance corridors in West Africa. CapEx in supporting pastoral development, p 8

Allen, V.G., Batello, C., Beretta, E.J., Hodgson, J., Kothmann, M., Li, X., McIvor, J., Milne, J., Morris, C., Peeters, A. and Sanderson, M. 2011. An international terminology for grazing lands and grazing animals (The Forage and Grazing Terminology Committee). Grass and Forage Science. 66: 2-28

Alliance for Food Sovereignty in Africa (AFSA). 2017. Pastoralism, Policy and Law in the EAC and IGAD Regions. Summary report. http://afsafrica.org/wp-content/uploads/2017/05/PASTORALISM-POLICY-AND-LAW-IN-THE-EAC-Booklet.pdf

Archibald, S., Lehmann, C. E. R., Gomez-Dans, J. L. and Bradstock, R. A. 2013. Defining pyromes and global syndromes of fire regimes. Proceedings of the National Academy of Sciences of the United States of America, 110 (16), 6442-6447

Arctic Council. 2013. Arctic Resilience Interim Report 2013. Stockholm Environment Institute and Stockholm Resilience Centre, Stockholm, ISBN 978-91-86125-43-1117 page

Armed Conflict Location & Event Data (ACLED). 2015. Real time analysis of African political violence. Conflict Trends report (NO. 41). http://www.acleddata.com/wp-content/uploads/2015/09/ACLED_Conflict-Trends-Report-No.41-September-2015_pdf.pdf

Augustine, D.J., Milchunas, D.G. 2009. Vegetation responses to prescribed burning of grazed shortgrass steppe Rangel. Ecol. Manag., 62 (2009), pp. 89-97

AU-IBAR. 2012/2015. Rational Use of Rangelands and Fodder Crop Development in Africa. African Union – Interafrican Bureau for Animal Resources (AU-IBAR) Monographic Series No. 1; http://www.un.org/en/africa/osaa/pdf/au/au-handbook-2015.pdf

Awgachew, S., Flintan, F., and Bekure, S. 2015. Particpatory rangeland management planning and its implementation in Ethiopia

Awuor, C. 2014. Reporton Isiolo County Adaptation Planning Committee County Adaptation Fund 2nd Monitoring Visit 10th to 14th February 2014. ADA Consortium

Balana, B.B., Muys, B., Haregeweyn, N., Descheemaeker, K., Deckers, J., Poesen, J., Nyssen, J. and Mathus, E. 2012. Cost-benefit analysis of soil and water conservation measures: The case of exclosures in northern Ethiopia. Forest Policy and Economics, 15, 27-36

Balmford, A., Green, J.M.H., Anderson, M., Beresford, J., Huang, C., Naidoo, R., Walpole, M. and Manica. A. 2015. Walk on the wild side: estimating the global magnitude of visits to protected areas. PLoS biology13.2 : e1002074

Barbier, E.B. 2011. Wetlands as natural assets | [Les zones humides en tant que biens naturels]. Hydrological Sciences Journal 56, 1360-1373

Bationo, A., Robin, R. and Swift, D. 2015. Chapter 1. Current types of grazing lands in Sub-Saharan Africa and associated management practices. In Grazing Lands, Livestock and Climate Resilient Mitigation in Sub-Saharan Africa:The State of the Science

Behnke R. H., Scoones, I. and Kerven, C. 1993. Range ecology at disequilibrium: new models of natural variability and pastoral adaptation in African savannas. Overseas Development Institute (ODI), London

Behnke, R.H. 2000. Equilibrium and non-equilibrium models of livestock population dynamics in pastoral Africa: their relevance to Arctic grazing systems Rangifer, 20 (2000), pp. 141-152

Beinart, W. 1984. Soil erosion, conservation and ideas about development: a southern African exploration, 1900-1960. Journal of Southern African Studies 11 (1), 52-81

Blench, R. and Sommer, F. 1999. Understanding Rangeland Biodiversity. Overseas Development Institute. London

Blignaut, J., Mander, M., Schulze, R., Horan, M., Dickens, C., Pringle, C., Mavundla, K., Mahlangu, I., Wilson, A., Mckenzie, M. and Mckean, S. 2010. Restoring and managing natural capital towards fostering economic development: Evidence from the Drakensberg, South Africa

Bond, C.A., Strong, A., Burger, N. and Weilant, A.S. 2017a. Guide to the Resilience Dividend Model. Santa Monica, California, USA: RAND Corporation

Borrelli, P., Robinson, D.A., Fleischer, L.R., Lugato, E., Ballabio, C., Alewell, C., Meusburger, K., Modugno, S., Schütt, B., Ferro, V., Bagarello, V.0., Oost, K.V., Montanarella, L. and Panagos, P. 2017. An assessment of the global impact of 21st century land use change on soil erosion. Nat Commun. 2017 Dec 8;8(1):2013. doi: 10.1038/s41467-017-02142-7

Briske, D.D., Derner, J., Brown, J., Fuhlendorf, S.D., Teague, W., Havstad, K., Gillen, R.L., Ash, A.J. and Willms, W. 2008. Rotational grazing on rangelands: reconciliation of perception and experimental evidence. Rangeland ecology & management, 61(1), 3-17

Brown, J.R. and Macleod, N.D. 2017. An ecosystem services filter for rangeland restoration. Rangeland Journal 39, 451-459

Bunning, S., McDonagh, J. and Rioux, J. 2011. Manuel for local level assessment of land degradation and sustainable land management. Part 1. Planning and methodological approach, analysis and reporting. Land degradation assessment in drylands. FAO. Rome. 2011

Butt, B. and Turner, M. D. 2012. Clarifying competition: the case of wildlife and pastoral livestock in East Africa. Pastoralism: Research, Policy and Practice, 2(1), 9

Byakagaba, P., Anthony, E., Bernard, B., David, D., and Briske 2018. Uganda's rangeland policy: intentions, consequences and opportunities." Pastoralism 8.1 (2018): 7

Catley, A., Lind, J., and Scoones, I. 2013. Pastoralism and development in Africa: dynamic change at the margins: Routledge

Cervigni, R. and Morris, M. 2016. Confronting Drought in Africa's Drylands: opportunities for Enhancing Resilience. Washington, DC: World Bank; and Agence Française de Développement. © World Bank. https://openknowledge.worldbank.org/handle/10986/23576 License: CC BY 3.0 IGO."

Chambers, R. and Conway, G. 1992. Sustainable rural livelihoods: practical concepts for the 21st century. IDS Discussion Paper No. 296. Brighton, IDS, p. 7–8

Copernicus. 2018. https://www.copernicus.eu/en

Council for Scientific and Industrial Research (CSIR), South Africa. 2011. available from: http://researchspace.csir.co.za/dspace/

Critchley, W. 2010. More People More Trees: environmental recovery in Africa', 2010. Practical Action Publishing, UK

Critchley, W., Reij, C. and Seznec, A. 1992. Water Harvesting for Plant Production. World Bank Technical Paper No 157. Africa Technical Department Series. Washington D.C

Davies, J. and Hatfield, R. 2007. The Economics of Mobile Pastoralism: a Global Summary. Nomadic Peoples, 11, 91-116

Davies, J., Ogali, C., Laban, P. and Metternicht, G. 2015. Homing in on the Range: Enabling Investments for Sustainable Land Management. Technical Brief 29/01/2015. Nairobi: IUCN and CEM. vi+

De Groot, R.S., Blignaut, J., Van der Ploeg, S., Aronson, J., Elmqvist, T. and Farley, J. 2013. Benefits of investing in ecosystem restoration. Conservation Biology 27:1286–1293

De Haan, C. and Cervigni, R. 2016. Vulnerability and Resilience in Livestock Systems in the Drylands of Sub-Saharan Africa (Chapter 5) in De Haan, C. (editor). 2016. Prospects for Livestock-Based Livelihoods in Africa's Drylands. Studies. Washington, DC: World Bank, http://dx.doi.org/10.1596/978-1-4648-0836-4 79

De Haan, C., Etienne, D., Garancher, B. and Quintero, C. 2016. Pastoralism Development in the Sahel A Road to Stability? International Bank for Reconstruction and Development / The World Bank

Descheemaeker, K., Raes, D., Nyssen, J., Poesen, J., Haile, M. and Deckers, J. 2009. Changes in water flows and water productivity upon vegetation regeneration on degraded hillslopes in northern

Douthwaite, B., Alvarez, S., Cook, S., Davies, R., George, P., Howell, J. and Rubiano, J. 2007. Participatory impact pathways analysis: A practical application of program theory in research for development. Canadian Journal Program Evaluation, 22, 127–159. ISSN: 0834-1516

Du Preez, C.C., Van Huyssteen, C.W. and Mnkeni, P.N.S. 2011. Land use and soil organic matter in South Africa 1: A review on spatial variability and the influence of rangeland stock production. S Afr J Sci. 2011;107(5/6), Art. #354, 8 pages. doi:10.4102/sajs. v107i5/6.354

Du Toit and Cumming. 1999. Functional significance of ungulate diversity in African savannas and the ecological implications of the spread of pastoralism

Du Toit, J.T. 2011. Coexisting with cattle. Science, 333(6050), 1710-1711

Du Toit, J.T., Cross, P.C., and Valeix, M. 2017. Managing the livestock–wildlife interface on rangelands Rangeland systems (pp. 395-425): Springer

Dudley, N., Shadie, P. and Stolton, S. 2013. Guidelines for applying protected area management categories including IUCN WCPA best practice guidance on recognising protected areas and assigning management categories and governance types. IUCN Best Practice Protected Area Guidelines Series no 21.IUCN. Notes: Volume incorporates two publications – a 2013 updated edition of Guidelines for applying protected area management categories (PAPS-016, published 2008) and a new publication, "IUCN WCPA best practice guidance on recognising protected areas and assigning management categories and governance types." Includes bibliographic references (pp. 85-86 and p. 31)

Dyer, N. 2008. Securing Pastoralism in East and West Africa:Protecting and Promoting Livestock Mobility: Review of theLegislative and Institutional Environment Governing Livestock Mobility in East and West Africa. IIED. http://pubs.iied.org/pdfs/G03036.pdf

Economic Community of West African States (ECOWAS). 2008. Promoting and Supporting Change in Transhumant Pastoralism in the Sahel and West Africa. Policy Note No.3 (http://www.oecd.org/dataoecd/35/14/38402714.pdf

Elmqvist, T., Maltby, E., Barker, T., Mortimer, M., Perrings, C., Aronson, J., Groot, R.D., Fitter, A., Mace, G., Norberg, J., Pinto, I. S. and Ring, I. 2010. Biodiversity, ecosystems and ecosystem services. In: KUMAR, P. (ed.) The Economics of Ecosystems and Biodiversity: The Ecological and Economic Foundations. London and Washington: Earthscan

Ericksen, P. and Crane, T. 2018. The feasibility of low emissions development interventions for the East African livestock sector: Lessons from Kenya and Ethiopia. ILRI Research Report 46. Nairobi, Kenya: ILRI

Esenu, B. and Ossiya, S. 2010. Positioning agro-pastoral women in livestock production. In: Flintan. 2011. Changing Nature Of Gender Roles In The Drylands Of The Horn And East Africa: Implications For DRR Programming https://reliefweb.int/sites/reliefweb.int/files/resources/F_R_479.pdf

Falloux, F. and Mukendi, A. 1988. Desertification Control and Renewable Resource Management in the Sahelian and Sudanian Z.ones of West Africa. World Bank Technical Paper No 70

Flint, C.G. and Luloff, A.E. 2005. Natural Resource-Based Communities, Risk, and Disaster: An Intersection of Theories. Society and Natural Resources, 18, 399-412

Flintan, F. 2011a. Broken Lands: Broken Lives? Causes, Processes and Impacts of Land Fragmentation in the Rangelands of Ethiopia, Kenya and Uganda. Nairobi: Regional Learning and Advocacy Programme

Flintan, F. 2011b. Changing Nature of Gender Roles In The Drylands Of The Horn And East Africa: Implications For DRR Programming. https://reliefweb.int/sites/reliefweb.int/files/resources/F_R_479.pdf

Food and Agricultural Organization of the United Nations (FAO). 1978. Report on the agro-ecological zones project. FAO, Rome

Food and Agriculture Organization of the United Nations (FAO). 2002. Cattle and small ruminant systems in sub-Saharan Africa: a systematic review. Available at: ftp://ftp.fao.org/docrep/fao/005/y4176E/y4176E00.pdf

Food and Agriculture Organization of the United Nations (FAO). 2003. Guidelines for Land Use Planning. Rome: FAO

Food and Agriculture Organization of United Nations (FAO), WLG 3. 2010. Gridded Livestock of the World 2010, FAO. http://www.fao.org/geonetwork/srv/en/main.search?extended=off&remote=off&region=&selregion=%3B180%3B-180%3B-90%3B90&northBL=90&westBL=-180&eastBL=180&southBL=-90&relation=equal&any=Livestock+GLW&themekey=&to=&from=&siteId=&hitsPerPage=10

Food and Agriculture Organization of the United Nations (FAO). 2018. Horn of Africa: Impact of Early Warning Early Action. UN Food and Agricultural Organisation

Fryxell, J.M., Wilmshurst, J.F., Sinclair, A.R., Haydon, D.T., Holt, R.D., and Abrams, P.A. 2005. Landscape scale, heterogeneity, and the viability of Serengeti grazers. Ecology Letters, 8(3), 328-335

Fuhlendorf, S.D., Fynn, R.W.S., McGranahan, D.A. and Twidwell, D. 2017. Heterogeneity as the Basis for Rangeland Management. In: Briske D. (eds) Rangeland Systems. Springer Series on Environmental Management. Springer, ChamLimb, R.F

Funt, C.G. and Luloff, A.E. 2005. Natural Resource-Based Communities, Risk, and Disaster: An Intersection of Theories. Society and Natural Resources, 18, 399-412

Fynn, R.W.S., and O'Connor, T.G. 2000. Effects of Stocking Rate and Rainfall on Rangeland Dynamics and Cattle Performance in a Semi-arid Savanna, South Africa. Journal of Applied Ecology. 37:491-507

Fynn, R.W.S., Augustine, D.J., Peel, M.J.S. and de Garine-Wichatitsk, M. 2016. Strategic management of livestock to improve biodiversity conservation in African savannahs: a conceptual basis for wildlife–livestock co-existence. Journal of Applied Ecology 53: 388–397

Fynn, R.W.S., Kirkman, K. and Dames, R. 2017. Optimal Grazing Management Strategies: Evaluating Key Concepts. African Journal of Range and Forage Science 34: 87-98

Fynn, R.W.S., Murray-Hudson, M., Dhliwayo, M. and Scholte, P. 2015. African Wetlands and Their Seasonal use by Wild and Domestic Herbivores. Wetlands Ecology and Management. 23:559-581

Galvin, K.A., Beeton, T.A. and Luizza, M.W. 2018. African community-based conservation: a systematic review of social and ecological outcomes. Ecology and Society 23(3):39. https://doi.org/10.5751/ES-10217-230339

Gammie, G. and Bievre, B.D. 2015. Assessing Green Interventions for the Water Supply of Lima, Peru-Cost-Effectiveness, Potential Impact, and Priority Research Areas. Washington Dc: Forest Trends

George, M.R., Larson-Praplan, S., Harper, J., Lewis, D. and Lennox, M. 2011. California's rangeland water quality management plan: an update. Rangelands 33, 33, 20-24

Goldstein, J.H., Presnall, C.K., Lopez-Hoffman, L., Gary, P., Nabhan, K.R.L., Ruyle, G.B. and Toombs, T.P. 2011. Beef and beyond: Paying for ecosystem services on Western US rangelands Rangelands, 33, 4-12

Gonzalez, P., Tucker, C.J. and Sy, H. 2012. Tree density and species decline in the African Sahel attributable to climate. Journal of Arid Environments, 78, 55-64

Government of Kenya (GoK). 2016. The 2016 Long Rains Food Security Assessment Report – A joint report by the Kenya Food Security Steering Group (KFSSG) and the Isiolo County Steering Group, July 2016. Nairobi: NDMA

Government of Kenya (GoK). 2017. Submission in the area of ecosystems, interrelated areas such as water resources and adaptation under the Nairobi work programme, NEMA. https://www4.unfccc.int/sites/NWPStaging/News/Pages/call-for-submission-ecosystems.aspx

Grandval, F. 2012. Pastoralism in Sub-Saharan Africa: Know its Advantages, Understand its Challenges, Act for its Sustainability. Food sovereignty brief. Inter-Réseaux Développement Rural and SOS Faim Belgium. http://pubs.iied.org/pdfs/17345IIED.pdf

Groom, R.J., and Western, D. 2013. Impact of land subdivision and sedentarization on wildlife in Kenya's southern rangelands. Rangeland ecology & management, 66(1), 1-9

Güneralp, B., Shuaib L., Hillary M., Parnell, S. and Seto, K.C. 2018. Urbanization in Africa: challenges and opportunities for conservation. Environ. Res. Lett. 13 (2018) 015002. https://doi.org/10.1088/1748-9326/aa94fe

Gyamfi, C., Ndambuki, J.M. and Salim, R.W. 2016 Hydrological responses to land use/cover changes in the Olifants Basin, South Africa. Water (Switzerland), 8, 588

Haregeweyn, N., Tesfaye, S., Tsunekawa, A., Tsubo, M., Meshesha, D.T., Adgo, E. and Elias, A. 2015. Dynamics of land use and land cover and its effects on hydrologic responses: case study of the Gilgel Tekeze catchment in the highlands of Northern Ethiopia

Harrison, E.P., Dzingirai, V., Gandiwa, E., Nzuma, T., Masviele, B. and Ndlovu, H. 2015. Progressing community-based natural resource management in Zimbabwe. Sustainability Research Institute Briefing Note Series No. 6. University of Leeds

Heady, H.F. 1960. Range Management in East Africa. Kenya Department of Agriculture and East African Agriculture and Forestry Research Organisation in co-operating with the United States Education Commission in the UK

Hempson, G.P., Archibald, S. and Bond, W.J. 2017. "The consequences of replacing wildlife with livestock in Africa." Scientific reports 7.1 (2017): 17196

Herger, M. 2018. Environmental Impacts of Red Meat Production. MSc Thesis. University of Bern

High Level Panel of Experts on Food Security and Nutrition (HLPE). 2011. Land tenure and international investments in agriculture. A report by the high level panel of experts (HLPE) on food security and nutrition Committee on World Food Security, Rome (2011)

Hoffman, T. and Vogel, C. 2008. Climate Change Impact on African Rangelands. Society for Rangeland Management

Holden, S. and Shiferaw, B. 2004. Land degradation, drought and food security in a less-favoured area in the Ethiopian highlands: a bio-economic model with market imperfections. Agricultural Economics, 30, 31-49

Holechek, J.L., Cibils, A.F., Bengaly, K., and Kinyamario, J.I. 2017. Human population growth, African pastoralism, and rangelands: A perspective. Rangeland ecology & management, 70(3), 273-280

Homewood, K. 2009. Ecology of African Patoralists Societies. James Currey, Ltd., Oxford, UK, 320 pp

Hopcraft, J.G.C. 2010. Ecological implications of food and predation risk for herbivores in the Serengeti. Ph.D. thesis, University of Groningen, Groningen, the Netherlands

Hruska, T., Huntsinger, L., Brunson, M., Li, W., Marshall, N., Oviedo, J. L. and Whitcomb, H. 2017. Rangelands as social–ecological systems Rangeland Systems (pp. 263-302): Springer

Ickowicz, A., Ancey, V., Corniaux, C., Duteurtre, G., Poccard-Chappuis, R., Touré, I., Vall, E. and Wane, A. 2012. "Crop–Livestock Production Systems in the Sahel—Increasing Resilience for Adaptation to Climate Change and Preserving Food Security." In Proceedings of FAO/OECD Workshop on Building Resilience for Adaptation to Climate Change in the Agriculture sector. 261–94. Rome, FAO-OCDE

Illius, A.W. and O'Connor, T.G. 1999. On the relevance of non-equilibrium concepts to arid and semiarid grazing systems. Ecological Applications 9:798–813

Intergovernmental Panel on Climate Change (IPCC). 2013. Long-term climate change: projections, commitments and irreversibility. In: Stocker TF, Qin D, Plattner G, Tignor MMB et al (eds) Climate change 2013: the physical science basis. Contribution of working group I to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, pp 1078–1080

Intergovernmental Panel on Climate Change (IPCC). 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp

Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES). 2018. Chapters of the thematic assessment report on land degradation and restoration of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

International Fund for Agricultural Development (IFAD). 2015. IFAD's operational framework for scaling up results. Rome, Italy: IFAD

International Institute for Environment and Development (IIED) and SOS Sahel. 2010. Modern and mobile: The future of livestock production in Africa's drylands. IIED and SOS Sahel, ISBN 978-1-84369-752-7

International Union for Conservation of Nature (IUCN), United Nations Environment Programme – UN Environment World Conservation Monitoring Centre (UNEP-WCMC). 2016. The world database on protected areas (WDPA) Cambridge: UNEP-WCMC

International Union for Conservation of Nature (IUCN). 2018. Available from: https://www.iucn.org/theme/protected-areas

International Union for Conservation of Nature (IUCN) Red List. 2019. https://www.iucnredlist.org/resources/spatial-data-download

Jandreau, C., and Berkes, F. 2016. Continuity and change within the social-ecological and political landscape of the Maasai Mara, Kenya. Pastoralism, 6 (1), 1

Jarso, I., Tari, D. and King-Okumu, C. 2017. Recommendations to the County Government of Isiolo for preparation of a strategic plan on water, energy and climate change. IIED Report. London: IIED

Jenet, A., Buono, N., Di Lello, S., Gomarasca, M., Heine, C., Mason, S., Nori, M., Saavedra, R. and Van Troos, K. 2016. The path to greener pastures. Pastoralism, the backbone of the world's drylands. Vétérinaires sans Frontières International (VSF-International). Brussels, Belgium

Joint Research Centre (JRC) and Center for International Earth Science Information Network (CIESIN). 2015. GHS population grid, derived from GPW4, multitemporal (1975, 1990, 2000, 2015). [Dataset] PID: http://data.europa.eu/89h/jrc-ghsl-ghs_pop_gpw4_globe_r2015a

Joss, L. 2018. Mapping land use in the lower Ewaso Ng'iro Basin and assessing the impact on hydrology. Master Thesis, Faculty of Science, University of Bern.

Kariuki, R., Simon, W. and Marchant, R. 2018. Rangeland Livelihood Strategies under Varying Climate Regimes: Model Insights from Southern Kenya. MDPI journal I Land 2018, 7, 47; doi:10.3390/land7020047www.mdpi.com/2073-445X/7/2/47/pdf

Kihara, J., MacCarthy, D.S., Bationo, A., Koala, S., Hickman, J., Koo, J., Vanya, C., Adiku, S., Beletse, Y., Masikate, P., Rao, K.P.C., Mutter, C.Z., Rosenzweig, C. and Jones, J.W. 2015. Perspectives on climate effects on agriculture: The international efforts of AgMIP in Sub-Saharan Africa. In Handbook of Climate Change and Agroecosystems: The Agricultural Model Inter comparison and Improvement Project (AgMIP) Integrated Crop and Economic Assessments, Part 2. C. Rosenzweig and D. Hillel, Eds., ICP Series on Climate Change Impacts, Adaptation, and Mitigation Vol. 3. Imperial College Press, pp. 3-24, doi:10.1142/9781783265640_0013

Kihiu, E.N. and Amuakwa, M.F. 2017. Improving Access to Livestock Markets for Sustainable Rangeland Management. African Journal of Economic Review, Volume V, Issue II, July 2017

Kihiu, E.N., and Amuakwa-Mensah, F. 2016. Improving access to livestock markets for sustainable rangeland management, 215. ZEF-Discussion Papers on Development Policy

King, Kaelo D., Buzzard, B and Warigia, G. 2015. Establishing a wildlife conservancy in Kenya: A guide for private land owners and communities. Kenya Wildlife conservancies Association. Pp 20-45

King-Okumu, C. 2016. Distilling the value of water investments. London, UK: IIED

King-Okumu, C. 2017. Adaptation to climate change: economic value and return on investments. London: IIED/NEF

King-Okumu, C., Jillo, B., Kinyanjui, J. and Jarso, I. 2018 Devolving Water Governance in the Kenyan Arid Lands: from top-down drought and flood emergency response to locally driven water resource development planning, International Journal of Water Resources Development 34 (4) 675-697 http://www.tandfonline.com/doi/full/10.1080/07900627.2017.1357539

King-Okumu, C., Wasonga, O.V. and Yimer, E. 2015. Pastoralism pays: new evidence from the Horn of Africa. Briefing 17312IIED London, UK: IIED

Kironchi, G., Kinyali, S.M. and Mbuvi, J.P. 1993. Validity of the Philip equation for infiltration into soils of Sirima and Mukogodo catchments in Laikipia District

Krätli S., Swift, S. and Powell, A. 2014. Saharan Livelihoods: Development and Conflict. Technical Report Sahara!Knowledge!Exchange, WB

Krätli, S. 2015. Valuing variability: New Perspectives on climate resilient drylands development. IIED. Edited by de Jode, H. Available from: http://pubs.iied.org/10128IIED.html

Land Matrix. 2016 https://landmatrix.org/

Le Houerou, H.N. 1989. The grazing land ecosystems of the African Sahel, Berlin, Germany, Springer-Verlag

Lee, D.L. and Bond, L.M. 2018. Quantifying the ecological success of a community-based wildlife conservation area in Tanzania, Journal of Mammalogy, Volume 99, Issue 2, 3 April 2018, Pages 459–464, https://doi.org/10.1093/jmammal/gyy014

Limb, R.F., Fuhlendorf, S.D., Engle, D.M., and Miller, R.F. 2016. Synthesis paper: assessment of research on rangeland fire as a management practice. Rangeland ecology & management, 69(6), 415-422

Liniger, H.P. and Thomas. D.B. 1998. GRASS: Ground cover for the Restoration of the Arid and Semi-arid Soils. In: Advances in GeoEcology 31, 1167-1178, CATENA Verlag, Reiskirchen

Liniger, H.P. and Weingartner, R., 2000. Mountain forests and global water crisis. In: Mountains of the World, Mountain Forests and Sustainable Development. Mountain Agenda, Paul Haupt, Bern

Liniger, H.P., Gikonyo, J., Kiteme, B. and Wiesmann, U. 2005. Assessing and managing scarce tropical mountain water resources – the case of Mount Kenya and the semi-arid Upper Ewaso Ng'iro Basin. Mountain Research and Development 25(2); 163-173

Liniger, H.P., Mekdaschi Studer, R., Hauert, C., and Gurtner, M. 2011. Sustainable Land Management in Practice – Guidelines and Best Practices for Sub-Saharan Africa. TerrAfrica, World Overview of Conservation Approaches and Technologies (WOCAT) and Food and Agriculture Organization of the United Nations (FAO)

Liniger, HP., Mekdaschi Studer, R., Moll, P. and Zander, U. 2017. Making sense of research for sustainable land management. Centre for Development and Environment (CDE), University of Bern, Switzerland and Helmholtz-Centre for Environmental Research GmbH – UFZ, Leipzig, Germany

Liniger, HP., Meksaschi, R.S., Hauert, C., and Gurtner, M., 2011. "La Pratique de La Gestion Durable Des Terres. Directives et Bonnes Pratiques Pour l'Afrique Subsaharienne Applications Sur Le Terrain." FAO

Lipper, L., Dutilly-Diane, C. and McCarthy, N. 2010. Supplying carbon sequestration from West African rangelands: Opportunities and barriers. Rangeland Ecology and Management 63, 155-166

Lovei, M., Agostini, P., Bea, E., Dardel, P. E., Kanungo, G., Oodally, Y. and Seck, M. 2017. Fighting land degradation at landscape scale: sustainable land and water management in Africa's drylands and vulnerable landscapes (English). Washington, D.C.: World Bank Group http://documents.worldbank.org/curated/en/740111505365636082/Fighting-land-degradation-at-landscape-scale-sustainable-land-and-water-management-in-Africa-s-drylands-and-vulnerable-landscapes

Lovschal, M., Peder, K.B., Jeppe, P., Irene, A., Alice, O., Aggrey, T. and Jens-Christian, S. 2017. Fencing bodes a rapid collapse of the unique Greater Mara ecosystem. Scientific Reports volume 7, Article number: 41450 (2017) https://www.nature.com/articles/srep41450.pdf

Madzudzo, E. 1995. A general overview of CAMPFIRE: success and constraints. Pp 155-164 in Turner S. and Critchley, W. Successful Natural Resource Management in Southern Africa. CDCS, Vrije Universiteit Amsterdam

Makokha, S., Witwer, M. and Monroy, L. 2013. Analysis of incentives and disincentives for live cattle in Kenya. Technical notes series, MAFAP. Rome: FAO

Markelova, H., Meinzen-Dick, R., Hellin, J., and Dohrn, S. 2009. Collective action for smallholder market access. Food policy, 34(1), 1-7

Mati, B.M., Mutie, S., Gadain, H., Home, P. and Mtalo, F. 2008. Impacts of land-use/cover change on the hydrology of the transboundary Mara River, Kenya/Tanzania. Lakes Reserv. Res. Manag., 13, 169-177

McGahey, D., Davies, J., Hagelberg, N., and Ouedraogo, R. 2014. Pastoralism and the Green Economy – a natural nexus? Nairobi: IUCN and UNEP. x + 58p

Mekdaschi Studer, R. and Liniger, H. 2013. Water Harvesting: Guidelines to Good Practice. Centre for Development and Environment (CDE), Bern; Rainwater Harvesting Implementation Network (RAIN), Amsterdam; MetaMeta, Wageningen; The International Fund for Agricultural Development (IFAD), Rome

Millennium Ecosystem Assessment (MEA). 2005a. Ecosystems and Human Well-being: Desertification Synthesis. Millennium Ecosystem Assessment. World Resources Institute, Washington, DC

Millennium Ecosystem Assessment (MEA). 2005b. Ecosystems and Human Well-Being: Policy Responses. Appendix D: glossary. Findings of the Responses Working Group. Millennium Ecosystem Assessment. 654 pp; http://www.millenniumassessment.org/documents/document.776.aspx.pdf

Milne, E. 2016. Grazing lands in Sub-Saharan Africa and their potential role in climate change mitigation: What we do and don't know. Available from: https://www.researchgate.net/publication/304366428_Grazing_lands_in_Sub Saharan_Africa_and_their_potential_role_in_climate_change_mitigation_What_we_do_and_don%27t_know [accessed Jul 09 2018]

Milne, E. and Williams, S. (Eds.). 2015. Grazing Lands, Livestock and Climate Resilient Mitigation in Sub-Saharan Africa, State of the Science. Report for USAID Project Contract No. AIDOAAL1000001 Available at: http://www.vivo.colostate.edu/lccrsp/reports/GrazingLandsLivestockClimateMitigation_Paper1_Final6Aug2015editedv4a.pdf

Milton, S., Richard, W., Dean, J., Morné, A., du Plessis and Roy Siegfried, W. 1994. A conceptual model of arid rangeland degradation: the escalating cost of declining productivity. BioScience 44:70–76

Ministry of women's affairs (MoWA). 2006. National action plan for gender equality (NAP-GE) 2006-2010. Addis Ababa

Mudhara, M., Critchley, W., Di Prima, S., Dittoh, S. and Sessay, M. 2016. Community Innovations in Sustainable Land Management: Lessons from the Field in Africa. Routledge/ Earthscan Studies in Natural Resource Management. ISBN 1317278712, 9781317278719

Murray-Hudson, M., Wolski, P., and Ringrose, S. 2006. Scenarios of the impact of local and upstream changes in climate and water use on hydro-ecology in the Okavango Delta, Botswana. Journal of Hydrology, 331(1-2), 73-84

Muthee, A. 2006. An Analysis Of Pastoralist Livestock Products Market Value Chains And Potential External Markets For Live Animals And Meat.Kenya Livestock Sector Study. Kenya: AU-IBAR and NEPDP

Mwangi, E. 2009. Property right and governance of Africa's rangelands: A policy overview. Natural Resources Forum, 33:160-170

Mwangi, E. and Ostrom, E. 2009. "Top-down solutions: looking up from East Africa's rangelands." Environment: Science and Policy for Sustainable Development 51.1: 34-45

Mwangi, H.M., Julich, S., Patil, S.D., Mcdonald, M.A. and Feger, K.H. 2016. Relative contribution of land use change and climate variability on discharge of Upper Mara River, Kenya. J. Hydrol. Reg. Stud, 5, 244–260

Mwangi, H.M., Lariu, P., Julich, S., and Mcdonald, M.A. and Feger, K.H. 2017. Characterizing the intensity and dynamics of land-use change in the Mara River Basin, East Africa Forests

Muwaya, S., Molo, R., Ssendawula, J., Mugerwa, S., Lwakuba, A., and Di Prima, S. 2016. 8 Community initiatives for improving degraded ecosystems in Uganda. Community Innovations in Sustainable Land Management: Lessons from the field in Africa, 124.

Niamir-Fuller, M., Kerven, C. and Reid, R. 2012. Pastoralism: Research, Policy and Practice 2012, 2:8

Nill, D., Klaus A., Van den Akker, E., Schöning, A., Wegner, M., Van der Schaaf, C. and Pieterse. J. 2011. Water-spreading weirs for the development of degraded dry river valleys: experience from the Sahel. GIZ and KfW, Germany

Nolte, K., Chamberlain, W. and Giger, M. 2016. International Land Deals for Agriculture. Fresh insights from the Land Matrix: Analytical Report II. Bern, Montpellier, Hamburg, Pretoria: Centre for Development and Environment, University of Bern; Centre de coopération internationale en recherche agronomique pour le développement; German Institute of Global and Area Studies; University of Pretoria; Bern Open Publishing

Nori, M., Switzer, J. and Crawford, A. 2005. Herding on the brink: Towards a global survey of pastoral communities and conflict. An Occasional Working Paper from the IUCN Commission on Environmental, Economic and Social Policy. International Institute for Sustainable Development www.iisd.org/natres/security/pastoralism.asp

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

Nygaard, I. and Bolwig, S. 2017. Evolution of the jatropha biofuel niche in Ghana. UNEP DTU Partnership Working Paper Series 2017:1, UNEP DTU Partnership, Technical University of Denmark

O'Conner, D.A., Butt, B. and Johannes, B.F. 2015. Foraging ecologies of giraffe (Giraffa camelopardalis reticulata) and camels (Camelus dromedarius) in northern Kenya: effects of habitat structure and possibilities for competition?, Volume: 53, Issue: 2, Pages: 183-193, First published: 30 January 2015, DOI: (10.1111/aje.12204)

O'Connor, T.G., Haines, L.M. and Snyman, H.A. 2001. Influence of precipitation and species composition on phytomass of a semi-arid African grassland. Journal of Ecology 89: 850–860

Okello, B. 1996. Utilization of Above Net Primary Production in Mukogodo Ranelands, Laikipia, Kenya. A thesis submitted in partial fulfillment of the degree of Master of Science (Range Management) at the University of Nairobi. Kenya

Ongoma, V., Haishan, C. and George, W.O. 2018. Variability of extreme weather events over the equatorial East Africa, a case study of rainfall in Kenya and Uganda. Theoretical and Applied Climatology, 131(1-2), 295-308, 2018 https://doi.org/10.1007/s00704-016-1973-9; https://www.researchgate.net/publication/308952813_Variability_of_Extreme_Weather_Events_over_the_Equatorial_East_Africa_a_case_study_of_Rainfall_in_Kenya_and_Uganda

Osofsky, S.A., Cleaveland, S., Karesh, W.B., Kock, M.D., Nyhus, P.J., Starr, L. and Yang, A. (Eds). 2005. Conservation and Development Interventions at the Wildlife/Livestock Interface: Implications for Wildlife, Livestock and Human Health. IUCN, Gland, Switzerland and Cambridge, UK. xxxiii + 220pp.

Overseas Development Institute (ODI). 2009. Pastoralism, policies and practice in the Horn and East Africa A review of current trends. Humanitarian policy group (hpg) Synthesis Paper

Owen, S. 2004. Functional heterogeneity in resources within landscapes and herbivore population dynamics Landscape Ecology, 19 (2004), pp. 761-771

Oxby, C. 2011. Will the 2010 'code pastoral' help herders in central Niger? Land rights and land use strategies in the grasslands of Abalak and Dakoro Departments. Nomadic peoples, 15(2), 53-81

Pellant, M., Shaver, P., Pyke, D.A. and Herrick, J.E. 2005. Interpreting indicators of rangeland health, version 4. Technical Reference 1734-6. U.S. Department of the Interior, Bureau of Land Management, National Science and Technology Center, Denver, CO. BLM/WO/ST-00/001+1734/REV05. 122 pp

Polley, H.W., Bailey, D.W., Nowak, R.S. and Mark S.S. 2017. Ecological Consequences of Climate Change on RangelandsClimate. In: Briske, David D. (editor) 2017. Rangeland Systems – Processes, Management and Challenges. Springer Series on Environmental Management pages pp 229-260

Porensky, L.M. and Veblen, K.E. 2015. Generation of ecosystem hotspots using short-term cattle corrals in an African savanna. Rangeland Ecology & Management, 68, 131–141

Pratt, D.J. and Gwynne, M.D. 1977. Rangeland Management in East Africa. Hodder and Stoughton, Sevenoaks, UK

Prins, H.H. 2000. Competition between wildlife and livestock in Africa. In Wildlife conservation by sustainable use. Edited by: Prins HHT, Geu Grootenhuis T, Dolan T. Boston: Kluwer Academic Publishers; 2000:53–80

Providoli, I., Zeleke, G., Kiteme, B., Bantider, A., Mwangi, J. and editors. 2019. Shaping Sustainable Socio-Ecological Landscapes in Africa: The Role of Transformative Research, Knowledge, and Partnerships. Bern, Switzerland: Centre for Development and Environment (CDE), University of Bern, with Bern Open Publishing (BOP)

Rebelo, L., McCartney, M. and Finlayson, C. 2009. Wetlands of Sub-Saharan Africa: distribution and contribution of agriculture to livelihoods. Wetlands Ecol. Manage., 18 (2009), pp. 557-572

Reynolds, M. and Buendia, J. 2017. Permanently Sequester Anthropogenic Carbon Dioxide – Through Hydraulic Fracturing; SPE 185033 presented at the SPE Canada Unconventional Resources Conference, Calgary AB, Feb 15–16

Rigaud, K.K., de Sherbinin, A., Jones, B., Bergmann, J., Clement, V., Ober, K., Schewe, J., Adamo, S., McCusker, B., Heuser, S. and Midgley, A. 2018. Grounds well: Preparing for Internal Climate Migration. World Bank, Washington, DC. © orld Bank. https://openknowledge.worldbank.org/handle/10986/29461 License: CC BY 3.0 IGO

Robinson, T.P., Thornton, P.K., Franceschini, G., Kruska, R.L., Chiozza, F., Notenbaert, A., Cecchi, G., Herrero, M., Epprecht, M., Fritz, S., You, L., Conchedda, G. and See, L. 2011. Global livestock production systems. Rome: Food and Agriculture Organization of the United Nations (FAO) and International Livestock Research Institute (ILRI). pp. 152

Robinson, T.P., Wint, G.R.W., Conchedda, G., Van Boeckel, T.P., Ercoli, V. and Palamara, E. 2014. Mapping the Global Distribution of Livestock. PLoS ONE 9(5): e96084. https://doi.org/10.1371/journal.pone.0096084

Rogues, K G., O'Connor, T.G. and Watkinson, A.R. 2001. Dynamics of shrub encroachment in an African savanna: relative influence of fire, herbivory, rainfall and density dependence. Journal of Applied Ecology 38:268-280

Rota, A. 2018. Lessons learned Engaging with pastoralists – a holistic development approach. Pastoral development. Rome: IFAD

Rota, A., and Sperandini, S. 2009. 'Livestock and Pastoralists. Livestock Thematic Papers – Tools for Project Design.' (International Fund for Agricultural Development (IFAD): Rome.)

Sala, O.E., Yahdjian, L., Havstad, K. and Aguiar, M.R. 2017. "Rangeland ecosystem services: Nature's supply and humans' demand." Rangeland Systems. Springer, Cham, 2017. 467-489

Sandford, S. 1983. Management of Pastoral Development in the Third World. John Wiley & Sons in association with the Overseas Development Institute, London

Sandford, S., and Scoones, I. 2006. Opportunistic and conservative pastoral strategies: Some economic arguments. Ecological Economics, 58(1), 1-16.

Savory, A. 1983. The Savory grazing method or holistic resource management. Rangelands, 5(4), 155-159

Savory, A. 2013. Response to request for information on the "science" and "methodology" underpinning Holistic Management and holistic planned grazing. Savory Institute. URL http://www. savoryinstitute. com

Schmocker, J., Liniger, H.P., Ngeru, J.N., Brugnara, Y., Auchmann, R. and Brönnimann, S. 2015. Trends in mean and extreme precipitation in the Mount Kenya region from observations and reanalyses. Int J Climatol 36:1500–1514. doi:10.1002/joc.4438

Scoones, I. 1991. Wetlands in Drylands: Key resources for agricultural and pastoral production in Africa. Ambio 20 (8) 366-371

Scoones, I., ed. 1994. Living with Uncertainty: New direction in pastoral development in Africa. Intermediate Technology Publications. Rugby, UK

Sensenig, R., Demment, M.W. and Laca, E.A. 2010. Allometric scaling predicts preferences for burned patches in a guild of East African grazers. Ecology 91: 2898–2907

Serdeczny, O., Adams, S., Baarsch, F., Coumou, D., Robinson, A. and Hare, W. 2017. Climate change impacts in sub-Saharan Africa: from physical changes to their social repercussions. Regional Environmental Change 17(6): 1585–1600

Shiferaw, H., Schaffner, U., Bewket, W., Alamirew, T., Zeleke, G., Teketay, D. and Eckert, S. 2019a. Modelling the current fractional cover of an invasive alien plant and drivers of its invasion in a dryland ecosystem. Scientific Reports, https://doi.org/10.1038/s41598-018-36587-7

Shiferaw, H., Bewket, W., Alamirew, T., Zeleke, G., Teketay, D., Bekele, K., Schaffner, U., Eckert, S. 2019b. Implications of land use/land cover dynamics and Prosopis invasion on ecosystem service values in Afar Region, Ethiopia. Science of the Total Environment, https://doi.org/10.1016/j.scitotenv.2019.04.220

Shine, T. and Dunford, B. 2016. What value for pastoral livelihoods? An economic valuation of development alternatives for ephemeral wetlands in eastern Mauritania. Pastoralism: Research, Policy and Practice (2016) 6:9. DOI 10.1186/s13570-016-0057-x

Siedenburg, J. 2016. Community-based Cost Benefit Analysis (CBCBA). Findings from DFID Kenya's Arid Lands Support Programme Evidence on Demand. London, UK: Landell Mills

Sonneveld, B.G.J.S., Pande, S., Georgis, K., Keyzer, M.A., Seid Ali, A. and Takele, A. 2010. Land Degradation and Overgrazing in the Afar Region, Ethiopia: A Spatial Analysis. Land Degradation and Desertification: Assessment, Mitigation and Remediation pp 97-109

Spinoni, J., Naumann, G., Carrao, H., Barbosa, P. and Vogt, J. 2014. World drought frequency, duration, and severity for 1951–2010. Int. J. Climatol. 348:2792–804

Tabutin, D. and Schoumaker, B. 2004. « La démographie de l'Afrique au sud du Sahara des années 1950 aux années 2000 », Population 2004/3 (Vol. 59), p. 455-555. DOI 10.3917/popu.403.0521

Tanaka, J.A., Brunson, M. and Torrell, L.A. 2011. A social and economic assessment of rangeland conservation practices. In: BRISKE, D. D. (ed.) Conservation Benefits of Rangeland Practices: Assessment, Recommendations and Knowledge Gaps. Washington, DC: USDA Natural Resources Conservation Service.

Tari, D. and Pattison, J. 2014. Evolving Customary Institutions in the Drylands An opportunity for devolved natural resource governance in Kenya? Issue Paper. London: International Institute for Environment and Development.

Taye, G., Vanmaercke, M., Poeson, J., Deckers, J. and Haregeweyn, N. 2018. Determining RUSLE P- and C-factors for stone bunds and trenches in rangeland and cropland, North Ethiopia Land Degradation and Development 29, 812-824

Touré, I., Ickowicz, A., Wane, A. and Garba, I. 2012. Atlas des évolutions des systèmes pastoraux au Sahel : 1970-2012. Rome: FAO, CIRAD, 36 p

Turner, B.L., Kasperson, R.E., Matson, P.A., McCarthy, J.J., Corell, R.W., Christensen, L., Eckley, N., Kasperson, J.X., Luers, A., Martello, M.L., Polsky, C., Pulsipher, A. and Schiller, A. 2003. A framework for vulnerability analysis in sustainability science. Proceedings of the National Academy of Sciences of the United States of America, 100 (2003), pp. 8074-8079

Tyrrell, P., Russell, S. and Western, D. 2017. Seasonal movements of wildlife and livestock in a heterogeneous pastoral landscape: implications for coexistence and community based conservation. Global Ecology and Conservation 12, 59-72

United Nations Convention to Combat Desertification (UNCCD). 2001. Strategies for the communication of information and its use to generate best practices for combating desertification and mitigating the effect of drought, Committee on Science and Technology. UNCCD Ref. ICCD/COP (5)/CST/ 6 12 Sep 2001

United Nations Environment Programme – UN Environment World Conservation Monitoring Centre (UNEP-WCMC). 2016. The State of Biodiversity in Africa. A Mid-Term Review of Progress towards the Aichi Biodiversity Targets. UNEP-WCMC, Cambridge

United Nations Environment Programme – UN Environment World Conservation Monitoring Centre (UNEP-WCMC). 2017. World Database on Protected Areas User Manual 1.5. UNEP-WCMC: Cambridge, UK. Available at: http://wcmc.io/WDPA_Manual

Van Steenbergen, F. 2010. Guidelines on Spate Irrigation. Food and Agriculture Organization of the United Nations: Rome. http://www.fao.org/3/i1680e/i1680e.pdf

Van Steenbergen, F., Haile, A.M., Alemehayu, T., Alamirew, T. and Geleta, Y. 2011. Status and potential of spate irrigation in Ethiopia Water Resour. Manag., 25 (2011), pp. 1899-1913, 10.1007/s11269-011-9780-7

Vardakoulias, O. and Nicholles, N. 2014a. Managing uncertainty: an economic evaluation of community-based adaptation in Dakoro, Niger. London: New Economics Foundation, CARE

Vardakoulias, O. and Nicholles, N. 2014b. Simplified guidelines for Social Cost-Benefit Analysis of Climate Change adaptation projects on a local scale London: New Economics Foundation (NEF) and CARE

Veblen, K.E. 2012. Savanna glade hotspots: Plant community development and synergy with large herbivores. J. Arid Environ. 78, 119–127 (2012). doi:10.1016/j.jaridenv.2011.10.016

Venton, C.C. 2018. Economics of resilience to drought. USAID

Vetter, S. 2013. Development and sustainable management of rangeland commons – aligning policy with the realities of South Africa's rural landscape. Afr. J. Range Foroage Sci., 30 (2013), pp. 1-9

Wane, A., Mballo, A.D. and Sy, A.B. 2016. Sénégal – Evaluation des risques agricoles – Sous-secteurs de l'élevage et de la pêche, IFAD-Platform for Agricultural Risk Management, 160 p. http://p4arm.org/app/uploads/2015/02/PARM_Senegal_RAS_ExecutiveSummary_EN.pdf

Water Resources Management Authority (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

Water Resources Management Authority (WRMA). 2016a. Surface water and groundwater resources assessment in Wajir County for decision-making: final report. Nairobi: Geekan Kenya Ltd for the Kenyan Water Resource Management Authority (WRMA)

Water Resources Management Authority (WRMA). 2016b. Water Resources Assessment for Decision Making in Garissa County final report June 2016. Contract No. WRMA/GOK/MTAP2/3/1/2015-2016 – LOT 1. Nairobi: MTAP

Western, D., Groom, R. and Worden, J.S. 2009a. The Impact of Subdivision and Sedentarization of Pastoral Lands on Wildlife in an African Savanna Ecosystem. Biological Conservation, 142:11:2538-2546.

Western, D., Russell, S. and Cuthill, I. 2009b. The status of wildlife in protected areas compared to non-protected areas of Kenya. PloS One,4(7):e6140. 10.1371/journal.pone.0006140

Western, D., Waithaka, J., and Kamanga, J. 2015. Finding space for wildlife beyond national parks and reducing conflict through community-based conservation: the Kenya experience. Parks, 21, 51-62

Wigley, B.J., Bond, W.J. and Hoffman, M.T. 2010. Thicket expansion in a South African savanna under divergent land use: local versus global drivers?Glob. Change Biol. 16, 964–976.doi:10.1111/j.1365-2486.2009.02030.x (doi:10.1111/j.1365-2486.2009.02030.x)

Wint, W. and Robinson, T. 2007. Gridded livestock of the world 2007. FAO

Woodhouse, P. 2003. African enclosures: A default mode of development. World Development, 31. doi:10.1016/s0305-750x(03)00140-2

World Atlas of Desertification (WAD). 2018: Cherlet, M., Hutchinson, C., Reynolds, J., Hill, J., Sommer, S., von Maltitz, G. (Eds.), World Atlas of Desertification, Publication Office of the European Union, Luxembourg, 2018

World Bank. 2011. World Development Report 2011: Conflict, Security, and Development. Washington, DC: World Bank. http://siteresources.worldbank.org/INTWDRS / Resources/WDR2011_Full_Text.pdf

World Database on Protected Areas (WDPA). 2018. https://protectedplanet.net/

World Overview of Conservation Approaches and Technologies (WOCAT). 2018. Questionnaire on SLM Technologies (Core) – A tool to help document, assess, and disseminate SLM practices (revised). https://www.wocat.net/library/media/15/

World Travel & Tourism Council (WTTC). 2018. Travel & tourism economic impact 2018 Kenya. https://www.wttc.org/-/media/files/reports/economic-impact-research/countries-2018/kenya2018.pdf

Wright, I., Ericksen, P., Mude, A., Robinson, L.W., and Sircely, J. 2015. Importance of livestock production from grasslands for national and local food and nutritional security in developing countries. Paper presented at the International Grasslands Congress. New Delhi. URL: https://cgspace.cgiar.org/handle/10568/69389

Young, T.P., Palmer, T.M. and Gadd, M.E. 2005. Competition and compensation among cattle, zebras, and elephants in a semi-arid savanna in Laikipia, Kenya. Biological Conservation.Volume 122, Issue 2, March 2005, Pages 351-359

Zougmoré, R., Partey, S., Ouédraogo, M., Torquebiau, E. and Campbell, B. 2018. Facing climate variability in sub-Saharan Africa: analysis of climate-smart agriculture opportunities to manage climate-related risks. Cahiers Agriculture 27(3): 34001

Glossary

This glossary covers the most important technical terms used in this publication. Where there are no references cited for the entries, these are working definitions as employed by the authors – in the context of the book. It must be pointed out that some terms – such as **'rangelands'** itself have multiple definitions in the literature. For some entries we give alternative definitions. Bold terms in a definition are defined in the glossary.

For a more comprehensive glossary on rangeland related terms the reader is referred to the glossary list of 'Global **Rangelands**'[1], the glossary chapter (Appendix 4) of the Millennium Ecosystem Assessment (MEA 2005b), and 'an international terminology for grazing lands and **grazing** animals (Allen et al. 2011).

Adaptation: Adjustment in natural or human systems to a new or changing environment (MEA 2005).

Agrobiodiversity: The variety and **variability** of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture, including crops, livestock, forestry and fisheries[2].

Agro-ecological zones: Geographic regions having similar climate and soils for agriculture (FAO 1978).

Agropastoralism: Systems that, in addition to **pastoral** livestock production, involve some form of crop cultivation (Allen et al. 2011).

Agropastoralists: People who practice **agropastoralism**.

Biodiversity (biological diversity): The **variability** among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of habitats (based on Convention on Biological Diversity)[3].

Biome: A major portion of the living environment of a particular region (such as a fir forest or **grassland**), characterized by its distinctive vegetation and maintained largely by local climatic conditions[4].

Browsing: Feeding of herbivores on leaves, soft shoots/ woody twigs, or fruits of high-growing, generally woody, plants such as shrubs and trees.

Capacity building: A process of strengthening or developing human resources and skills, institutions, organizations, or networks (e.g. through training, etc.). Also referred to as capacity development or capacity enhancement (MEA 2005).

Carrying capacity: The maximum stocking rate that will achieve a target level of animal performance, in a specified **grazing** system and that can be applied over a defined time without deterioration of the **grazing** land (Allen et al. 2011).

Climate change adaptation (CCA): The process of adjustment to actual or expected climate and its effects. In human systems, **adaptation** seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects (IPCC 2014).

Climate change mitigation (CCM): Efforts to reduce or prevent emission of greenhouse gases. Mitigation can mean using new technologies and renewable energies, making older equipment more energy efficient, or changing to more sustainable management practices or consumer behaviour[5].

Climate change resilience: The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for **adaptation**, learning, and transformation. (IPCC 2014, building on the definition used in Arctic Council 2013)

Common property resource: A good or service shared by a well-defined community (MEA 2005).

Conservation: The protection, care, management and maintenance of ecosystems, habitats, wildlife species and populations, within or outside of their natural environments, in order to safeguard the natural conditions for their long-term permanence[6].

Conservancy: Land set aside by an individual landowner, body corporate, group of owners or a community for purposes of wildlife **conservation**[7].

Cropland: Land devoted to the production of cultivated crops. May be used to produce **forage** crops (Allen et al. 2011).

Decision maker: A person whose decisions, and the actions that follow from them, can influence a condition, process, or issue under consideration (MEA 2005).

Degradation of land: Reduction or loss of biological or economic productivity of the land (see Box 2.3)[8].

Desertification: Land **degradation** in **drylands** resulting from various factors, including climatic variations and human activities (see Box 2.3)[9] (based on MEA 2005).

Desert: Land on which vegetation is sparse or absent and is characterized by an arid climate. Deserts may be classified as hot or cold deserts depending on latitude and elevation (Allen et al. 2011).

Dry forests: A type of forest characterized by relatively sparse distributions of pine, juniper, oak, olive, acacia, mesquite, and other drought-resistant species growing in scrub woodland, savanna, or chaparral settings, occurs in the southwestern United States, Mediterranean region, sub-Saharan Africa, and semiarid regions of Mexico, India, and Central and South America.[10]

Drylands: Ecosystems characterized by a lack of water. They include cultivated lands, scrublands, **shrublands**, **grasslands**, **savannahs**, **semi-deserts** and true **deserts**. The lack of water constrains the production of crops, **forage**, wood, and other **ecosystem services**. Four dryland subtypes are widely recognized: dry sub-humid, semiarid, arid, and hyperarid, showing an increasing level of aridity or moisture deficit[11].

Ecosystem functions: An intrinsic characteristic of an ecosystem related to the set of conditions and processes through which an ecosystem maintains its integrity. They include such processes as water cycling, nutrient cycling, production, decomposition, and fluxes of energy (MEA 2005).

Ecosystem services: The benefits people obtain from ecosystems. These services are categorized into (a) provisioning services such as food and water, (b) regulating services such as flood and disease control, (c) cultural services such as spiritual, recreational, and cultural benefits, and (d) supporting services, such as nutrient cycling, that maintain the conditions of life on Earth (MEA 2005 and Liniger et al. 2017).

Ecological gradient: A gradation from one ecosystem to another when there is no sharp boundary between the two.[12.]

Equilibrium/ non-equilibrium: Equilibrium **grazing** systems and strategies are characterised by climatic stability that results in predictable primary production allowing optimal stocking rates because livestock reproduce and produce at a rate determined by the availability of feed, which is an inverse function of stock density. Non-equilibrium **grazing** systems and strategies are suited to situations where low and erratic rainfall produces unpredictable fluctuations in **forage** supplies and hence setting stocking rates is of little value because fluctuation in rainfall has a stronger effect than animal numbers on the abundance of **forage** (Behnke 2000).

Governance: The process of regulating human behaviour in accordance with shared objectives. The term includes both governmental and non-governmental mechanisms (MEA 2005).

Grassland: Land where grass or grass-like vegetation grows and is the dominant form of plant life[13].

Grazable forestland: Forestland that produces, at least periodically, understorey vegetation that can be grazed. Trees and shrubs can be browsed. (Allen et al. 2010).

Grazing: Feeding of herbivores on herbaceous **forage** (grass or forbs).

Group ranch: A livestock production system or enterprise where a group of people jointly own freehold title to land, maintain agreed stocking levels and herd their livestock collectively which they own individually. Selection of members to a particular group ranch was based on kinship and traditional land rights[14].

Forage/ forage crops: Edible parts of plants, other than separated grain, that can provide feed for **grazing** animals or that can be harvested for feeding. (Allen et al. 2011).

Functional heterogeneity: Spatial and temporal variation in the grass height (structure), **productivity**, phenology, composition and chemical attributes of **grassland** and **savannah** plant communities, which determine the abundance, stability, diversity and spatial distribution of large mammalian herbivores[15].

Heterogeneity: Associated with variable patterns and processes that are dynamic in space and time and lead to complexity that is an essential characteristic of **rangelands** (Fuhlendorf et al. 2017).

Holistic management: "Manage the relationships between land, g**razing** animals and water in ways that mimic nature"[16].

Intrinsic value: The value of someone or something in and for itself, irrespective of its utility for someone else[17]. Hence, every species has a value and role in nature. It has a right to exist, whether or not it is known to be useful to humans.

Landscape: An area of land that contains a mosaic of ecosystems, including human-dominated ecosystems (MEA 2005).

Land use: Human activities, which are directly related to the land, making use of its resources, or having an impact upon it (WOCAT 2018).

Livelihood: Comprises the capabilities, assets (human, social, natural, physical, financial, and political capitals) and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation[18] (based on Chambers and Conway 1992).

Natural grassland: Natural ecosystem dominated by indigenous or naturally occurring grasses and other herbaceous species used mainly for **grazing** by livestock and wildlife (Allen et al. 2011).

Natural resources: Resources produced by nature, commonly subdivided into non-renewable resources, such as minerals and fossil fuels, and renewable natural resources that propagate or sustain life and are naturally self-renewing when properly managed, including plants and animals, as well as soil and water[19].

Nomadism: Nomads are members of a group of people who have no fixed home and move according to the seasons from place to place in search of food, water, and **grazing** land[20]. Their movements are opportunistic following **pasture** and water resources in a pattern that varies from year to year according to the availability of resources (Liniger et al. 2011).

Non-livestock rangeland products: Products from the **rangelands** that are not livestock related. Sometimes wildlife and tourism (and even carbon credits) are included in this category, but it is normally used to describe medicinal plants, plants yielding products of commercial value such as honey, gum arabic (from *Acacia senegal*), shea butter, handicrafts, etc.

Off-site: Downstream: away from fields or principal area of activity; concerns adjacent areas or areas further away from the area where specific activities are applied. Used to demonstrate that activities in one area also have impacts outside the area (e.g. downstream flooding)[21].

On-site: Refers to the area in which a land management practice is applied, the location itself[22].

Opportunism: Conscious policy and practice of taking advantage of circumstances – with little regard for principles or with what the consequences are for others. Or: the art, policy, or practice of taking advantage of opportunities or circumstances often with little regard for principles or consequences[23].

Pastoral system: A livestock production system found in rangeland areas where livestock **grazing** is the predominant form of **land use** (FAO, 2002).

Pastoralism: A **livelihood** system based on open, yet managed, **grazing** of animals on **natural** or semi-natural **grassland**, **grassland** with trees, and/or open **woodlands**. Animal owners may or may not have a permanent residence while livestock are moved to distant **grazing** areas, according to the availability of resources (Jenet et al. 2016).

Pastoralists: People who practice **pastoralism**

Pasture: Land used permanently (five years or more) to grow herbaceous **forage** crops, either cultivated or growing wild (wild prairie or **grazing** land) for harvest by **grazing**, cutting, or both[24] (Allen et al. 2011).

Productivity: The rate at which goods are produced or work is completed[25]. In the context of this book: mostly related to land productivity as the rate of biomass and the quality produced.

Ranch: Commercial raising of grazing animals, mainly for meat but also milk and other products under extensive production systems usually with controlled boundaries and paddocks[26].

Rangelands: ecosystems that are dominated by grasses, grass-like plants, combined with various degrees of bush and tree cover that are predominantly grazed or browsed, and which are used as a natural and semi-natural ecosystem for the production of livestock and safeguarding of wildlife and additional **ecosystem services** (Blench and Sommer 1999, Allen et al. 2011 and McGahey et al. 2014).

Rangeland condition: Range condition is the present state of **health** of the range in relation to what it could be with a given set of environmental and managerial factor[27].

Rangeland degradation: Reduction in the capacity of the rangeland to provide ecosystem goods and services, over a period of time, for its beneficiaries (Bunning et al. 2011). Land **degradation** includes: soil erosion by water and wind, chemical and physical soil deterioration, and biological and water **degradation** (WOCAT 2018).

Rangeland health: The state of the rangeland – reflecting the degree of **rangeland degradation** and the **ecosystem functions** and services rendered.

Rangeland management: The use of **rangeland** by various **rangeland users** to produce the goods and services required by them.

Rangeland users: A wide variety of people who rely on resources from the rangeland to enable them to support viable **livelihoods**.

Resilience: The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for **adaptation,** learning, and transformation[28].

Rotational grazing: Shifting of livestock to different units of a **pasture** or range in regular but flexible sequence to permit the recovery and growth of the **pasture** plants after **grazing**[29].

Savannah (or Savanna): Grassland characterized by precipitation between 375 and 1500 mm/ year, variable proportions of trees or large shrubs, especially in tropical and sub-tropical regions. It is often a transitional vegetation type between **grassland** and **forestland** (Allen et al. 2011).

Scaling out: Widespread dissemination and adoption of SLM practices by an increasing number and range of land users (based on Douthwaite et al. 2007 and IFAD 2015).

Scaling up: Expansion of practices employed by few to many land users and the integration of SLM into national policies and planning mechanisms to facility the spreading (**scaling out**) of the land covered by SLM (based on Douthwaite et al. 2007 and IFAD 2015).

Sedentary /sedentary systems: Not migratory: settled households[30].

Shrubland: Land on which the vegetation is dominated by low-growing woody plants (Allen et al. 2011).

Stakeholder(s): People involved in or impacted by land management, such as individual land users and land owners, representatives from associations and local initiatives, indigenous people, local/ regional/ national government and their agencies, private enterprises/ business representatives, as well as researchers working in the involved research projects (Liniger et al. 2017).

Steppe: Semi-arid, sparse and flat to rolling **grassland** characterized by short to medium-height grasses occurring with other herbaceous vegetation and occasional shrubs (Allen et al. 2011).

Sub-Saharan Africa (SSA): The World Bank[31] characterises Sub-Saharan Africa as consisting of following countries:

Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo, Dem. Rep. of Congo, Rep.Cote d'Ivoire, Equatorial Guinea, Eritrea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, and Zimbabwe.

Note: the northern part of Sudan (north of the 20°North) has been excluded from the definition of SSA in this book.

Transhumance: Regular movements of herds between fixed points in order to exploit the seasonal **variability** of **pastures**. When these **grazing** grounds are reached herders and their livestock remain for a defined period before they move forward to next **grazing** grounds: for example the Fulbe follow a century–old **grazing** route northward to the borders of the Sahara, and southward to the moist **savannah** during the wet and the dry seasons, respectively (Liniger et al. 2011).

Variability: means the tendency to shift, change or deviate from the usual state (applicable to climate especially rainfall and the availability of water and fodder resources)[32].

Vulnerability: the capacity to be wounded, i.e., the degree to which a system is likely to experience harm due to exposure to a hazard (Turner et al. 2003).

Watershed/ catchment: Also drainage basin, catchment basin, river basin. A watershed is a topographically limited area from which all water is drained by a common water course/ outlet. It is the area with a common water flow or drainage system joining in one body of water such as a river, lake, reservoir, estuary, **wetland**, sea, or ocean (Liniger et al. 2017).

Wetlands: Transitional areas between terrestrial and aquatic systems in which the water table is usually at or near the surface or the land is covered by shallow water. Under the Ramsar Convention, wetlands can include tidal mudflats, natural ponds, marshes, potholes, wet meadows, bogs, peatlands, freshwater swamps, mangroves, lakes, rivers and even some coral reefs[33].

Woodland: A plant community in which, in contrast to a typical forest, the trees are often small, characteristically short-bowled relative to their crown depth and forming only an open canopy with the intervening area being occupied by shorter vegetation, commonly grass (Allen et al. 2011).

[1] https://globalrangelands.org/glossary/P?term=

[2] http://www.fao.org/faoterm/en

[3] https://www.iucn.org/downloads/en_iucn__glossary_definitions.pdf

[4] https://www.iucn.org/downloads/en_iucn__glossary_definitions.pdf

[5] http://web.unep.org/climatechange/mitigation

[6] https://www.iucn.org/downloads/en_iucn__glossary_definitions.pdf

[7] https://sgp.undp.org/all-documents/country-documents/911-establishing-a-wildlife-conservancy-in-kenya/file.html

[8] https://www.iucn.org/downloads/en_iucn__glossary_definitions.pdf

[9] https://www.wocat.net/en/glossary/#heading-d

[10] McGraw-Hill Dictionary of Scientific & Technical Terms, 6E, Copyright © 2003 by The McGraw-Hill Companies, Inc.

[11] www.greenfacts.org/glossary/

[12] https://www.encyclopedia.com/science/dictionaries-thesauruses-pictures-and-press-releases/ecocline

[13] http://www.oxfordreference.com/search?q=grassland&searchBtn=Search&isQuickSearch=true

[14] http://www.fao.org/Wairdocs/ilRi/x5485e/x5485e0t.htm

[15] https://besjournals.onlinelibrary.wiley.com/doi/epdf/10.1111/1365-2664.12591 (see also Hopcraft, J.G.C., Olff, H. & Sinclair, A.R.E. (2010) *Herbivores, resources and risks: alternating regulation along primary environmental gradients in savannas. Trends in Ecology & Evolution, 25, 119 –128)*

[16] https://holisticmanagement.org/wp-content/uploads/2011/12/HolisticManagement-1-22.pdf; *Savory, Allan. "Principles of Holistic Management, Empowering Caretakers of the Land". Savory Institute. Archived from the original on 9 January 2012. Retrieved 6 April 2013.*

[17] http://millenniumassessment.org/documents/document.59.aspx.pdf

[18] https://www.unisdr.org/files/16771_16771guidancenoteonrecoveryliveliho.pdf

[19] https://www.iucn.org/downloads/en_iucn__glossary_definitions.pdf

[20] http://www.thefreedictionary.com/nomadic

[21] https://www.wocat.net/en/glossary#heading-o

[22] https://www.wocat.net/en/glossary#heading-o

[23] https://www.merriam-webster.com/dictionary/opportunism#h1

[24] www.fao.org/fileadmin/templates/ess/ess_test_folder/Definitions/LandUse_list.xls

[25] https://www.merriam-webster.com/dictionary/productivity

[26] https://www.wocat.net/en/glossary#heading-r

[27] http://www.fao.org/wairdocs/ilri/x5543b/x5543b0o.htm

[28] https://www.wocat.net/en/glossary/#heading-r

[29] https://www.merriam-webster.com/dictionary/rotation%20grazing

[30] https://www.merriam-webster.com/dictionary/sedentary

[31] https://data.worldbank.org/region/sub-saharan-africa

[32] https://www.biology-online.org/dictionary/Genetic_variability

[33] https://www.iucn.org/downloads/en_iucn__glossary_definitions.pdf

Table showcasing good practices and instituions

Technology groups: TG1 enabled mobility, TG2 controlled grazing, TG3 range improvement, TG4 supplementary feeding, TG5 infrastructure improvement;

Approach groups: AG1 community based NRM, AG2 land & water use planning, AG3 marketing & alternative income, AG4 wildlife & nature tourism;

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Duncan Collins Khalai **d.khalai@cgiar.org**		Index Based Livestock Insurance (IBLI)	IBLI was designed to help protect pastoralists and their livestock against the effects of prolonged forage scarcity. It triggers payment to pastoralists when the forage situation deteriorates to levels considered to be severe, as compared to historical conditions over time.	International Livestock Research Institute (ILRI) - Kenya
Ken Otieno **peterkenotieno009@gmail.com**		**Social Tenure Domain Model (STDM)**	STDM is about people and their relationships with land. The tool as applied secures tenure through the recognition of tenure diversity and social contexts. It facilitates proper land use and management to minimize practices that lead to degradation.	Resource Conflict Institute (RECONCILE) - Kenya
Ibrahim Jarso **jarsoibra@gmail.com**	Caroline King-Okumu caroking@yahoo.com	**Dedha grazing system as a natural resource management technology**	The Dedha is an ancient, traditional rangeland resources governance system practiced by Boran pastoralists to adapt to severe and recurrent droughts. It is based on three grazing zones: wet season, dry season, and drought reserves. Water governance is based on a traditional hierarchy of rights.	Resource Advocacy Programme (RAP) - Kenya
Bonnet Bernard **b.bonnet@iram-fr.org**		**Sécurisation de la mobilité pastorale via la concertation et l'accès aux points d'eau**	Securing the mobility of pastoralism through access to water sources (open wells and ponds in pastoral areas) and marking the livestock routes for transhumance: the case of the project Almy Al Afia in Chad and its consultative approach.	Centre de coopération internationale en recherche agronomique pour le développement/ Institut de recherches et d'applications des méthodes de développement (CIRAD/ IRAM)
Karl-Peter Kirsch-Jung **kpkirs@web.de**		**Mise en place d'un suivi écologique de la gestion locale des ressources sylvo-pastorales - Indice du couvert végétal**	A system for ecological monitoring provides accurate observations on the development of sylvo-pastoral resources, the management of which is handed over to land users. The used method is to record the Vegetation Cover Index (VCI) to register changes compared with an initial survey.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

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Paul Kahiga mathaiya_kahiga@yahoo.co.uk		Rotational grazing	Rotational grazing is a process whereby livestock are strategically moved to fresh paddocks, or partitioned pasture areas, to allow vegetation in previously grazed pastures to regenerate.	Jomo Kenyatta University - Kenya; Kenya Agricultural Research Institute (KARI) Headquarters - Kenya; International Centre for Research in Agroforestry (ICRAF) - Kenya
Michael Herger **michael.herger@scnat.ch**		**Il Ngwesi Group Ranch grazing with Holistic Management principles**	A Masai group ranch applied "Holistic Management" principles consisting of: separate, planned grazing in villages during the rains, "bunching" and moving of all animals in herds during the dry season. Denuded land is recovered by a "boma" technology: i.e. strategic corralling of animals overnight, and reseeding of degraded land.	Centre for Development and Environment (CDE), University of Bern
Michael Herger **michael.herger@scnat.ch**		Lolldaiga Hills Ranch: Rotational Grazing and Boma-Based Land Reclamation	Lolldaiga Hills ranch is a private ranch and conservancy with livestock production and tourism. Rotational grazing and "boma technology" is used to manage livestock on semi-arid lands with limited water resources.	Centre for Development and Environment (CDE), University of Bern
Michael Herger **michael.herger@scnat.ch**		Borana Ranch Grazing with Holistic Management Principles	Borana is a private ranch which combines livestock production with conservation and tourism. "Holistic Management" is applied as a principle for livestock production on semi-arid lands with limited water resources. Grazing comprises "bunching" and rotational movement of all animals in herds.	Centre for Development and Environment (CDE), University of Bern

Rangeland use systems (RUS): 1 pastoral, 2 agropastoral, 3 bounded without wildlife, 4 bounded with wildlife, 5 parks & reserves, 6 pastures.

Projects	Database code	Country	Region	Rangeland mgt groups	Rangeland use system	Linked to:	Title
Index Based Livestock Insurance, Kenya (IBLI)	T 3361	Kenya	Eastern and Horn of Africa	TG1	1	A 3283	Kenya Livestock Insurance Program (KLIP)
Participatory Community Resource Mapping project	T 3318	Kenya	Eastern and Horn of Africa	TG1	1	A 3379	Participatory Community Resource Mapping using the Social Tenure Domain Model (STDM)
Strengthening Adaptation and Resilience to Climate Change in Kenya Plus (StARCK+)	T 3403	Kenya	Eastern and Horn of Africa	TG1	2	A 3345	Empowering Dedha institutions in governing the natural resources of Isiolo rangelands
Almy Al Afia project	T 3356	Chad	West Africa	TG1	1		
Programme Gestion des Ressources Naturelles, Mauretanie (ProGRN)	T 2081	Mauritania	West Africa	TG1	1	A 1980	Gestion locale collective des ressources naturelles

Projects	Database code	Country	Region	Rangeland mgt groups	Rangeland use system	Linked to:	Title
	T 1741	Kenya	Eastern and Horn of Africa	TG2	3		
Master thesis	T 2092	Kenya	Eastern and Horn of Africa	TG2	4		
Master thesis	T 2982	Kenya	Eastern and Horn of Africa	TG2	4		
Master thesis	T 2972	Kenya	Eastern and Horn of Africa	TG2	4		

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Edmund Barrow Edmund.Barrow@iucn.org		Ngitili Dry-Season Fodder Reserves	Ngitili are traditional enclosures for in-situ conservation and rehabilitation of vegetation, practiced by the Wasukuma agropastoralists in Shinyanga, Tanzania.	International Union for Conservation of Nature (IUCN)
Ibo Zimmermann **izimmermann@nust.na**	Colin Nott canott@iafrica.com.na Uhangatenua Kapi uhangatenuak@yahoo.co.uk Amon Kapi	**Combined herding for planned grazing**	Daily combining of livestock from all households into a single herd to be driven to different designated portions of the communal grazing area. Grass can then recover by replenishing its reserves before being re-grazed some months later.	Namibia University of Science and Technology (NUST) - Conservation Agriculture Namibia (Conservation Agriculture Namibia) - Namibia
Lehman Lindeque lehman.lindeque@gmail.com		Rotational Grazing	Rotational grazing is a management system based on the subdivision of the grazing area into a number of enclosures and the successive grazing of these paddocks by animals in a rotation so that not all the veld (grazing area) is grazed simultaneously.	Ministry of Agriculture, Livestock and Fisheries (MoA) - Kenya
Richard Fynn **richardwsfynn@gmail.com**		**Split Ranch Grazing Strategy**	Split Ranch Grazing involves grazing half the available area for a full year maintaining the grassland in an immature, high-quality state, while resting the other half, allowing optimal recovery from the previous full years grazing. The concept can also be used in pastoral-wildlife systems.	Okavango Research Institute, University of Botswana
Wanda Mphinyane Mphinyanew@mopipi.ub.bw		Game Ranching	To conserve/sustain rangeland through controlled grazing of wildlife enterprise.	University of Botswana
Franziska Kaguembèga-Müller kaguembega@newtree.org		Assisted Natural Regeneration of Degraded Land	Fenced 3 ha plots are set aside to allow for natural regeneration of highly diverse forests.	newTree - nouvelarbre - Switzerland

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Harry Wells **harrybmwells@gmail.com**	Hanspeter Liniger hanspeter.liniger@cde.unibe.ch	**Rangeland Restoration by cutting invasive species and grass reseeding and managing grazing**	Rangeland Restoration' is part of a Holistic Rangeland Management approach. It involves clearing of invasive vegetation (predominantly Acacia reficiens) and reseeding with grass (Cenchrus ciliaris) and allowing resting and reduced grazing pressure to rehabilitate degraded communal grazing land.	Kalama Community Wildlife Conservancy
Betty Adoch bettyadoch7@gmail.com	Joy Tukahirwa j.tukahirwa@infocom.co.ug	Rotational grazing of goats for pasture conservation and improvement.	Rotational grazing by improved goats variety enhances/ increases soil fertility, biodiversity and production of pastures and generates farmyard manure applied on cropland.	Uganda Landcare Network (ULN) - Uganda
Betty Adoch bettyadoch7@gmail.com	Joy Tukahirwa j.tukahirwa@infocom.co.ug	Reclamation of indigenous pastures for dairy farming	Dairy cattle (Friesian) are grazed on indigenous pastures to promotes conservation of the indigenous grass species (guinea grass), which protects the soil against soil erosion and promotes biodiversity.	Uganda Landcare Network (ULN) - Uganda
Daniel Danano dale.daniel@fao.org		Improved grazing land management	Rehabilitation of communal grazing lands, through planting of improved grass and fodder trees and land subdivision, to improve fodder and consequently livestock production.	Ministry of Agriculture and Natural Resources (MoA) - Ethiopia; Food and Agriculture Organization of the United Nations (FAO)
Daniel Danano dale.daniel@fao.org		Area closure for rehabilitation	Enclosing and protecting an area of degraded land from human use and animal interference, to permit natural rehabilitation, enhanced by additional vegetative and structural conservation measures.	Ministry of Agriculture and Natural Resources (MoA) - Ethiopia; Food and Agriculture Organization of the United Nations (FAO)
Gizaw Desta Gessesse gizaw.d@wlrc-eth.org		Gully erosion management	Combination of practices divert excess runoff upstream of gully heads and control further development of the gully using appropriate structural and vegetative measures. Through the consultation and involvement of local community land eventually becomes productive.	Water and Land Resource Centre (WLRC)

Projects	Database code	Country	Region	Rangeland mgt groups	Rangeland use system	Linked to:	Title
	T 1351	Tanzania	Eastern and Horn of Africa	TG2	6		
Southern African Science Service Centre for climate change and Adaptive Land management (SASSCAL), German Federal Ministry of Education and Research (BMBF) - Germany	T 3326	Namibia	Southern Africa	TG2	3	A 3050	Community grazing management
	T 1356	South Africa	Southern Africa	TG2	3		
	T 3217	Botswana	Southern Africa	TG2	3		
	T 1386	Botswana	Southern Africa	TG2	5		
	T 1358	Burkina Faso	West Africa	TG2	6		

Projects	Database code	Country	Region	Rangeland mgt groups	Rangeland use system	Linked to:	Title
	T 3381	Kenya	Eastern and Horn of Africa	TG3	4		
Scaling-up SLM practices by smallholder farmers (IFAD), Uganda	T 2147	Uganda	Eastern and Horn of Africa	TG3	6		
Scaling-up SLM practices by smallholder farmers (IFAD), Uganda	T 2321	Uganda	Eastern and Horn of Africa	TG3	6		
	T 1049	Ethiopia	Eastern and Horn of Africa	TG3	6	A 2388	Local level participatory planning approach
	T 1048	Ethiopia	Eastern and Horn of Africa	TG3	6	A 2388	Local level participatory planning approach
Water and Land Resource Centre (WLRC) project	T 1597	Ethiopia	Eastern and Horn of Africa	TG3	6	A 2497 A 2495	Cut and Carry' Grazing system or 'Zero Grazing' (CCG) Community Organizations and Mobilization for Soil and Water Conservation Work (COM-SWC)

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Godfrey Baraba		Range enclosures	Is the restriction, reseedling of desmodium decoloratum, stylothensis hamata and Stilozobium spps in the demarcated overgrazed land.	Bukoba district council, Kyerwa District Council, Missenyi District Council - Tanzania; Food and Agriculture Organization of the United Nations (FAO) - Tanzania
Rick Nelson Kamugisha rkamu2016@gmail.com	Bernard Fungo bfungo1@yahoo.com Richard Otto Kawawa ottorichardk@gmail.com Joy Tukahirwa j.tukahirwa@infocom.co.ug	Controlled livestock grazing for soil fertility improvement	Integrated crop-livestock production for improved soil fertility management. Local cows are tied to trees to facilitate manure collection.	Uganda Landcare Network (ULN) - Uganda
Kevin Mganga **kmganga@seku.ac.ke**		**Grass reseeding**	Grass reseeding is a sustainable land management practice aimed at rehabilitating degraded pastures and providing livestock feed. This is mainly carried out with indigenous perennial grass species.	Department of Range and Wildlife Sciences, South Eastern Kenya University (SEKU) - Kenya
Wilson Bamwerinde bamwerinde@gmail.com		Improved fodder production on degraded pastureland	Transformation of degraded pastureland to high quality fodder plots.	Food and Agriculture Organization of the United Nations (FAO) - Uganda
Gizaw Desta Gessesse gizaw.d@wlrc-eth.org		Area closure on degraded lands	Area closure on degraded lands is a land management practice used to rehabilitate and conserve the natural resource bases, and enhance its natural regeneration and restoring capacity and productive functions by excluding animal and human interferences through community consultation and collective actions.	Water and Land Resource Centre (WLRC)
Allan Bubelwa allan.bubelwa@gmail.com		Area enclosures for protection of riverine ecosystem and regeneration of cut and carry materials.	Area enclosures for protection of riverine ecosystem and purposeful regeneration of mulching and pasture materials for cut and carry	Bukoba District Council, Missenyi District Council - Tanzania; Food and Agriculture Organization of the United Nations (FAO) - Tanzania
Nicholas Euan Sharpe **nick@agrolynx.org**	Txaran Basterrechea txaranb@yahoo.es	Community supported pasture and rangeland rehabilitation works	Rehabilitation of rangelands involves selection of key pasture and fodder species, and their reintroduction into strategic areas through stakeholder participation. The technology is also supported by communal management plans, which were created to address the root causes of land degradation.	Food and Agriculture Organisation Angola (FAO) - Angola
Dirk Pretorius **dirk@smc-synergy.co.za**	Buckle Jacob JBuckle@environment.gov.za South Africa's national government	Pitting to restore degraded catchment of Mount Fletcher Dam	To improve water infiltration and vegetation cover by creating small ponds on bare soil in an effort to reduce sheet and rill erosion.	SMC Synergy (SMC Synergy) - South Africa
Dirk Pretorius **dirk@smc-synergy.co.za**		Spekboom (Portulacaria afra) planting within riplines for thicket biome restoration	The restoration of the thicket biome in the Eastern Cape is assisted by planting "spekboom" (elephant bush), an indigenous succulent plant within contour lines/ riplines on degraded hillslopes. The increased vegetation cover reduces runoff and soil loss.	SMC Synergy (SMC Synergy) - South Africa
Franci Petra Jordaan weifj@potch1.agric.za		Rangeland Rehabilitation	Rangeland rehabilitation where we use perennial grasses to rehabilitate the footslopes in a semi-arid region on a clay loam soil	Department of Agriculture North West Province - South Africa
Johannes Laufs **johannes.laufs@giz.de**	Asellah David asellah.david@giz.de	**Bush Thinning and Biomass Processing by Manual or Mechanised Means**	In Namibia, excess bush is harvested to reduce competition with other plants, especially grasses. Bush can be thinned manually (e.g. with axes), semi-mechanised (e.g. chainsaws) or fully mechanised (e.g. customised equipment). After cutting, the bush is left to dry and then processed into chips or other products.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
Klaus Kellner klaus.kellner@nwu.ac.za		Restoration of degraded rangeland	Eradication of invasive species and revegetation of degraded rangelands by different treatments, including oversowing with grass seed mixture, supplementing with lime, cattle dung, and "brush packing" (laid out branches).	Gauteng Department of Agriculture and Rural Development, South Africa; Potchefstroom Universiteit vir CHO, South Africa

Projects	Database code	Country	Region	Rangeland mgt groups	Rangeland use system	Linked to:	Title
The Transboundary Agro-ecosystem Management Project for the Kagera River Basin (GEF-FAO / Kagera TAMP)	T 1612	Tanzania	Eastern and Horn of Africa	TG3	6		
Scaling-up SLM practices by smallholder farmers (IFAD), Uganda	T 2761	Uganda	Eastern and Horn of Africa	TG3	6		
	T 2288	Kenya	Eastern and Horn of Africa	TG3	6	A 3285	On-farm indigenous pasture establishment demonstrations
The Transboundary Agro-ecosystem Management Project for the Kagera River Basin (GEF-FAO / Kagera TAMP)	T 1588	Uganda	Eastern and Horn of Africa	TG3	6		
Water and Land Resource Centre (WLRC) project	T 1598	Ethiopia	Eastern and Horn of Africa	TG3 / TG4	6	A 2497	Cut and Carry' Grazing system or 'Zero Grazing'
The Transboundary Agro-ecosystem Management Project for the Kagera River Basin (GEF-FAO / Kagera TAMP)	T 1607	Tanzania	Eastern and Horn of Africa	TG3/ TG4	6	A 2488	Active participation of herder leader (WAKONDO) in management of grassland and riverine ecosystems
Reabilitação de terras e gestão das áreas de pastagem nos sistemas de produção agro-pastoris dos pequenos produtores no sudoeste de Angola (RETESA)	T 3141	Angola	Southern Africa	TG3	2	A 3173	Restoration of traditional pastoral management forums
Working on Ecosystems (Natural Resource Management Programmes – Department of Environmental Affairs (DEA), South Africa)	T 3377	South Africa	Southern Africa	TG3	3	A 2414	Working for Water Wetland rehabilitation
Working on Ecosystems (Natural Resource Management Programmes – Department of Environmental Affairs (DEA), South Africa)	T 3614	South Africa	Southern Africa	TG3	3	A 2415	Interactive community approach, biodiversity increase
	T 1379	South Africa	Southern Africa	TG3	3		
Ministry of Agriculture, Water and Forestry (MAWF)/GIZ Support to De-bushing Project	T 2203	Namibia	Southern Africa	TG3	3	A 2809	Bush Control and Biomass Utilisation
	T 1416	South Africa	Southern Africa	TG3	3		

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Schalk Meyer		Combating of invader plants and bush packing	The combating of Invaders to preserve water resources & the rehabilitation of the bare ground by means of brush packing to prevent soil erosion.	Gauteng Department of Agriculture and Rural Development - South Africa
Ibo Zimmermann izimmermann@nust.na	Kahl Uwe, Middelplaats farm - Namibia; Pringle Hugh, Ecosystem Management Understand-ing - Australia	Infiltration ditches and ponding banks	Construction of contour ditches and ponding banks/ bunds to trap rainwater for infiltration. Improved growth of plants and replenishment of groundwater is promoted, while safely discharg-ing excess water to avoid erosion. Integrated with other technologies that treat rangeland degrada-tion - rather than a stand-alone technology.	Namibia University of Science and Technology (NUST)
Dirk Pretorius dirk@smc-synergy.co.za	Jacob Buckle JBuckle@environment.gov.za South Africa's national government	**Reshaping of gully erosion through inte-gration of silt fences, erosion blankets and brush packing**	The rehabilitation of gully erosion by re-sloping the banks of the gully in an effort to manage the energy of the water entering the system. Bare soil is protected by covering it with erosion blankets, brush packing and the establishment of silt fences.	SMC Synergy (SMC Synergy) - South Africa
Dieter Nill dieter.nill@giz.de		Firebreaks	Firebreaks cut vast tracts of rangeland into smaller areas, with a view to limiting damage in the event of wildfire.	Deutsche Gesellschaft für Internationale Zusammen-arbeit (GIZ) - Germany; Direction des Eaux et Forêts - Senegal; Misereor - Germany
Dieter Nill dieter.nill@giz.de		Nardi/Vallerani trenches	Nardi/ Vallerani trenches are microcatchments which are made using a special tractor-pulled plough to restore degraded and encrusted forests and rangelands	Deutsche Gesellschaft für Internationale Zusammen-arbeit (GIZ) - Germany
Tony Rinaudo tonyrinaudo@worldvision.com.au	Dov Pasternak d.pasternak@cgiar.org	Farmer Managed Natural Regenera-tion (FMNR)	FMNR is the systematic regeneration of living and sprouting stumps of indigenous vegetation which used to be slashed and burned in traditional field preparation.	The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Sahelian Centre, Niger; World Vision - Australia
Karl-Peter Kirsch-Jung kpkirs@web.de		Ouverture manuelle de pare-feux	Annual projects for the development of manual firewalls based on the mobilization of local labor to weed the trunks retained in a firewall scheme with the "fire truck" (harrow) or with branches pulled by animal or mechanical traction (car) and using hoes and rakes.	Deutsche Gesellschaft für Internationale Zusammen-arbeit (GIZ)
Sabina Galli Vallerani valleranisystem@gmail.com		**Vallerani system**	A special tractor-pulled plow that constructs micro-catchments. It combines the traditional techniques of rainwater harvesting with mechani-zation for large scale land rehabilitation.	Vallerani system, Italy; Reach Africa; Reach Italia
Abdoulaye Soumaila leffnig@yahoo.fr; abdoulayesambosoumaila@gmail.com		**Firebreaks**	Firebreaks are strips from which dry vegetation – straw - is removed in order to stop the progres-sion of fire into the large areas of grazing land. They are of paramount importance for protecting and securing available grazing.	Groupe de Recherche, d'Etudes et d'Action pour le Développement (GREAD) - Niger
Abdoulaye Soumaila leffnig@yahoo.fr; abdoulayesambosoumaila@gmail.com		**Assisted Natural Regeneration (ANR) on agro-pastoral, sylvo-pastoral and pastoral land, Niger**	Assisted Natural Regeneration (ANR) is a simple and low-cost agroforestry technique. It involves locating and preserving shoots from stumps of woody and herbaceous vegetation on communal land used for agro-pastoralism, sylvo-pastoralism or pastoralism. The aim is to accelerate the pro-cess of natural regeneration resulting from natural seedlings or from sprouting stumps inherently present in the area.	Groupe de Recherche, d'Etudes et d'Action pour le Développement (GREAD) - Niger
Abdoulaye Soumaila leffnig@yahoo.fr; abdoulayesambosoumaila@gmail.com		Fixation des dunes sur des terres com-munautaires sylvo-pastorales (cuvettes oasiennes) des départements de Gouré et de Maïné-Soroa	The fight against the silting of the oasis basins is carried out through two dune fixation techniques: (i) the mechanical or primary fixation, which sta-bilizes the sandy masses in movement or prevents the formation of these sandy masses on obstacles (infrastructures, afforestation, cuvette borders), and (ii) the biological or definitive fixation based on creating a permanent vegetal cover on the dune.	Groupe de Recherche, d'Etudes et d'Action pour le Développement (GREAD) - Niger; Food and Agriculture Organization of the United Nations (FAO)

Projects	Database code	Country	Region	Rangeland mgt groups	Rangeland use system	Linked to:	Title
	T 1373	South Africa	Southern Africa	TG3	3	A 2344 A 2346	Awareness raising Technical and scientific support & Job creation in community sector (poorest of the poor)
Southern African Science Service Centre for climate change and Adaptive Land management (SASSCAL), German Federal Ministry of Education and Research (BMBF) - Germany	T 2989	Namibia	Southern Africa	TG3	4	A 2847	Arrangements to convert degraded rangeland into fruitful landscape
Working on Ecosystems (Natural Resource Management Programmes – Department of Environmental Affairs (DEA), South Africa)	T 3359	South Africa	Southern Africa	TG3	6	A 2416	All participants, with the emphasis of getting know-how to the farmer
Manual of Good Practices in Small Scale Irrigation in the Sahel (GIZ)	T 1615	Senegal	West Africa	TG3	1		
Good Practices in Soil and Water Conservation - A contribution to adaptation and farmers resilience towards climate change in the Sahel (GIZ)	T 1613	Niger	West Africa	TG3	2		
	T 1340	Niger	West Africa	TG3	2		
Programme Gestion des Ressources Naturelles, Mauretanie (ProGRN)	T 2089	Mauritania	West Africa	TG3	2	A 1980	Collective local management of natural resources
	T 1528	Burkina Faso	West Africa	TG3	2		
Projet de cash for work pour l'ouverture de bandes pare-feux à Ameidida (Abalak, Tahoua), Niger	T 2323	Niger	West Africa	TG3	2		
Projet d'appui à la Sécurité Alimentaire et au Développement de Maradi (PASADEM) - Projet de surveillance pastorale en Afrique subsaharienne (Départements d'Abala, de Banibangou et de Filingué), Niger (ACF / AREN)	T 2325	Niger	West Africa	TG3	2	A 2328	Pastoralism in Niger: monitoring system for movements and spatial adaptation strategies of transhumant livestock keepers
Projet de lutte contre l'ensablement des cuvettes oasiennes dans les départements de Gouré et de Maïné-Soroa, Niger (PLECO)	T 3257	Niger	West Africa	TG3	2		

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Abdoulaye Soumaila leffnig@yahoo.fr; abdoulayesambosoumaila@gmail.com		Fertilisation des sols par rotation	Rotational fertilization is an integrated crop-livestock management measure practiced by the agropastoralist Peulh.	Groupe de Recherche, d'Etudes et d'Action pour le Développement (GREAD) - Niger
Dieter Nill dieter.nill@giz.de		Promoting bourgou growing	Replanting and cultivating bourgou improves the availability of forage for livestock	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) - Germany
Dieter Nill dieter.nill@giz.de		Assisted natural regeneration	Assisted natural regeneration (ANR) is an agroforestry technique, which consists in protecting and preserving tree seedlings growing naturally on cropland or forest/rangeland.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) - Germany; Misereor - Germany
Dieter Nill dieter.nill@giz.de		Semi-circular bunds (for crops and forest/rangeland)	Semi-circular bunds are used to rehabilitate degraded, denuded and hardened land for crop growing, grazing or forestry.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) - Germany
Eva Schlecht schlecht@uni-kassel.de; eschlec1@gwdg.de		Night Corralling	Night corralling of cattle, sheep and goats on cropland during the dry season (November-April) replenishes soil fertility of agricultural land depleted by continuous cropping.	Georg August Universität Göttingen - Germany
Issaka Dan Dano **i.dandano@vsf-belgium.org**	Koen Vantroos k.vantroos@vsf-belgium.org	Restoration of grazing land invaded by Sida cordifolia	Restoration of grazing land invaded by Sida cordifolia through the seeding of Hibiscus sabdariffa, for sustainable access to grazing areas and for reduced conflicts between farmers and livestock keepers.	Vétérinaire Sans Frontière - Niger
Julie Zähringer julie.zaehringer@cde.unibe.ch julie_z60@hotmail.com		Agroforestry parkland	A traditional agroforestry parkland with scattered trees beneficial for soil properties (e.g. Faidherbia albida) or providing food for human beings and cattle (e.g. Sclerocarya birrea)	Center for Development and Environment (CDE), University of Bern; Centre de Suivi Ecologique (CSE), Senegal
Aicha Maman achdoutchi@yahoo.fr		Rehabilitation and protection of the rangeland of Guidan Issa	The rehabilitation of a rangeland consists of fencing and subsequently seeding with herbaceous plants adapted to arid zones and to degraded soils.	Hilfswerk der Evangelischen Kirchen Schweiz (HEKS) - Switzerland
Rebecka Ridder rebecka.ridder@giz.de		Anti erosion measures	Combining different measures such as stone rows, dikes and dams to stabilize and restore the soil and increase water infiltration. Trees alongside these structures allow an enhancement of these structural measures.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) - Germany

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Joyce Saiko **j.saiko@yahoo.com**		Soil and water conservation. This assist in regeneration of pasture and prevention of desertification due to poor land use practices	The Maasai people set aside some acres of land, fence it and plant grass where the land is bare or allow natural standing grass to germinate then harvest it and store as hay for future use. This also helps in preventing soil erosion and surface run off.	Neighbours Alliance Initiative Kenya
Aine Amon aine3amon@gmail.com	Drake Mubiru drakenmubiru@yahoo.com	**Dairy cattle fed with supplementary fodder**	Elephant grass and calliandra, are harvested and chopped to produce fodder for dairy cows. The chaff is then mixed with cotton seed cake, molasses and maize bran to improve palatability and nutrient quality for dairy cows. The cattle graze in paddocks during the day and receive the fodder at evening milking.	National Agricultural Research Organisation (NARO) - Uganda
Johanna Goetter goetter@b-tu.de		Sustainable propagation of the fodder tree Euphorbia stenoclada ("samata")	During the dry season, livestock keepers cut branches of an evergreen tree-like succulent locally named "samata" (Euphorbia stenoclada), as a feed supplement for their animals. Propagation of "samata" with recovery periods sustain the local livestock system while reducing the pressure on natural vegetation.	World Wildlife Fund (WWF); University of Antananarivo - Madagascar; Brandenburg Technical University (btu) - Germany
Blasius Azuhnwi **azuhnwibn@yahoo.com**		**Alliance Farming**	Alliance farming refers to collaboration between crop farmers and pastoralists, who agree to use the same land and related resources (crop residues as fodder for pastoralists; dung as fertilizer for crop farmers) for their mutual benefit.	Ministry of Livestock, Fisheries and Animal Industries, Yaounde, Cameroon

Projects	Database code	Country	Region	Rangeland mgt groups	Rangeland use system	Linked to:	Title
	T 953	Niger	West Africa	TG3	2		
Manual of Good Practices in Small Scale Irrigation in the Sahel (GIZ)	T 1637	Mali	West Africa	TG3	4		
Programme d'Appui à l'agriculture Productive (GIZ / PROMAP)	T 1626	Niger	West Africa	TG3	6		
Good Practices in Soil and Water Conservation - A contribution to adaptation and farmers resilience towards climate change in the Sahel (GIZ)	T 1614	Niger	West Africa	TG3	6		
	T 952	Niger	West Africa	TG3	6		
Programme d'Appui au Secteur de l'Elevage au Niger (PASEL 7)	T 3176	Niger	West Africa	TG3	6		
Recueil d'expériences de gestion durable des terres au Sénégal (GEF-FAO/ LADA)	T 1167	Senegal	West Africa	TG3	6		
SLM and DRR (Swiss NGO DRR Platform and CDE/ WOCAT)	T 689	Niger	West Africa	TG3	6		
	T 613	Burkina Faso	West Africa	TG3	6	A 608	Combating erosion, recovery and enhancement of degraded land and climate change adaptation (EKF Project)

Projects	Database code	Country	Region	Rangeland mgt groups	Rangeland use system	Linked to:	Title
	T 3220	Kenya	Eastern and Horn of Africa	TG4	3		
Scaling-up SLM practices by smallholder farmers (IFAD), Uganda	T 3367	Uganda	Eastern and Horn of Africa	TG4	6		
Sustainable Landmanagement in south-western Madagascar (SuLaMa) (BMBF)	T 1677	Madagascar	Southern Africa	TG4	2	A 2545	Increasing environmental awareness using comic-style illustrations as a visual communication tool
Mbororo Social and Cultural Development Association (MBOSCUDA) - Cameroun	T 3342	Cameroun	West Africa	TG4	2	A 3319	Promoting farmers and pastoralists consultations in managing rangelands

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Allan Bubelwa allan.bubelwa@gmail.com		Indigenous water collecting pond and livestock watering trough	Construction of indigenous water pond and a livestock watering trough along an underground water source.	Bukoba District Council, Missenyi District Council - Tanzania; Food and Agriculture Organization of the United Nations (FAO) - Tanzania
Guyo Roba **guyo.roba@iucn.org**		**Sub-Surface Dams (SSD)**	Constructions stretching across sand filled dry riverbeds, down towards the impermeable floor of the riverbed. Sand dams are built along dry rivers with huge sand deposits and where water can be easily extracted. The aim is to raise groundwater tables and increase the storage capacity for water withdrawals.	International Union for Conservation of Nature (IUCN)
Rick Nelson Kamugisha rkamu2016@gmail.com	Bernard Fungo bfungo1@yahoo.com Joy Tukahirwa j.tukahirwa@infocom.co.ug	Under ground water abstraction for livestock production	Waterhole is excavated for abstracting underground water for watering livestock as well as irrigating crops during the dry season.	Uganda Landcare Network (ULN) - Uganda; Centre Ecologique Albert Schweitzer (CEAS) - Switzerland
Déthié Soumaré Ndiaye dethie@cse.sn		Bassin de rétention de Piterki	Storage infrastructure for mobilization and recovery of runoff	Centre de Suivi Ecologique (CSE), Senegal; Service Départemental du Développement Rural, Senegal; Center for Development and Environment (CDE), University of Bern
Abdoulaye Soumaila leffnig@yahoo.fr; abdoulayesambosoumaila@gmail.com		Amélioration de la distribution des puits pour un pastoralisme durable	Pastoralism, is a traditional mode of extensive livestock rearing, based on the movement of herds between the rich pastures of the northern pastoral areas (rainy season) and those of the northern regions. south (dry season) depending on seasonal availability of water and pastures / fodder (including residual cropland vegetation).	Groupe de Recherche, d'Etudes et d'Action pour le Développement (GREAD) - Niger
Heinz Bender		Water-spreading weirs for the development of degraded dry river valleys	Water-spreading weirs are structures that span the entire width of a valley to spread floodwater over the adjacent land area.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) - Germany
Ababu Lemma lemma.belay@yahoo.com		Couloirs de passage	The 'couloirs de passage' are formally defined passageways, which channel the movements of livestock herds in the agro-pastoral zones of Niger, by linking pastures, water points and coralling areas, be it within village areas (internal couloirs) or on open land (external couloirs).	Groupe de Recherche, d'Etudes et d'Action pour le Développement (GREAD) - Niger
Nouhoun Zampaligré **nouhoun@gmail.com**		**Forage Christine**	A modern hydraulic complex in the centre of the Sahelian region of Burkina Faso for watering livestock in the dry season.	Institut de l'environnement et de recherches agricoles (INERA) - Burkina Faso
Dieter Nill dieter.nill@giz.de		Permeable rock dams	Permeable rock dams serve to restore seriously degraded farmland and forest/rangeland and are used to fill in gullies and control water flow.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) - Germany; Misereor - Germany

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Ken Otieno **peterkenotieno009@gmail.com**		Participatory community resource mapping using the Social Tenure Domain Model (STDM)	The STDM tool secures tenure through the recognition of tenure diversity and social contexts. Secure tenure builds confidence among the resource users, promotes confidence to investment at different levels: small-scale, large-scale, urban and rural investors all benefit from security of tenure.	Resource Conflict Institute (RECONCILE) - Kenya

Projects	Database code	Country	Region	Rangeland mgt groups	Rangeland use system	Linked to:	Title
The Transboundary Agro-ecosystem Management Project for the Kagera River Basin (GEF-FAO / Kagera TAMP)	T 1157	Tanzania	Eastern and Horn of Africa	TG5	3	A 2589	
	T 3340	Kenya	Eastern and Horn of Africa	TG5	3		
Scaling-up SLM practices by smallholder farmers (IFAD), Uganda	T 2304	Uganda	Eastern and Horn of Africa	TG5	6		
Recueil d'expériences de gestion durable des terres au Sénégal (GEF-FAO / LADA)	T 1433	Senegal	West Africa	TG5	1		
	T 1355	Niger	West Africa	TG5	1		
	T 1536	Chad	West Africa	TG5	2		
	T 1353	Niger	West Africa	TG5	2	A 2328 A 2324	
	T 2994	Burkina Faso	West Africa	TG5	2		
Manual of Good Practices in Small Scale Irrigation in the Sahel (GIZ)	T 1617	Burkina Faso	West Africa	TG5	6		

Projects	Database code	Country	Region	Rangeland mgt groups	Rangeland use system	Linked to:	Title
	A 3379	Kenya	Eastern and Horn of Africa	AG1	1	T 3318	Social Tenure Domain Model

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Giacomo de' Besi giacomo.debesi@fao.org	Deborah Duveskog deborah.duveskog@fao.org	**Pastoralist field schools (PFS)**	PFS improve livelihoods and resilience of pastoral communities through hands-on experimental and participatory learning. They are "schools without walls" that introduce good agricultural and marketing practices while building on local knowledge.	Food and Agriculture Organization of the United Nations (FAO) - Kenya
Lance W. Robinson L.Robinson@cgiar.org	Enoch Mobisa Ontiri E.Ontiri@cgiar.org; Peter Tyrrell, peterdavidtyrrell@gmail.com, SORALO and University of Oxford	**Community-based rangeland management in the southern Kenyan rangelands**	Olkiramatian Group Ranch strengthened the capacity of its community governance structures and began to engage in more rigorous implementation of seasonal grazing plans. This was based on traditional ecological knowledge and rangeland management practices.	International Livestock Research Institute (ILRI) - Kenya
Daniel Danano dale.daniel@fao.org		Local level participatory planning approach	An approach used by field staff to implement conservation activities, involving farmers in all stages of planning, implementation and evaluation.	Ministry of Agriculture and Natural Resources (MoA) - Ethiopia; Food and Agriculture Organization of the United Nations (FAO)
Kevin Mganga kmganga@seku.ac.ke		On-farm pasture establishment demonstrations	On-farm indigenous pasture establishment demonstrations offer a practical approach to encourage adoption in the arid and semi-arid environments in Kenya.	Department of Range and Wildlife Sciences, South Eastern Kenya University (SEKU) - Kenya
Abdoulaye Soumaila leffnig@yahoo.fr; abdoulayesambosoumaila@gmail.com		Champ Ecole Pastorale	The Pastoral Field School (PFS) is an area of exchange of experiences and knowledge where breeders producers who share the same interests, research, discuss and make decisions on the management of herds and natural resources based on their real situation.	Groupe de Recherche, d'Etudes et d'Action pour le Développement (GREAD) - Niger
Blasius Azuhnwi (azuhnwibn@yahoo.com		Promoting farmers and pastoralists consultations in managing rangelands.	Dialogue platforms bring together rangeland users including farmers, pastoralists/agropastoralists to learn, discuss and implement low stake conflict mitigation strategies and mutually beneficial alliances.	Ministry of Livestock, Fisheries and Animal Industries, Yaounde, Cameroon
Rebecka Ridder rebecka.ridder@giz.de	Martin Baumgart martin.baumgart@afci.de AFC	Combating erosion, recovery and enhancement of degraded land and climate change adaptation	The approach applied in this project is an integrated and multi-stakeholder approach in the South West of Burkina Faso, based on watershed management and sustainable land management with a strong emphasis on local participation.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

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Allan Bubelwa allan.bubelwa@gmail.com		Livestock keepers initiative for continued dry season animal drinking water supply	Livestock keepers groups and local government collaboration for management of livestock watering points.	Bukoba District Council, Missenyi District Council - Tanzania; Food and Agriculture Organization of the United Nations (FAO) - Tanzania
Allan Bubelwa allan.bubelwa@gmail.com		Integrated and collaborative approach in management of savannah rangelands with high livestock	Using integrated and collaborative approach in managing land degradation and conflicts in Savannah range land with high livestock.	Bukoba District Council, Missenyi District Council - Tanzania; Food and Agriculture Organization of the United Nations (FAO) - Tanzania
Ibrahim Jarso jarsoibra@gmail.com	Caroline King-Okumu caroking@yahoo.com	Empowering Dedha institutions in governing the natural resources of Isiolo rangelands	This approach aims to revive and strengthen the traditional natural resource management institutions of Boran pastoralists in Northern Kenya. The Dedha traditional system has been steadily eroded by external factors and formalised systems after the emergence of the nation-state.	Resource Advocacy Programme (RAP) - Kenya
Thomas Kalytta t.kalytta@worldvision.ch	Irene Ojuok irene_ojuok@wvi.org	Farmer Managed Natural Regeneration (FMNR) implementation approach	The aim of the approach is to promote FMNR and sustainable land and natural resource management through disseminating the basic idea of regenerating trees.	World Vision International (WVI) - Switzerland

Projects	Database code	Country	Region	Rangeland mgt groups	Rangeland use system	Linked to:	Title
Improved food security, livelihoods and resilience of vulnerable pastoral communities in the Greater Horn of Africa	A 3337	Ethiopia	Eastern and Horn of Africa	AG1	2		
Restoration of degraded land for food security and poverty reduction in East Africa and the Sahel: taking successes in land restoration to scale (IFAD and the EU)	A 3321	Kenya	Eastern and Horn of Africa	AG1	4	T 3372	Ecosystem-wide seasonal grazing management in community land
	A 2388	Ethiopia	Eastern and Horn of Africa	AG1	6	T 1048	Area closure for rehabilitation
	A 3285	Kenya	Eastern and Horn of Africa	AG1	6	T 2288 T 3328	Grass reseeding Multi purpose tree species for suplementing animal pasture
Intégration de la résilience climatique dans la production agricole et pastorale (FEM/FAO/PROMOVARE/Union Européenne/PPAAO)	A 2324	Niger	West Africa	AG1	1	T 1353	Couloirs de passage
Mbororo Social and Cultural Development Association (MBOSCUDA) - Cameroon	A 3319	Cameroun	West Africa	AG1	2	T 3342	Alliance Farming
Energy and Climate Fund (EKF) project	A 608	Burkina Faso	Western Africa	AG1	6	T 2288 T 613	Grass reseeding Anti erosion measures

Projects	Database code	Country	Region	Rangeland mgt groups	Rangeland use system	Linked to:	Title
The Transboundary Agro-ecosystem Management Project for the Kagera River Basin (GEF-FAO / Kagera TAMP)	A 2589	Tanzania	Eastern and Horn of Africa	AG2	2	T 1157	Indigenous water collecting pond and livestock watering trough
The Transboundary Agro-ecosystem Management Project for the Kagera River Basin (GEF-FAO / Kagera TAMP)	A 2538	Tanzania	Eastern and Horn of Africa	AG2	2		
Strengthening Adaptation and Resilience to Climate Change in Kenya Plus (StARCK+)	A 3345	Kenya	Eastern and Horn of Africa	AG2	2	T 3403	Dedha grazing system as a natural resource management technology
SLM and DRR (Swiss NGO DRR Platform and CDE/WOCAT)	A 733	Kenya	Eastern and Horn of Africa	AG2	2	T 507	Farmer Managed Natural Regeneration (FMNR)

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Ibrahim Jarso **jarsoibra@gmail.com**	Caroline King-Okumu caroking@yahoo.com	Inclusive strategic planning for water, energy and climate change in the rangelands	Inclusive strategic planning for water, energy and climate change in the rangelands involves convening stakeholder groups and reviewing databases to prepare for future needs for rangeland, water and other resources under changing climatic conditions.	Resource Advocacy Programme (RAP) - Kenya
Ibrahim Jarso **jarsoibra@gmail.com**	Caroline King-Okumu caroking@yahoo.com	**Participatory mapping, database building, and monitoring of rangeland resources**	Participatory mapping and monitoring of vegetation types and other natural resources in the rangelands involves convening stakeholder groups, reviewing conditions of rangeland, water and other resources under changing climatic conditions.	Resource Advocacy Programme (RAP) - Kenya
Fiona Flintan		**Joint village land use planning**	Joint village land use planning is a process facilitated by Tanzania's land policy and legislation. It supports the planning, protection and management of shared resources across village boundaries. It is an important tool towards land use planning and better rangeland management.	International Livestock Research Institute (ILRI) - Kenya
Harry Wells **harrybmwells@gmail.com**	Hanspeter Liniger hanspeter.liniger@cde.unibe.ch	Stabilization Through Conservation ('StabilCon') approach	The 'StabilCon' is a non-aggressive, low-intensity stabilization model that seeks to reconcile the needs of both humans and their natural environment. 'StabilCon' aims to co-develop: sustainable natural resource management and human security in rural areas.	Lolldaiga Hills Ltd, Kenya
Peter Tyrrell **peterdavidtyrrell@gmail.com**	Christina Ender cender@conservation.org Conservation International, Kenya	Chyulu Hills Community REDD + Project	The project combines two government agencies, three local NGOs and four communities together under the Chyulu Hills Conservation Trust (CHCT). The objective is to set-up a 30-year 'payment for ecosystem service' scheme in the landscape. A main goal is to improve grazing and livestock management to prevent further rangeland and forest resources degradation.	South Rift Association of Land Owners (SORALO), Kenya and Wildlife Conservation Research Unit, University of Oxford, UK
Gizaw Desta Gessesse gizaw.d@wlrc-eth.org		Cut and Carry' Grazing (CCG) system or 'Zero Grazing'	In a CCG system (zero grazing) the community is consulted to identify and agree on areas to be closed and protected from free grazing; user groups are established to share equitably the fodder biomass harvested from communal closed areas.	Water and Land Resource Centre (WLRC)
Klaus Kellner klaus.kellner@nwu.ac.za		Working for Water	Government funded restoration/rehabilitation initiative as part of Working for Water project. Aim was to eradicate alien invasive.	Gauteng Department of Agriculture and Rural Development, South Africa; Potchefstroom Universiteit vir CHO, South Africa
Nicholas Euan Sharpe **nick@agrolynx.org**	David Tarrason d.tarrason@gmail.com Txaran Basterrechea txaranb@yahoo.es	**Restoration of traditional pastoral management forums**	The transhumance pastoral communities of Southern Angola traditionally held gatherings of chieftains and community leaders to discuss management of commonly held pastoral resources. However, the conflicts of the last century led to the breakdown of traditional governance and management systems. The RETESA project has supported their recovery to reduce land degradation and improve local livelihoods.	Food and Agriculture Organisation Angola (FAO) - Angola
Ibo Zimmermann **izimmermann@nust.na**	Kahl, Uwe, Middelplaats farm - Namibia; Pringle, Hugh, Ecosystem Management Understanding - Australia	Arrangements to convert degraded rangeland into fruitful landscape	Making arrangements between a commercial farmer and agriculture students to raise the productivity of rangeland - through managing runoff to grow multipurpose trees and bushes.	Namibia University of Science and Technology (NUST)

Projects	Database code	Country	Region	Rangeland mgt groups	Rangeland use system	Linked to:	Title
Strengthening Adaptation and Resilience to Climate Change in Kenya Plus (StARCK+)	A 3441	Kenya	Eastern and Horn of Africa	AG2	3		
Strengthening Adaptation and Resilience to Climate Change in Kenya Plus (StARCK+)	A 3439	Kenya	Eastern and Horn of Africa	AG2	3		
Sustainable Rangeland Management Project (ILC / ILRI)	A 3336	Tanzania	Eastern and Horn of Africa	AG2	4		
	A 3615	Kenya	Eastern and Horn of Africa	AG2	4		
	A 3426	Kenya	Eastern and Horn of Africa	AG2	4		
Water and Land Resource Centre project (WLRC)	A 2497	Ethiopia	Eastern and Horn of Africa	AG2	6	T 1597 T 1598 T 1601	Gully erosion management Area closure on degraded lands Vegetated graded soil bund
Working for Water project	A 2338	South Africa	Southern Africa	AG2	2	T 3614 T 3359	Spekboom (Portulacaria afra) planting within riplines for thicket biome restoration Reshaping of gully erosion through integration of silt fences, erosion blankets and brush packing
Reabilitação de terras e gestão das áreas de pastagem nos sistemas de produção agro-pastoris dos pequenos produtores no sudoeste de Angola (RETESA)	A 3173	Angola	Southern Africa	AG2	2	T 3141	Community supported pasture and rangeland rehabilitation works
Southern African Science Service Centre for climate change and Adaptive Land management (SASSCAL), German Federal Ministry of Education and Research (BMBF) - Germany	A 2847	Namibia	Southern Africa	AG2	2	T 2989	Infiltration ditches and ponding banks

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Philippe Zahner philippe.zahner@deza.admin.ch		Technical and scientific support & Job creation in community sector (poorest of the poor)	To make the community aware of precious resources like water and the preservation of it, the control of alien encroachment, creation of job opportunities and the training of the undeveloped communities.	Gauteng Department of Agriculture and Rural Develo (Gauteng Department of Agriculture and Rural Develo) - South Africa; Swiss Agency for Development and Cooperation (DEZA / COSUDE / DDC / SDC) - Switzerland
Ibo Zimmermann **izimmermann@nust.na**	Colin Nott canott@iafrica.com.na; Uhangatenua O. Kapi uhangatenuak@yahoo.co.uk); Kapi Amon	Community grazing management	Agreement among community members to jointly manage their communal grazing area by combining their livestock into a single herd. The herd is moved according to an agreed growing season plan that provides sufficient recovery for perennial grasses, and a non-growing season plan to graze in a way that prepares soil and plants for the next season.	Conservation Agriculture Namibia; Zakumuka Producers Co-operative, Namibia;
Joachim Nopper joachim.nopper@uni-hamburg.de		Participatory monitoring and evaluation of long-term changes in ecosystems	Establishing a knowledge base and communication platform in collaboration with para-ecologists for monitoring changes in ecosystems, to aid decision-making in forest management.	Universität Hamburg (UHH) - Germany University of Antananarivo - Madagascar
Issaka Dan Dano **i.dandano@vsf-belgium.org**	Koen Vantroos k.vantroos@vsf-belgium.org	**Management of transboundary transhumance**	Management of transboundary transhumance in order to create the conditions for conflict-free access to resources for livestock keeping in Niger and northern Benin.	Vétérinaire Sans Frontière - Niger
Karl-Peter Kirsch-Jung **kpkirs@web.de**		Gestion locale collective des ressources naturelles	A transfer of responsibility for the management of the sylvo-pastoral resources of the State to the user associations. Collaborative development of a local convention defining the management rules, including the conditions of access, use and control of shared resources in a selected area.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
Abdoulaye Soumaila **leffnig@yahoo.fr;** **abdoulayesambosoumaila@gmail.com**		Pastoralisme au Niger : Système de suivi des mouvements et stratégies d'adaptation spatiale des éleveurs transhumants	This approach, traditional in nature, consists of a Geographical Information System, which integrates the water resources, the movement of populations, and the spatial distribution of grazing land, also in terms of the quantities of forage resources. The aim of the approach is to provide a tool to support the management of pastoralism and the identification, tracking and prevention of potential food crises.	Groupe de Recherche, d'Etudes et d'Action pour le Développement (GREAD) - Niger
Abdoulaye Soumaila **leffnig@yahoo.fr;** **abdoulayesambosoumaila@gmail.com**		'Travail contre argent' de la Cellule Crises Alimentaires/Cabinet du Premier Ministre	The "Labor-for-Money" approach is a community-based and participatory approach, which consists on implementation of anti-erosion measures (Water and Soil Conservation / Soil Defense and Restoration - or sustainable land management) through HILF (High Intensity Labor Force) remunerated for the vulnerable social groups in food insecurity.	Groupe de Recherche, d'Etudes et d'Action pour le Développement (GREAD) - Niger
Vivian Onyango **Vivian.Onyango@fao.org**	Moctar Sacande moctar.sacande@fao.org	**Community participation in large-scale land restoration for Africa's Great Green Wall programme**	FAO has been using acommunity participatory approach to implement large-scale land restoration in the Sahel. In the framework of the Great Green Wall initiative, adapted, suitable and useful native tree species, shrubs, and fodder grasses are planted in agro-sylvo-pastoral land in response to community needs.	Food and Agriculture Organization of the United Nations (FAO) - Kenya
Dieter Nill dieter.nill@giz.de		Creating scale models for the development of lowland areas and the participation of the farming community	Creating models when developing lowland areas encourages the different actors involved to enter into negotiations and participate in decision-making on the design and farming of a lowland area.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ); HELVETAS - Swiss Intercooperation
Dieter Nill dieter.nill@giz.de	Identifying and prioritizing scheme sites using a territorial, multi-stakeholder approach	The desired objectives are to identify the priority actions for investment that have been agreed by local actors within the framework of the pastoral scheme, and to develop lowland areas.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ); HELVETAS - Swiss Intercooperation	

Projects	Database code	Country	Region	Rangeland mgt groups	Rangeland use system	Linked to:	Title
	A 2346	South Africa	Southern Africa	AG2	3	T 1373	Combating of invader plants and bush packing
Southern African Science Service Centre for climate change and Adaptive Land management (SASSCAL)	A 3050	Namibia	Southern Africa	AG2	3	T 4135 T 4134 T 3326	Community-Based Closed Area Management Closed Area Management in Abagerima Learning Watershed Combined herding for planned grazing
Sustainable Landmanagement in south-western Madagascar (SuLaMa) (BMBF)	A 2610	Madagascar	Southern Africa	AG2	5		
Programme d'Appui au Secteur de l'Elevage au Niger (PASEL 7)	A 2850	Niger	West Africa	AG2	1		
Programme Gestion des Ressources Naturelles, Mauretanie (ProGRN)	A 1980	Mauritania	West Africa	AG2	1	T 2089 T 2081	Manual opening of firewalls Implementing the ecological monitoring of locally managed sylvo-pastoral resources – Vegetation cover index
Projet de surveillance pasto-rale en Afrique subsaharienne (Départements d'Abala, de Banibangou et de Filingué), Niger (ACF / AREN)	A 2328	Niger	West Africa	AG2	1	T 2325 T 1353	Assisted Natural Regeneration on agro-pastoral, sylvo-pastoral and pastoral land Couloirs de passage
Koira Tégui Foulan Koira's Kori treatment project, Niger	A 1900	Niger	West Africa	AG2	2		
FAO-Action Against Desertification	A 2909	Niger	West Africa	AG2	2		
	A 2500	Mali	Western Africa	AG2	2		
	A 2499	Mali	Western Africa	AG2	2		

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Paolo Groppo paolo.groppo@fao.org	Carolina Cenerini carolina.cenerini@fao.org	Participatory Negotiated Territorial Development	Participatory Negotiated Territorial Development (PNTD) is a rural development approach developed by FAO.	Food and Agriculture Organization of the United Nations (FAO); Swiss Agency for Development and Cooperation (DEZA / COSUDE / DDC / SDC) - Switzerland
Judith Macchi judith.macchi@heks.ch	Aicha Maman achdoutchi@yahoo.fr; Christine Lottje christine.lottje@heks.ch	Consensus-based management of the rangelands of Guidan Issa	The consensus-based management of the area of Guidan Issa consists of rehabilitating this resource for agro-pastoral livelihoods in a participatory and inclusive way, by considering the various actors involved in the exploitation and management of this rangeland area.	Hilfswerk der Evangelischen Kirchen Schweiz (HEKS) - Switzerland

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Duncan Collins Khalai **d.khalai@cgiar.org**	Andrew Mude a.mude@cgiar.org	**Kenya Livestock Insurance Program (KLIP)**	KLIP is a Government of Kenya funded drought insurance program for vulnerable pastoralists located in the Arid and Semi-Arid Lands of Kenya. KLIP's overall objective is to reduce the risk of livestock mortality emanating from drought and help to build resilience of vulnerable pastoralists for enhanced and sustainable food security.	International Livestock Research Institute (ILRI) - Kenya
Peter Tyrrell **peterdavidtyrrell@gmail.com**	Henry Bailey hmgb87@yahoo.com, Mugie Conservancy	Mugie Resource Sharing and Livestock to Markets Program	Selected livestock are bought from the communities, then fattened and marketed by the Mugie conservancy management on a 'resource sharing' basis – generating income for both the conservancy and the community. This encourages the development of local value chains and market-based incentives.	South Rift Association of Land Owners (SORALO), Kenya and Wildlife Conservation Research Unit, University of Oxford, UK
Peter Tyrrell **peterdavidtyrrell@gmail.com**	Alex Freeland alex@marabeef.com, Mara Beef Limited	**Mara Beef: value added beef for for improved rangeland management, livelihoods, and conservation**	Mara Beef provided a new direct to market sales approach for pastoralist's, in an effort to make livestock production more viable to local landowners. It is combined with rangeland management and training to improve pastoral livlihoods, restore rangelands and prevent degradation, and support biodiversity conservation.	South Rift Association of Land Owners (SORALO), Kenya and Wildlife Conservation Research Unit, University of Oxford, UK
Peter Tyrrell **peterdavidtyrrell@gmail.com**		**Northern Rangelands Trust (NRT) - Livestock to Markets**	NRT works across the rangelands of northern Kenya to improve market access to pastoral communities across 20,000 square kilometers. The program improves local revenue generation, incentives to reduce herd size, and channels funding into improved rangeland management across the conservancies.	South Rift Association of Land Owners (SORALO), Kenya and Wildlife Conservation Research Unit, University of Oxford, UK
Johannes Laufs **johannes.laufs@giz.de**	Asellah David asellah.david@giz.de	Bush Control and Biomass Utilisation	Public and private stakeholders in Namibia are cooperating in the national Bush Control and Biomass Utilisation programme. There are three components: (1) Creation of an enabling framework, (2) Advisory Services and (3) Value Chain Development.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

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Ibo Zimmermann **izimmermann@nust.na**	Nils Odendaal nils@namibrand.org Namib Rand Nature Reserve - Namibia	**Restoration of game migration routes across the Namib Desert**	Seventeen former sheep farms have been joined to form the world's largest private nature reserve aimed at regenerating biodiversity to support high-quality low-impact tourism, environmental education and research. All farm owners are members of the management association.	Namibia University of Science and Technology (NUST) - Namibia
Harry Wells **harrybmwells@gmail.com**	Hanspeter Liniger hanspeter.liniger@cde.unibe.ch	**Holistic Rangeland Management combined with high end tourism**	Community wildlife conservancies facilitate (1) sustaining and/or improving rangeland productivity e.g by 'bunched grazing', short-term 'bomas', clearing invasive species and grass reseeding; and (2) provide funding for improved grazing practices, additional income for the community and reduction of livestock grazing pressure through high end tourism and monetary donations.	Lolldaiga Hills Ltd, Kenya

Projects	Database code	Country	Region	Rangeland mgt groups	Rangeland use system	Linked to:	Title
	A 2570	Ghana	Western Africa	AG2	2		
SLM and DRR (Swiss NGO DRR Platform and CDE/WOCAT)	A 690	Niger	West Africa	AG2	3		

Projects	Database code	Country	Region	Rangeland mgt groups	Rangeland use system	Linked to:	Title
Index Based Livestock Insurance, Kenya (IBLI)	A 3283	Kenya	Eastern and Horn of Africa	AG3	2	T 3361	Index Based Livestock Insurance
	A 3427	Kenya	Eastern and Horn of Africa	AG3	3		
	A 3425	Kenya	Eastern and Horn of Africa	AG3	3		
	A 3435	Kenya	Eastern and Horn of Africa	AG3	3		
Ministry of Agriculture, Water and Forestry (MAWF)/GIZ Support to De-bushing Project	A 2809	Namibia	Southern Africa	AG3	3	T 2203	Bush Thinning and Biomass Processing by Manual or Mechanised Means

Projects	Database code	Country	Region	Rangeland mgt groups	Rangeland use system	Linked to:	Title
NamibRand Nature Reserve	A 3286	Namibia	Southern Africa	AG4	5		
	A 3399	Kenya	Eastern and Horn of Africa	AG4 / AG2	4		

TerrAfrica is a partnership that aims to address land degradation, build resilient landscapes and improve livelihoods in Sub-Saharan Africa by scaling up harmonized support for country-driven sustainable landscapes management interventions. This is achieved through coalition building, knowledge management, improved programming, and investment promotion across sectors and stakeholders.

The World Overview of Conservation Approaches and Technologies (WOCAT) is a global network on Sustainable Land Management (SLM) that promotes the assessment, sharing and use of knowledge to support adaptation, innovation and up-scaling of SLM. WOCAT has developed a well-accepted framework and standardised tools for documentation, monitoring, evaluation and dissemination of SLM knowledge, covering all steps from data collection with several questionnaires, to the Global SLM Database and to evidence-based decision support. The Global SLM database is officially recognized by the United Nations Convention to Combat Desertification (UNCCD) as the primary source for the reporting of 'Best Practices in SLM'.

WOCAT

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