



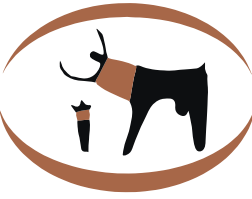
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35

The dynamics of natural resources
in Somaliland—Implications for
livestock production



RESEARCH
PROGRAM ON
Livestock



The dynamics of natural resources in Somaliland—Implications for livestock production

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Disclaimer

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Acronyms

FAO	Food and Agriculture Organization of the United Nations
IDP	Internally displaced person
NGO	Non-governmental organization
PGIS	Participatory geographic information system
SWALIM	Somalia Water and Land Information Management project

Summary

Agriculture is the most important sector of Somaliland's economy. In 2012, the sector contributed more than 40% of Somaliland's GDP—with the livestock sub-sector contributing 29.5%. Livestock production in the country is mainly extensive in pastoral systems that rely on fragile natural resources. The objective of this study was to investigate and document the current natural resources relevant to livestock production in Somaliland, identify the major drivers of land and resource use including landscape functions, and to identify pastoralists' existing strategies to adapt to changes in land use in the country. Traditionally, pastoralists have governed water access and grazing in their lands through institutions, rules and regulations.

The study showed that increasingly there are multiple claims on natural resources and land in Somaliland and that these competing claims are being exacerbated by climate stress, in conjunction with other factors such as population growth and urbanization. Water points and water access are at the centre of these claims. However, these water points and the surrounding areas are increasingly settled, and often enclosed, by pastoralists who have lost their animals. Settlers have also established enclosures for production of crops and fodder. This effectively blocks the transhumance routes and herders' access to the water vital to their livelihoods, damaging livestock production and herders' adaptive capacity. This is exacerbated by the practice of harvesting trees around the settlements to make charcoal, which further degrades community pastures. As such, there is increasing likelihood of conflict between pastoralists and settlers.

This report discusses two policy options designed to reduce land degradation and increase the adaptability to climate change: communal rangeland management, and land-use planning for pastoral corridors and areas. The development and effective implementation of either of these policies requires a strong participatory approach that involves pastoralists. This report also discusses how emerging new earth observation technologies could be a game changer in supporting the monitoring of these policies from the sky.

Introduction

Description of the Somaliland climate and natural resource base

Somaliland is located in the Horn of Africa, with an area of 137,600 km² and a population of about 3.80 million people. It is estimated that approximately 11% of the population lives in rural areas, 34% is nomadic, 2% is internally displaced persons (IDPs) and the remainder (53%) reside in major towns (MoNP&D 2017). These towns include Hargeisa (with a population of about 500,000), Burao (>100,000), Borama (>80,000), and Laas Caanood (over 30,000). Somaliland faces a high population growth estimated at 4.3% per annum¹. This growth is much higher in urban areas, where it reaches approximately 20% per year in Hargeisa (MoNP&D 2011).

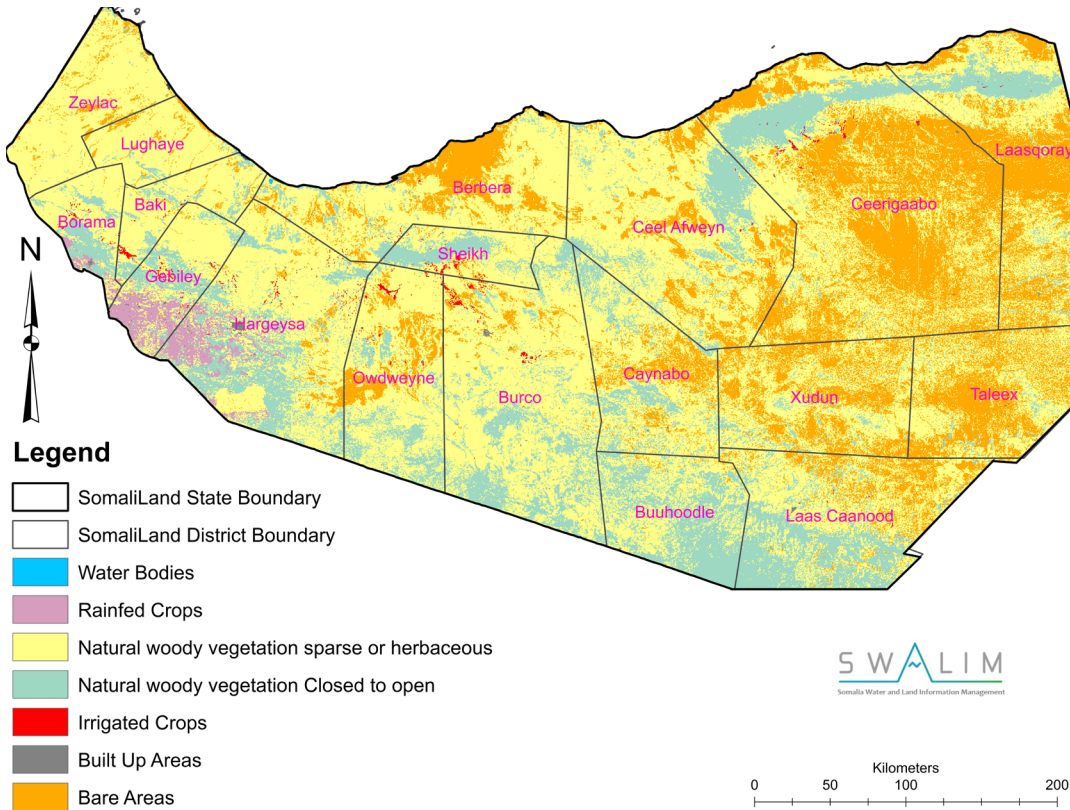
Somaliland's environment consists of a variety of ecosystems, comparatively limited biodiversity and scarce water resources (Figure 1) (Monaci et al. 2007). The topography is characterized by three main landforms: (i) Piedmonts and the coastal plain (*Guban*) situated southward from the Red Sea with elevations ranging from sea level to 600 m; (ii) Hills and dissected mountains (*Oogo*) of rugged features and rising to more than 1,500 m; and, (iii) the plateau (*Hawd*) with large areas of undulating plains. There are three main climate zones in Somaliland: (i) desert; (ii) arid; and, (iii) semi-arid. The vegetation is characterized mostly by grass, shrubs and woodland. Perennial grasses such as *Lasiurus scindicus* and *Panicum turgidum* and scattered trees such as *Balanites orbicularis*, *Acacia tortilis* and *Boscia minimiflora* are the most predominant vegetation in the coastal zone of Somaliland, particularly in the western part. *Juniperus procera* woodland is more present in the mountainous areas. In the plateaus, *Acacia etbaica* bushes and woodland as well as open grasslands or *bans* are common. In these areas pressure on grazing is intense. The *Hawd* is characterized by *Commiphora* woodland and bushes. The *Nugaal* valley largely supports sparse trees such as *Acacia tortilis* and shrubs (MoNP&D 2017).

Temperatures are generally high throughout the year, with the maximum being 36–38°C in the coastal areas (Basnyat 2007). Rainfall has bimodal distribution, with the first main rainy season, *Gu*, occurring between April and June and the second, *Deyr*, from August to November. The two dry seasons are *Jilaal* (December and March) and *Hagaa* (July and August). It is important to note that areas around Sheikh, Hargeisa, Borama and Erigavo towns receive the higher volumes of rainfall, an average of 400 mm per year, supporting limited crop production. The northern coastline is characterized by low rainfall amounting to less than 100 mm per year. The rest of Somaliland receives an annual rainfall ranging from 200 mm to 300 mm (Figure 2) (Paron and Vargas 2007).

The low precipitation amounts have led to scarce water resources, and absence of permanent rivers and lakes. Groundwater (from dug wells, boreholes and springs) is the main source of water for the majority of the people. This water source is harnessed by the rural and urban population to meet domestic and livestock water needs as well as for small-scale irrigation. In 2012, according to FAO SWALIM (Petersen and Gadain 2012), there were a total of 1,037 water sources of which more than half were shallow wells. Dams were restricted only to the region west and south of Hargeisa, while springs were found in the mountainous regions, particularly in Awdal, between Hargeisa and Berbera and around Erigavo regional towns.

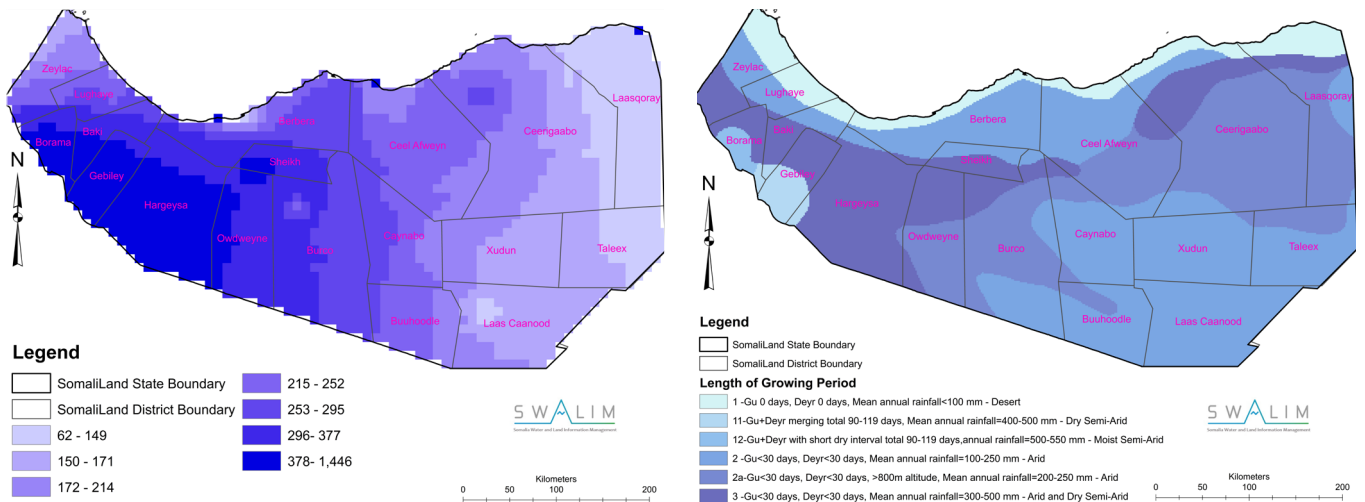
1. Calculated based on figures from the United Nations Development Programme for the years 1999 to 2005.

Figure 1: Land cover of Somaliland.



Source: FAO SWALIM

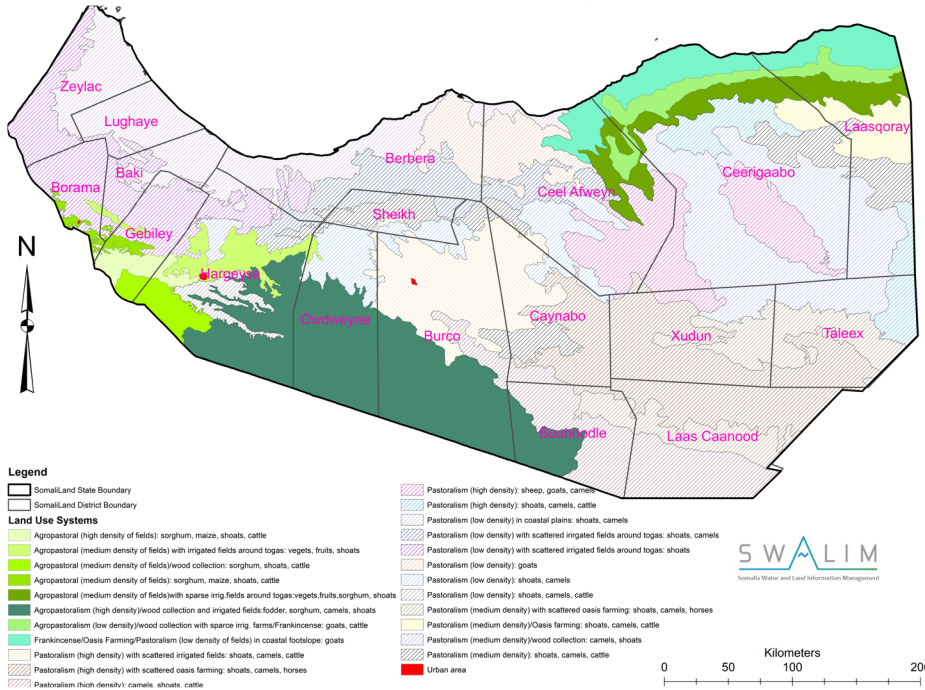
Figure 2: Rainfall maps of Somaliland.



Source: FAO SWALIM

The major land use is pastoralism with agro-pastoralist zones in the southwest where most rain-fed cropland is found and the northeast where irrigated cropland is found. Cattle are mostly found in the west, the wetter part of Somaliland, camels in the driest and goat and sheep elsewhere.

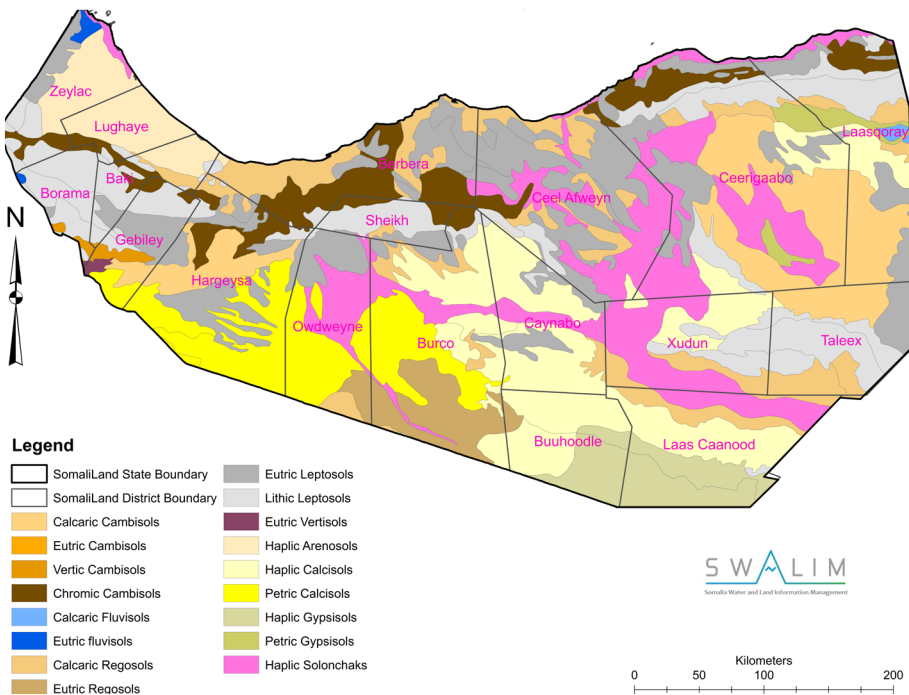
Figure 3: Land use system map of Somaliland.



Source: FAO SWALIM

Somaliland has different types of soils (see Figure 4 for a simplified soil map). The soils are Leptosol, Cambisol, Regosols and Solonchaks². Overall, the soils have poor structure with high permeability, low moisture retention capability and inadequate internal drainage. Though the nature of these dryland soils makes them of poor quality, the clearing of vegetation for farming purposes, cutting trees for charcoal production and overgrazing have magnified their deficiencies. The progressive decline in soil quality (fertility) has impacted on the productivity of both farming and grazing lands.

Figure 4: Simplified soil map of Somaliland.



Source: FAO SWALIM

2. Leptosol are soils that are very shallow; Cambisol are those soils at the beginning of formation and whose horizon differentiation is weak; Regosols are those that weakly developed mineral soil in unconsolidated material resulting from erosion; and, Solonchaks are salty soils that drain poorly.

Historical review of land use

A review of the history of land use and land-use planning in Somaliland reveals five different phases: the pre-colonial time (before 1887), the colonial time (1887–1960), civilian rule of government after independence (1960–1969), revolutionary military socialist regime (1969–1990) and the collapse of the revolutionary regime (after 1990). Each of these periods have had different policies and land-use planning processes or influences resulting in different land and resource utilization approaches (Venema et al. 2009).

In the pre-colonial time a set of customary norms (known as *Xeer*) provided the rules of interaction among members of a clan and other neighbouring groups. They guided access to and use of pasture, water and other natural resources, and every member of a clan had the right of access to the rangelands and water resources within the territory inhabited by the clan. Whereas the rangelands themselves were managed communally, private property rights were assumed for any infrastructure built on the rangelands. This property fell under Islamic law and could be inherited under those conditions. In wetter areas and enclosures for cropping, every household within the community was designated a plot for cultivation. Land in urban areas was considered privately owned. To a certain extent, this customary law is still applied today (Venema et al. 2009).

During the British colonial rule, much common land including in the pastoral areas was privatized, individualized and then registered, with title deeds issued for agricultural land covering a 50-year lease period. Other land uses were defined vis-à-vis grazing reserve—which aimed at increasing the availability of fodder in the dry period; forest reserve; and public water points. This rule favoured settlement of pastoralists (Venema et al. 2009).

From 1960–69 under the civilian rule, new land rights gave all Somali the right to use and live in any location. However, while free grazing in rangelands was maintained, other grazing areas were privatized. In the revolutionary period, a socialistic land tenure regime was adopted, stipulating that all land belongs to the state, all the infrastructure on land was nationalized and any customary agreements between clans was declared invalid. Despite the new rules, the traditional land rights of clans were de facto maintained. The collapse of the Somali central government in 1991 led to the breakdown of all formal institutional and social structures, leading to an increase in illegal appropriation of land and water resources (Venema et al. 2009). To a certain extent, the old traditional clan-based customary law is still respected on communal land. Currently the Somaliland government is developing a new land tenure law, about which no one was willing to share details about because it is a sensitive topic.

Emerging issues that necessitated this study

Agriculture is the most important sector for Somaliland's economy. In 2012, the sector contributed to more than 40% of the GDP—with the livestock sub-sector contributing 29.5%, crops and forestry 13.4%, and fisheries 0.2% (MoP&ND 2017). The sector is also a major employer, with livestock production and related activities employing around 27% of women and 20% of men. Most of the livestock production has traditionally been done under nomadic pastoralism. However, in the recent past, there has been an increasing shift towards adoption of agro-pastoralism at the expense of nomadic pastoralism in more regions of Somaliland. Agro-pastoralism involves the integration of limited crop cultivation and pastoral livestock production. It has been observed that the agro-pastoral production system has in one way or another allowed some livestock keepers to improve household food security by generating household food and income from both crops and livestock, thus minimizing the increasing risk of relying solely on pastoralism (MoNP&D 2017). However, ongoing drought challenges this investment in crop growing.

The current Somaliland National Development Plan (2017–2022) states that the evolving shift away from a pastoral livelihood system is driven by a number of factors. First, the country has been going through an intense process of population growth in urban areas, mainly driven by rural to urban migration. At the moment, the urban population already accounts for almost half of the total population.

Second, more frequent and severe climate hazards, especially droughts (Petersen and Gadain 2016), are challenging pastoral livelihoods sometimes with destitute pastoralists ‘dropping out’ of production moving to urban centres and/or alternative livelihood practices. The climate hazards have also contributed to increased soil degradation and erosion, progressive reduction in rainfall and higher temperatures that have not only intensified the negative impacts on natural resources but also caused additional changes that include altering the livestock mating calendar (Hartmann and Sugulle 2009).

It is estimated that about 30% of Somaliland’s land is severely degraded (MoNP&D 2017). The most common types of degradation include loss of vegetation cover, soil erosion³ and deforestation⁴. The vegetation types that have been highly exposed to land degradation include grass, forbs, sparse shrubs, and short trees, which are the prime sources of feed for livestock. The loss of these vegetation types has been attributed to livestock grazing and unregulated agricultural activities in the rangelands. The increase in agricultural activities has been associated with increasing land enclosures, all of which have affected the traditional livestock grazing patterns in some areas and led to the concentration of livestock in others. Besides, the proliferation of Berkheds (traditional underground water reservoirs) has also increased livestock and population concentration in certain areas where the surrounding vegetation has been exposed to further deterioration. Furthermore, the loss of native vegetation, has been accompanied by proliferation of invasive plant species such as Parthenium weeds (*Keligii noole*), Prosopis (*Garanwaa*) and Cactus (*Tiintiin*) all which have high seed production capacity and adapt easily to a wide range of climatic and soil conditions. Though livestock will for example eat Prosopis pods, they are generally unconsidered unsuitable for livestock particularly in their raw state and the loss of grazing land to these invasive species outweighs any benefit (Omuto et al. 2009; Vargas et al. 2009).

These changes have contributed to the increase in conflicts over land use. Understanding the dynamics that drive land use change is important for supporting policymakers’ development of a land use policy that contributes to the reduction of land conflicts. Such policies can support the emergence of a multifunctional landscape⁵ that accommodates the pastoral production system that needs to adapt to new climatic conditions as well as the new emerging claims from settlers (Leemans and de Groot 2003). The objective of this study was to investigate and document the current natural resources relevant to livestock production in Somaliland, identify the major drivers of land use change at landscape scale that influence landscape functions, and identify pastoralists’ existing strategies to adapt to these changes. It is envisaged that the information generated will inform policy formulation that will accommodate these new and evolving land uses by combining, where possible, different landscape functions.

3. Soil erosion has been attributed to natural conditions and to land mismanagement, especially overgrazing, heavy wind storms, sloppy terrain, increases in numbers of water points—hand wells, boreholes and underground water reservoirs (Berkheds), deforestation and some water harvesting techniques applied in agricultural areas.

4. Deforestation on the other hand has mainly been attributed to charcoal production. The rapid process of population growth as well as urbanization has significantly increased the demand for charcoal over the years. Various markets offer charcoal for sale, because it is a major source of household energy. Charcoal production has been an important source of income and part of the coping strategies for many subsistence farmers and pastoralists. Moreover, the inability to enforce Somaliland’s environment legal framework has exacerbated the deforestation trend (MoPD&E and CLHE 2014).

5. Multifunctional landscape entails the landscape which accommodate these new claims on land by combining, where possible, different landscape functions, i.e. the capacity of the landscape to provide good and services for society, in the same location (Dalgaard et al. 2007; Willemen et al. 2008). The Millennium Ecosystem Assessment distinguishes four categories of services. Supporting services are necessary for the production of all other ecosystems services, provisioning services, are the products obtained from ecosystems (including the use of natural resources), regulating services are benefits obtained from the regulation of ecosystem processes such as nutrient cycles or pollination and finally cultural services, the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences on material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences (Leemans and de Groot 2003).

Material and methods

This study was executed in three phases and implemented between April and November 2016. This research consisted of three phases:

- Phase I: Key informant interviews and literature review
- Phase II: Participatory geographic information system (PGIS) mapping with mixed stakeholder groups
- Phase III: Satellite image analysis to confirm major dynamics.

Phase I

Phase I entailed two steps. The first step involved a review of secondary information on the nature and diversity of the natural resource base in Somaliland and its relation to livestock production. The second step of phase I involved key informant interviews to triangulate collected information and also gather more information for implementation of phase II of the study.

Key informant discussions were held with representatives from the Ministry of Environment and Rural Development, Ministry of Agriculture, Ministry of Livestock, FAO SWALIM, and an environmental and public awareness raising NGO Candlelight. The focus of the discussions was on the:

- Identification of the major dynamics that shape the natural resource use in Somaliland;
- Understanding of the current level of available information and possible gaps; and
- Identification of the correct set-up for the PGIS workshop and how it can be used to fill identified information gaps.

Phase II

Information from phase I was analysed and used to implement phase II of the study, which encompassed operationalization of the PGIS workshop. Invited participants represented different stakeholders, namely governmental representatives from different administrative levels, pastoral communities and NGOs. This workshop, which included three mixed stakeholder groups, each with seven participants, with diverse backgrounds, first identified and discussed the important natural resources for livestock, and then ranked these resources in order of importance. In a second step, they delineated, i.e. set the boundaries to their work, an area within which they mapped the current availability and distribution of these resources. After mapping the resources, and through a moderated discourse, they were required to answer the following questions for each resource:

- What are the current conditions of the natural resource in different seasons?
- Who has rights and responsibilities relative to the natural resource? How do they gain access? How is the resource governed?
- How are the different users interacting? Are there conflicts of interest, positions, and needs?
- Are there any regulating policies or (customary) practices?

-
- What are the major drivers of change in a) recent years? and b) changes likely in the future?
 - What adaptation strategies have been observed by different land uses?

The participatory mapping allowed the identification of the major dynamics around natural resources and the discussions around the location and permitted definition of criteria to map the different functions of land for the livestock sector.

On completion of this exercise, the participants were asked to imagine they were boarding a plane that would take them to year 2030 and see how a great Somaliland where great health care and meaningful free schools were proposed as entry points, would look like. Participants were then asked to describe the livestock sector and the landscape they imagine seeing in 2030. These ‘future visions’ exercises allowed identification of participants’ aspirations and defined scenarios to investigate future functions of the landscape.

Phase III

Finally, in phase III, major dynamics of change and the adaptation strategies were identified through a discourse analysis on data collected in phases I and II. For those dynamics that are land based and can be potentially be observed with satellite images, historical free satellite images were then screened with Google Earth to confirm that the dynamics can be observed.

Results

This section presents the findings from each of the three phases separately.

Phase I: Key informant interviews

Key informant interviews were held with five stakeholders, this section reports the thoughts, opinions and lines of logic of their narratives.

Stakeholder I (ministry)

The first stakeholder was a representative of the one of the ministries. He identified five interlinked dynamics that in his opinion are shaping the natural resource use.

- Increasing land degradation and lack of concomitant rangeland management. For this stakeholder, land degradation is at the centre of his preoccupation. He pointed out three dynamics that increase land degradation. Firstly, the increasing number of livestock that requires more biomass and therefore contributes to increased degradation. This would not be such a problem, if, and this was his second point, rangelands were managed in a way to optimize biomass production. Thirdly, he mentioned that land degradation is accelerated by tree cutting for charcoal production.
- Increasing numbers of private enclosures. With the recurrent droughts in Somaliland, there is an increasing number of pastoralists who have given up on their nomadic lifestyle stopping mobility with animals. They are settling near water points to either engage in crop farming or other forms of livelihoods. Stakeholder I identified a major driver of this transformation as the significant reduction in household livestock numbers or in some cases, total loss of livestock herds due to cyclic droughts. Other motivations for settling are better access to schools for children and to health services. Settlers often enclose land to pursue their activities, which from the perspective of this stakeholder is illegal. In his understanding, under current Somaliland law, rangelands are considered as public goods and cannot be enclosed for private use. The government has the right to take down these enclosures and has been doing so. However, he felt that the government did not have sufficient means to take all illegal enclosures down.
- Charcoal production resulting in deforestation. Settlers need energy and alternative sources of income. Charcoal production has become an important income generating activity as charcoal even gets exported. Yet, this leads to increased deforestation, which decreases the capacity of soil to absorb water, leading to increased erosion and therefore more degradation. This links to the first point in this list.
- Social changes in the Somali society. Many young people do not really see a future in the pastoral lifestyle and therefore move to urban areas in search of jobs. This leaves the pastoral families without the young men who usually scout for grazing land before animals move. This obliges the older generation to settle too, reinforcing the settlement (point 2).
- Road creation which increases soil erosion. There are more and more off-road vehicles driving in the area. They create paths that accelerate erosion and therefore increases land degradation.

Clearly for this stakeholder land degradation was at the centre of his attention, and he explained several dynamics that need to be controlled to keep the carrying capacity of Somaliland's natural resources to support the livestock system. In addition, his major criticism of the international community was that the relief aid they provided was too short-sighted. According to him, Somaliland needs development projects to support the emergence of rangeland management plans and the capacity to enforce them on the ground.

He also expressed his worry about youth stepping out of the pastoral lifestyle, as it will result in a generation that lacks the knowledge and the competencies to make policies for managing the fragile resources of Somaliland.

Stakeholder 2 (ministry)

For stakeholder 2, the major problem is the changes of rainfall patterns. He explained that droughts are now more frequent, and this is the key problem. Not only can grazing land not recover but also crop failure is common in those area with rain-fed agriculture. For him, the best solution is to have a good rainfall monitoring system and rainfall prediction to help people to make the right decisions. He is actively contributing to on the ground climatic data collection and its management.

Stakeholder 3 (ministry)

This stakeholder is also from a ministry. He had two major preoccupations, namely climate change and the loss of pastures. Climate change was at the top of his priority because he saw it as the major threat for Somaliland. Climate change adaptation was therefore the centre of this discourse, as he felt that it is key to the survival of the Somali society. He mentioned diverse adaptation strategies that are already happening on the ground, namely the switch from cattle to sheep and goats, and from sheep and goats to camels among pastoralists. Also, he noted that many households are deciding to settle. In order to sustain their livelihood, the settlers have ventured into new activities such as crop or fodder farming and making a business of selling fodder to others or in some cases even set up dairy farms. All these activities, however, require that land becomes enclosed and threaten the traditional migration routes that other pastoralists still need to maintain their moving herds.

The second biggest issue, he said, was the loss of pasture quality resulting from the lack of management and increased land degradation. Finally, he mentioned animal health during dry seasons as a major problem that should not be forgotten. Despite not having a direct impact on natural resources, animal health issues influence pastoralist decision-making.

Stakeholder 4 (NGO)

Stakeholder 4 saw the lack of fodder resulting from climate change and the loss of the pastoral system as the major challenges. To address this some of the projects they were involved in have split Somaliland in two categories that require different solutions:

- Agro-pastoralist areas
- Pastoralist areas

In agro-pastoralist areas, they recommend feed and fodder planting, showing communities how to plan local fodder grasses and how the use of manure can improve fodder productivity.

In pastoral areas, stakeholder 4 helps households restock with animals. After a drought, households who have lost too many animals usually decide to settle, as there is no need for migration anymore and access to services is easier. This speeds degradation in areas nearest to settlements, as these pastures face sustained pressure and do not recover. Also, the NGO offers communities training on soil and water management techniques which, if implemented correctly, should enhance the vegetation and rehabilitate degraded land.

Stakeholder 5 (NGO)

This stakeholder also saw the impact of climate change and land degradation as the central problems. They have set up an information system to help the government to make better decisions. But despite of the growing amount of information and evidence, some stakeholders have difficulties in using the original data. They said there was a need to help stakeholders put meaning to these datasets both on water and land to develop evidence-based policies.

Phase II: Participatory mapping

The participatory mapping exercise in mixed stakeholder groups had two separate activities. The first was the mapping of the resources and discussions relative to the current state of the resource including dynamics driving change. A second exercise consisted of visioning the future, trying to understand the different visions that stakeholders had regarding the livestock sector in Somaliland. This section reports in detail the discussions from the groups, as a mean to document the primary qualitative data that was collected through this exercise. At the end a cross-group reflection that point out the communalities within the groups is presented.

Mapping of current resources

Discussions from Group I

Natural resource ranking

Group I first came up with the following natural resources: land, water, livestock feed, livestock human resource, pasture minerals, and fodder. In the discussion, group members were asked to list the natural resources in order of their importance. Anything animals feed on (fodder, pasture, grass, minerals, trees) was grouped into one inclusive category (livestock feed). The group then came up with a list of more than seven things they called natural resources, but after further discussion these were reduced to four and listed in order of importance as follows.

- Land
- Water
- Livestock feed
- Livestock

Setting working delineations

The participants were informed that mapping of natural resources related to the livestock sector would be done in some regions and not the whole country. The central regions of Somaliland were selected because they had sufficient information available. The group agreed on the delineation to work with and focused on the North-South axis as requested.

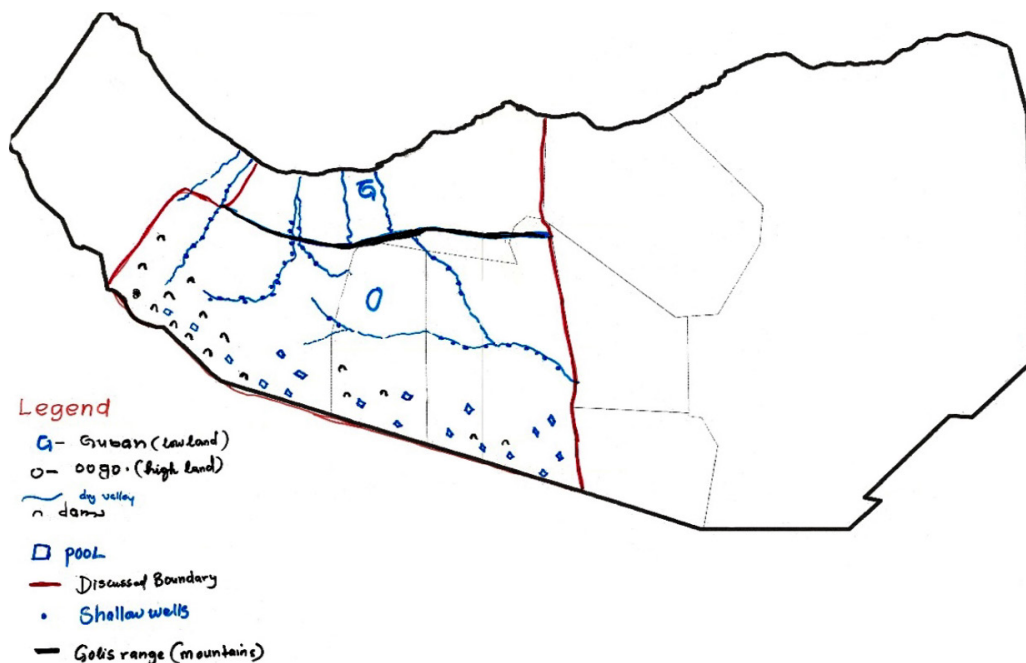
Natural resource mapping for water

The group members divided the land into two, Oogo (the highlands) and Guban (lowlands) because of their different climatic, altitude, vegetation cover and water availability, Guban is along the coast and northern part of Somaliland while Oogo is in the southern part of Somaliland. These two regions are separated from by the Gollis mountains. Water sources mentioned in the discussion were divided into five categories:

- Shallow wells
- Springs
- Dams

- Boreholes
 - Pools/small water catchments
 - Dry seasonal rivers/ valley

Figure 5: Water resource map (Group 1).



Different sources of water are common in different regions, for example, shallow wells are mostly found along the dry seasonal rivers/valleys, while dams and pools are common in the south (far Oogo). Shallow wells are mostly used by crop farmers. Boreholes are mostly close to urban areas where the demand for water is higher.

Finally, it was noted that reduced rainfall resulted in lower ground water levels as well as poorer water taste and quality. Yet, land cover changes that result from the human activities contribute to the valleys swelling with heavy and strong running water that destroy bridges and floods towns.

Natural resource mapping for feed

The group also mapped livestock feed as shown in Figure 6.

Group 1 divided the livestock feed into a number of components, e.g. natural grass without enclosures, natural grass under private enclosure, grass under government enclosure, fodder, crop residue, trees, and shrubs. The description of their work is shown in Table 2.

Natural grass under private enclosure is common in Salah lay area, Beer, Qoyta, Oodwayne, and Suuqsade. The private enclosures are steadily increasing, although the government has banned fencing of some enclosures. However, because of frequent lack of enforcement people often ignore them and continue fencing. The land use is changing into a business investment which can be sold from one owner to another. The group also mentioned and praised the benefits of three government enclosures namely Qool'Aday, Aroori, and Togwajaale. They said more of such enclosures are needed to save Somaliland's livestock during droughts. Another advantage of such enclosures that was cited by the group was that they save the land from overgrazing and erosion.

Figure 6: Feed map (Group I).

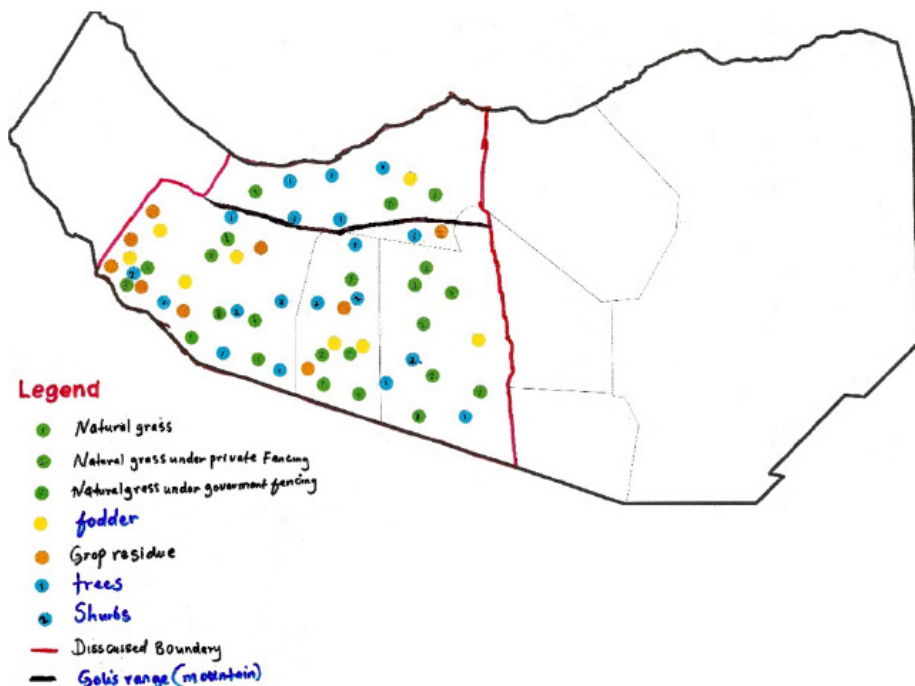


Table 1: Water source descriptions (Group I)

	Non-perennial rivers	Boreholes	Dams
What are the current conditions in different seasons?	Seasonal	Permanent	Seasonal
Who has rights and responsibility relative to the natural resource? How do they gain access?	Public, everyone can access without restriction	Settlements are starting to be source of conflicts; however, other users do not have any conflicts	Public and private: some people create their own dams there are other dams dug by international NGOs and government institutions which are private
How are the different users interacting? Are there conflicts of interest?	Mostly no conflict	Authorization from the ministry of water and environment is needed, approval depends on the reason for requesting the borehole Ownership of land is one of the reasons for approving or disapproving a request, next to the reason for the establishment. (For example, a businessman who tried to establish a borehole and create another source of water for Hargeisa town government, was refused because the government wants monopoly in water supply). Need is another important criterion, in some locations additional boreholes are not allowed	Communal land is becoming private which is a source of conflict. Some people allow dams to be built on land they own privately and later on refuse communal use and create enclosures
Are there any regulating policies or (customary) practices?	There is no policy yet, but a draft is at the Ministry of Water and Environment	Population increase and increased demand for water e.g. in Hargeisa city. Some parts of the town have not access to water. Increased socio-economic status is another cause of increased demand	
What are in your opinion the major drivers of change in recent years? and b) in the future?	There is more and more water shortage which pushes people to find new sources	Create more boreholes	
What adaptation strategies have you observed?	Water harvesting		

Table 2: Livestock feed source descriptions—Grass, fodder and crop residues (Group 1)

	Grass	Fodder	Crop residues
What are the current conditions in different seasons?	Grass is plenty in rainy seasons, but scares in the dry seasons	Seasonal	Seasonal
Who has rights and responsibility relative to the natural resource? How do they gain access?	Grazing land is a public good, the government tries to keep some for the dry season. The government does not allow animals to graze in certain areas in the rainy seasons e.g. in Qool Caday, Gacaniibaah. Some people produce grass for sale or for their own animals.	Private property	Private
How are the different users interacting? Are there conflicts of interest?	There is overgrazing during the dry season, i.e. the grass is used before flowers and seeds are grown. Government regulates access in some places. Yet conflicts occur when nomadic pastoralist come in contact with those who do not move	Production for own livestock by only a few people	Used for own livestock and sometimes sold to others
Are there any regulating policies or (customary) practices?	In principle, customary law foresees free access anytime, even in the dry season	There are no regulations	There are no regulations
What are in your opinion the major drivers of change in recent years? and b) in the future?	Charcoal production Climate change Droughts Deforestation Land degradation Overpopulation		
What adaptation strategies have you observed?	New migration patterns like migrating from west to east instead of the normal pattern of south to north Settlement in urban areas Internally displaced people (IDPs). Those no longer able to rear animals or grow feed for their animals lose everything and become IDPs in town Government enclosures	This is an answer to the lack of feed. Fodder production also calls for zero grazing.	This is also an answer to the lack of grass as crop residues can be stored and used during the drought.

The group discussed if there are people who grow fodder for animal feed and concluded that only few individuals grow alfalfa, Sudani grass etc for their animals and also sell to other pastoralists. The group mentioned three groups of farmers located in different villages, namely Biyo-guure (Berbera district), Wijiwaaji (Gabiiley district) and Gabilley (Gabilley district) who were growing fodder.

The group discussed trees as a natural resource and source of animal feed in the area they have mapped. They said they have seen changes including deforestation and charcoal making. Charcoal is normally used locally, but the group said in Gabilley area people had started exporting it to Djibouti. They said charcoal makers used to cut down dry trees but had shifted to using live trees.

Discussions from Group 2

Natural resource ranking

In the first step, participants in the second group identified natural resources that are important to livestock production namely: water, livestock, natural gums, pasture, land, human population, stones, cash crops, subsistence crops, seasons, tree and forests, hills and mountains, wildlife, sea, aquatic animals (fish), shelter etc. Afterwards, these natural resources were ranked according to their availability and support to mobility in livestock production as follows:

- Land
- Water
- Pasture
- Trees and forest

Participants argued that without land there is no base for any livestock production. Therefore, the first and most important resource is land. They said without water there is no life and water was listed second. Finally, they recognized that productive livestock needed access to good feeds and fodder, and therefore, the third option was livestock feed, which in its broadest meaning included pasture and trees.

They said increasing land grabbing has resulted in intense conflicts between clans. Land ownership is based on establishing settlement and permanent sources of water on that land and attempts at settling and establishing permanent water in a place can initiate clan-based conflict. But grazing in other clans' land is seen as normal and is not understood as land grabbing.

Beyond the three most important natural resources, population was suggested, based on the Somali saying, 'When God wants to give you wealth, he first gives you children.'

Setting working delineations

The group could not agree on a working delineation because the group was very diverse and included participants from areas that were not expected in the workshop. Also, since livestock distribution and species dominance differed across Somaliland, and focusing as requested on the particular North-South axis as seen as excluding interesting dynamics specific to camels, sheep and goats, which are mainly in eastern Somaliland. The group agreed to work with the boundary of Somaliland but start the discussion from central Somaliland. This allowed collection of information about the diversity in Somaliland, yet with fewer location-specific details.

Natural resource mapping for water

The group started off discussing the importance of land. It is the basic natural resource, because it is the base that provides grass for pasture and settlements. Participants then focused on the mapping of water as it was not clear to them how to map land beyond just delineating it. The reason for this was the fact that water can be delivered to locations where pastures are available. The group also agreed that without water trees, pastures and livestock would not survive.

They described different water sources, namely boreholes, streams, wells, lakes and underground streams in valleys (non-perennial streams) and had a general discussion on dynamics that shape or transform water resources. They said natural water bodies and valleys are shaped by many factors, including the extraction of stones for construction resulting from urbanization, farming, animal watering, and heavy downpours upstream. Near urban areas, more boreholes are being dug along river banks to tap into the underground streams.

The group mapped the major underground streams in Burco which is shown in Figure 7 with their characteristics summarized in Table 3.

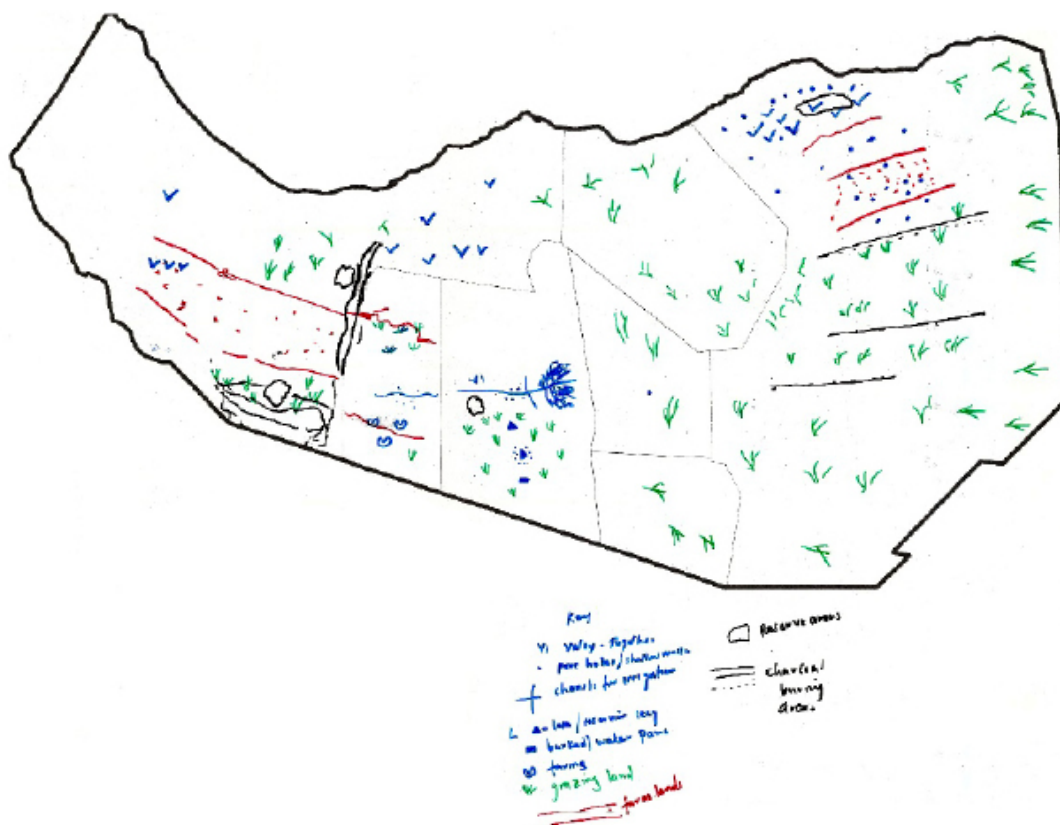
Table 3: Water resources descriptions (Group 2)

	Non-perennial river (VI)
What are the current conditions in different seasons?	In the rainy season, there are floods, which carry waste to other lands
Who has rights and responsibility relative to the natural resource? How do they gain access?	The government controls access to the valley near Burco. Law enforcement units always patrol the valley in Burao to scare away people extracting stones and sand from the valley. If anyone is caught in such activities he is arrested and fined.
How are the different users interacting? Are there conflicts of interest?	Construction companies, and pastoral communities. There are three sources of conflicts: Urbanization along water sources caused by encroachment of grazing lands leading to conflicts between pastoralists and urban dwellers Construction companies are in conflicts with pastoralists because pastoralists prevent them from harvesting sand and stones from the valleys. Dumping of chemicals and garbage causes tension in pastoral areas
Are there any regulating policies or (customary) practices?	Government regulates, meaning does not allow people to settle in the valley. Boreholes cannot be constructed around farms. The government have police patrols in areas where valleys intersect towns. In this they control any excavators attempting to remove sand or stones in the valley. The government restricts the introduction of new boreholes near valleys because permanent water encourages people to settle which would transform grazing lands into urban centres. The land ownership is governed by owning clan and the clan leaders have strict rules to prevent urbanization and creating enclosures.
What are in your opinion the major drivers of change in recent years? and b) in the future?	Increase of valley depth and width due to sand and stone harvesting for construction Heavy rains widen the valleys and cause floods. Expansion of valleys destroys grazing areas and wash away people and livestock Dumping garbage and chemicals in valleys. 90% of the water valleys are not used
What adaptation strategies have you observed?	Construction of soil bunds upstream to limit the effect of water flows on river banks Developed of policies that regulate activities along valleys around urban areas Construction of channels to irrigate farms Establishing farms and enclosures in flood plains to make use of the valley water

During the water mapping, other important issues were raised, namely the movement of livestock as well as the role of wildlife in livestock keeping. Firstly, pastoralists' natural migration pattern is governed by the rainy seasons. The general movement of pastoralists all over Somaliland is north to south and south to north. From December to February, pastoralists are in the coastal areas and the north. In the months of March to November, they are in plateau in the south. Sometimes, shocks, like severe droughts, can cause abnormal movement patterns east to west or west to east. In these scenarios, there are generally no conflicts. Such convergence of high population of livestock results in degradation of pastures and water reserves. They also cause severe soil erosion resulting from the treading of thousands of animals, which loosens the soils. Indeed, animal hooves dig into unstable soils, leading to the formation of gullies on slopes. This convergence of livestock also contributes to disease outbreaks and introduction of new species of tick in the environment. In addition to overgrazing created by such convergence other effects include the introduction of invasive species of grass and shrubs that replace the valued grasses and pastures.

Secondly, wild herbivores are very important because they are preyed upon by carnivorous wildlife, creating a buffer zone for livestock and pastoralists. There was a time when wildlife numbers declined due to droughts and hyenas were attacking animals and pastoralists.

Figure 7: Water and feed resources map (Group 2).



Natural resource mapping for livestock feed

During the discussion of livestock feed, the participants decided to focus on pasture and grazing land as well as trees and forests. They came up with the resources mapped in Figure 7: Water and feed resources map: Group 2 as described in Table 4.

During the reporting, several other issues were raised. For example, it was reported that the British had demarcated Somaliland into areas that could be farmed, and areas solely assigned for pastoralists. These demarcations are still in place and the policies are in force in the Hargeisa region and Erigavo. In other regions, these demarcations have been lost. The policy foresees that the demarcation cannot be changed unless the ministries of Livestock, Environment, and Agriculture jointly pass a document to parliament, which is the only body that can change the demarcation. These three ministries are now proposing to move the demarcation into the rangelands so that they can get space for Hargeisa town to develop and expand.

The government is responsible for the grazing land and must give permission to people to cultivate the land. Therefore, there is a policy on land demarcation between the agricultural and grazing areas. There were recently reserve areas established such as Qool Cadey, Wajale, Aroori, Dalo, and Gacan Libax. As shown on the map (Figure 7), the policy clearly states that grazing lands cannot be transformed into farms or urban areas unless approved by the parliament upon request by the ministries of agriculture, livestock, and the mayor of Hargeisa. Some policies state that reserves are not accessible to livestock unless the government clearly recognizes the existence of droughts. Also, animal movement in the normal pattern of migration have been hampered by urbanization. This leads pastoralists to either intersect towns or bypass the urban areas using other routes that are otherwise difficult terrain. For example, Hargeisa had livestock routes on the east and west sides, but due to the expansion of the city these routes have been blocked and alternative animal movement routes have been created.

Table 4: Livestock feed source descriptions—Pasture/ grazing land and trees and forests (Group 2)

	Pasture/grazing land	Trees and forests
What are the current conditions in different seasons?	<p>Land is very scarce, and, in addition, it is mismanaged and prone to deforestation. This leads to less grass on pastures. Increased population of livestock and humans as well as adoption of semi-sedentary systems have resulted in the loss of a sustainable equilibrium of livestock, people and the arid ecosystem. The drivers for this change include: lack of mobility of pastoralists, loss of diversification of livestock species (rearing one species) and keeping many animals in one area.</p> <p>In balancing pastures use the pastoralist used to move to the Guban during dry seasons and back to Hawd in rainy seasons which allowed the land to recover and pasture to regenerate.</p>	<p>There are fewer and fewer trees as they are used without replanting.</p> <p>The recurring droughts have exacerbated the condition by preventing trees from growing naturally or stump regeneration.</p> <p>Increased off-road driving path decrease the vegetation that covers the soil. This reduces soil moisture availability to the trees during the dry season</p>
Who has rights and responsibility relative to the natural resource? How do they gain access?	The government is responsible for the pastoral and cropping areas.	<p>Pastoralist use trees for fencing. Farmers clear trees to use the land for cropping.</p> <p>Trees are used for charcoal production.</p>
How are the different users interacting? Are there conflicts of interest?	There is conflict between farmers and pastoralists. Increasing land enclosures also cause conflicts as they are encroaching on grazing land	The users are the pastoralists, farmers and the traders
Are there any regulating policies or (customary) practices?	<p>There is a policy and demarcation of land used for pastoral and for farming areas. Reserve areas have been established e.g. Qool Cadey, Wajaale, Aroori and Dalo. The Dalo reserve is meant for tourist attraction due to it is attractive landscape. While the other reserves are meant for control of overgrazing so that pastures regenerate and provide seeds to replenish the areas where animals have overgrazed. This seed can be transferred to the grazed areas by wind, floods, and birds</p> <p>The government allows pastoralists to graze in the reserved areas during severe droughts.</p>	The government has policies concerning tree cutting. Charcoal production is illegal.
What are in your opinion the major drivers of change in recent years? and b) in the future?	<p>Increased population is causing urbanization, as a result grazing and cropping land is decreasing</p> <p>There is soil erosion and land degradation</p> <p>Pastures are also decreasing as a result of droughts</p>	Charcoal is an important source of energy whose production increases with population growth. It has also become an important business.
What adaptation strategies have you observed?	<p>Emergence of enclosures for grass production</p> <p>Livestock keepers share pastures during droughts. Pastoralists have memorandum of understanding in which during droughts clans can move in to the territory of other distant grazing lands without conflict and they are welcomed and given water</p> <p>The government enforces the exclusive use of enclosures, with offenders facing prison for two years</p> <p>Emergence of zero grazing</p> <p>New migration patterns</p>	<p>Private police to guard trees and forest have emerged</p> <p>Reserve areas have been established</p>

Land enclosures, urbanization and establishing water reserves are the triggers of conflict between pastoralists in Somaliland and this conflict leads to bloody clan clashes. There is increasing conflict between agricultural and livestock keepers due to increased land enclosure and decreased communal grazing lands.

It was also noted that land enclosures contribute to a reduction in livestock numbers. The justification for livestock number reduction relates to carrying capacity of the enclosures. The government fights against enclosures and in principle demolishes them if found. Some participants encouraged the establishment of enclosures in the rangelands which they claimed would provide opportunity for pastures to regenerate. They said such establishments also give pastoralists a sense of having private property.

Moreover, tree cutting is widespread for use in fencing, construction and charcoal making. Construction and fencing result from increasing urbanization. Charcoal production is growing rapidly because it provides reliable income streams and there are no proper policies regulating it. Charcoal production is driven by the energy demands of an increasing population and contributes to the degradation of rangelands. The fear of dwindling rangelands leads some of the people to establish enclosures where they can graze their animals during dry spells and droughts. Some participants said that enclosures near urban centres are mainly for business purposes and owners sell this land for construction.

In summary, increased population has resulted in increased urbanization, leading to increased establishment of agricultural lands at the cost of grazing lands. Prolonged drought has decreased the quality of pasture further. As a result, there is a trend of communal grazing land being increasingly fenced and enclosed for private use. During droughts, people tend to share enclosures giving preference to clanmates, leading to conflict with other migrants who come from far away in search of water and pastures. Several adaptation practices can be observed, such as feeding livestock with grains and crop residues and engaging private police to guard the environment (example is Candlelight NGO).

Discussions from Group 3

Natural resource ranking

Group 3 had six members from different relevant ministries, universities, NGOs and regions in addition to one facilitator and one reporter.

After introductions, the members were tasked to identify the most important natural resources for the livestock sector, keeping in mind the dynamics of those resources and their effect on climate change. Land, plants, water, human resources, sun, air, minerals, fodder and livestock were the natural resources they listed.

After further deliberation, the members grouped some of them into one and then ranked the resources according to their importance to livestock as follows:

- Land
- Water
- Livestock feed

Setting working delineations

The group, with the help of a facilitator, then discussed the meaning of delineation, its purpose and where to start from on the map. There was a challenge in terms of where to start the delineation because group members were from different parts of Somaliland. Each participant suggested that the delineation should include the area they knew. Members agreed to start in the east regions of Somaliland. The selected area bordered Buhodle District in the west, Xudun in the south, Eel Afwayn in the east and Odweyne in the north. The most important sources of water in the eastern regions of Somaliland are shown on the map are boreholes (W1) and streams (W2).

On the second day, the group decided to expand the area of interest in order to include more knowledge that participants had from other areas.

Natural resource mapping for water

The group was supposed to discuss the resources one by one and map each. They started with water. Then they categorized the water into three types: boreholes, streams and wells.

Figure 8: Water resource map (Group 3).



The group mapped the water on basis of dynamics or changes they have seen as shown in Table 5.

Table 5: Livestock feed source descriptions—Boreholes and streams (Group 3)

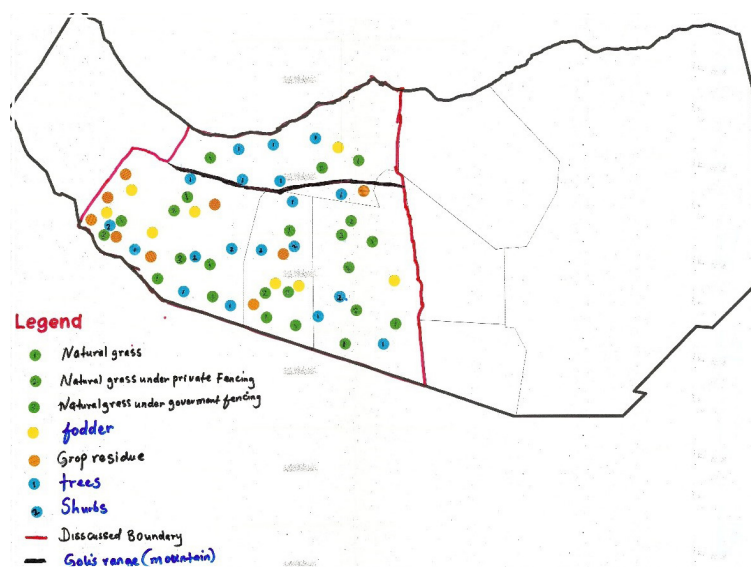
	W1: Boreholes	W2: Streams
What are the current conditions in different seasons?		Number of annual streams is decreasing
Who has rights and responsibility relative to the natural resource? How do they gain access?	Some are private while others are communal. The water from the private boreholes is sold to pastoralists when the communal ones are faulty. The communal boreholes are managed by customary laws set by the respective society	Streams are communal
How are the different users interacting? Are there conflicts of interest?	Different users include pastoralists for their livestock, for human consumption while and a small number of crop farmers People set rules and regulations and conflict is minimal	Different users include livestock, irrigation and human consumption People set customary laws so that nobody is allowed to spoil the water with garbage, leftover food etc
Are there any regulating policies or (customary) practices?	The private boreholes are managed by the owners and the rules they set but those communal bores are managed by customary laws set by the community elders such as first come first served.	There are customary laws.
What are in your opinion the major drivers of change in recent years? and b) in the future?	There number of boreholes is increasing because of more frequent droughts. People are also seeing the income/business benefits having boreholes Many local and international organizations have dug boreholes for pastoralists free of charge	More and more streams are drying off sooner in the season Others may switch from permanent to intermittent streams while some freshwater streams change to saline water
What adaptation strategies have you observed?	Digging more and deeper boreholes Using water tankers to collect and carry water from distant locations	Digging boreholes and making new dams Some people store water in bags and the sizes of these bags have increased

The group members debated about the current status of water unavailability in Somaliland and the negative impact it may have on livestock and agriculture if the situation does not change. The members acknowledged that pastoralists and agriculturalists in Somaliland are not aware of the failing natural resource of water, nor of innovations for long-lasting adaptation strategies to address the problem.

Natural resource mapping for livestock feed

In the second day of the workshop, Group 3 members debated which natural resource should be mapped, arriving at the conclusion to map livestock feed. They also agreed to extend the delineation of the map from the first day to guide the exercise.

Figure 9: Livestock feed map (Group 3)



It was agreed that livestock feed could be grouped into three main branches namely Acacia trees (F1), shrubs (F2) and grasses (F3).

Table 6: Livestock feed source descriptions—Acacia, shrubs and grasses (Group 3)

	F1: Geed Sare (Acacia trees)	F2: Geed Gaab (shrubs)	F3: Caws (grasses)
What are the current conditions in different seasons?	Acacia trees have been affected by cutting for charcoal especially in the Guban area In dry seasons cutting the acacia trees reaches at its peak	There is little change During the rainy season Shrubs grow or propagate rapidly but, this type of animal feed is mainly affected negatively by droughts or dry seasons	The current situation of grass is the worst. Grass depends on the amount of annual rainfall, which is unquestionably reducing, this negatively affects the grass
Who has rights and responsibility relative to the natural resource? How do they gain access?	The ministry of environment and local people Government has passed laws that prohibit the cutting of acacia trees for making charcoal. Local communities also prevent the cutting of acacia trees with the help of the government	There is less concern from the government and the local people, yet they are the most useful trees. The government does not have the financial and technical resources to protect all areas where shrubs grow The local people have pastoralist behaviour, i.e. going to where there is rain and shrubs	Some are privately owned while most of the grasslands are public
How are the different users interacting? Are there conflicts of interest?	There are used openly without conflict	People always share equally Shrubs are used equally by the livestock since all shrubs are communal, so the livestock of any pastoralist can feed on them	There is no policy and no customary rules
Are there any regulating policies or (customary) practices?	There are regulations by the ministry of environment The regulations include no barring cutting acacia trees to make charcoal.	There are no rules or regulations Shrubs are sufficient for the livestock so there is no conflict	
What are in your opinion the major drivers of change in recent years? and b) in the future?	There is more urbanization and population growth, so people cut the acacia trees for building their houses which reduced their density	There is more urbanization and more roads Many villages were set up in areas where shrubs grow which reduced the size and density of the shrubs	There is an invasive species of trees, <i>Prosopis juliflora</i> , which displaces grasses and is not eaten by animals
What adaptation strategies have you observed	The pastoralists grazed most of the acacia trees Many of the trees are now privately owned no one cuts them unless the owner permits	Pastoralists are now having privately owned fields of land where they grow the shrubs for their livestock	Still the grass is enough for the livestock

Vision of the future

Participants were asked to imagine boarding a 'time ship' which would take them to year 2030 where schools were free, and children had the tools to contribute to Somaliland society and where hospitals in Hargeisa had high-tech equipment and nobody would go abroad for health care. Participants were put into new groups to discuss their visions and they were asked to describe the livestock sector landscape at 2030.

Group A (1)

The first group came up with six different points. Firstly, livestock production system is changed to an intensive method. Communities would be proud and stop migrating to other countries, developing their own land instead. Animal health would have improved, and more animals could be exported to international markets. Somaliland would be a secure and united country without tribalism. With these developments, communities would be more aware of where they are going and how to maintain the resources without overusing them. Also, communities would rely on renewable sources of energy and there would be no need for charcoal production.

Group B (2)

In the second group, participants envisioned a change from the nomadic system to a zero-grazing system. Groups of people would be given land and the water access needed for this change. The enforcement of land policies and regulation would make this change possible.

Water access would be improved thanks to the creation of dams in the valleys, which would be used for irrigation of fodder crops. Because people recognize these valleys as a gift from Allah, resources would not be overused, but maintained within their carrying capacity, and soil and water conservation measures would be implemented. Consequently, Somaliland would become a prosperous country with green farms between every valley. The waters passing through these valleys would reach the Red Sea and the intensity of the waters would change the colour of the sea 10 km offshore.

Also, there would be plenty of dairy farms which would contribute to improved nutrition for all. These farms would be established in a way to not hamper pastoral migration routes and managed in a way to maintain natural resources. This would be made possible by the development of land reform policies based on regional information. Land would be demarcated according to clan borders. Each clan would be mobilized to create dams so that it could utilize the natural resource without conflicts.

Group C (3)

The third group envisioned skyscrapers in all major cities of Somaliland, whose independence from Somalia would have been finally recognized by the international community. Both economic and population growth would be at their peak. Consequently, Urbanization would be the major driver of change in the landscape.

Environmental protection and land demarcation laws would be enforced by the government and conflicts reduced. Farmers' education would be much higher, and though the number of pastoralists would be reduced, the quality of their production would be higher.

Somaliland livestock and agriculture industries would be heavily invested in by both the local and foreign businesses and entrepreneurs, resulting in increased livestock production. Better management would improve the quality of grazing land. In addition, thanks to the emergence of alternative energy sources, trees would be conserved, and charcoal production greatly reduced compared to 2016.

Cross-group analysis

First of all, all three groups ranked land, water and livestock feed as the three most important natural resources for livestock consistently in the same order of importance. Ranks beyond those three were less consistent and included livestock, human resource and markets.

Stories regarding dynamics around water were quite consistent across the groups. All mentioned the non-perennial streams at the valley bottom that have underground streams the year round. There are currently multiple claims on these valley bottoms, as they are used for grazing, for sand and stone extraction for construction and access to water.

With increasing population and climate change the degradation of these valleys, through overgrazing of the shores, erosion and the resulting flash floods is expected to continue. In terms of adaptation, it was noted that there are more, and deeper boreholes and dams being built, as well as more and more people depending on plastic containers to get water delivered and stored.

Patterns in livestock feeds were less consistent across the groups, mainly because different groups understood livestock feeds differently. One group focused on the multiple claims and functions of trees: as livestock feed, as construction material, as source of energy and income when transformed into charcoal, as ecosystem supporting function due to increasing water infiltration and reduction of flash floods. Other groups discussed different feed sources, including grazing land, crop-residue and planted fodder. Grazing land is generally communal land and can be used by anyone at any time. Overgrazing reduces availability of grass during the dry season. There are increasingly private pasture reserves for which access is limited. Feed and fodder production is increasing in private land enclosures that offer opportunities for sustained high-level dairy production by making more feed available during the dry season. But these enclosures illegally close migration routes, compounding land conflicts between clans.

Adaptation strategies identified include changes in migration routes that some groups mapped, the emergence of reserves, and building enclosures to produce feed and fodder. Interestingly, many participants also saw zero-grazing and a sedentary production with feed and fodder production as the future production system in Somaliland.

Phase III: Major dynamics and adaptation strategies identified

This section identifies the major landscape dynamics and adaptation strategies that can be derived from phases I and II. For those dynamics that are observable from the sky, freely available historic satellite images have been studied, and examples that confirm the discussed dynamics are shown.

Identified landscape dynamics

Settlements and private enclosures

The emergence of settlements and private land enclosures is one of the major dynamics observed in the region. Though it is illegal from the governmental perspective, land enclosure is happening increasingly around existing settlements for several reasons:

- After recurrent droughts, households that have lost most of their animals have no reason for a nomadic lifestyle and decide to settle near water points. Some NGOs work on restocking programs, so that settlers can take up their pastoral lifestyle again, i.e. mobility with their livestock herds.
- Some people build enclosures to start their own businesses, mostly dairy production (cattle, goats or camels depending on how dry it is at the given location). These businesses address the settlers' demand for dairy products and fodders. These farms are often financed with capital from the diaspora of Somalis abroad. They see that dairy farms have higher productivity than the traditional nomadic production, at least in the short run. They ignore the fact that these farms are part of a wider landscape that needs to support many other players too, and that in the long run they are contributing to irreversible interfere with the regeneration of natural resources. Indeed, these farms are increasingly blocking the existing traditional transhumance routes that have supported the regenerations of natural resources for centuries.
- Some people just enclose and claim land because they expect that there will be a lot of pressure on land and want to own a piece in a good location before it is too late. This is simply land speculation.
- Some people, especially the oldest and youngest generations, settle in order to enable access to education and health services.

Figure 10: Examples of relatively small enclosures emerging near a settlement identified on Google map.



Source: Google Earth

Figure 11: Examples of relatively big enclosures emerging near a settlement identified on Google map.



Source: Google Earth

Pastures surrounding settlements are often more degraded than others. Settlers by definition are land users who no longer move, which means that the pastures in the settled areas do not have time to recover, resulting in overgrazing.

The lack of green vegetation reduces water infiltration and therefore there is more run-off, increasing erosion and a reduction in overall water availability in the watershed.

However, as more and more land is claimed, the traditional migration routes are cut, impeding the mobility of those who have not yet settled. Because enclosures are illegal by Somaliland law, the ministry dismantles them. This is an ineffective approach, as they will reappear soon due to popular demand of some stakeholders.

Figure 12: Satellite image of the same location in 2003 and 2013 from Google Earth showing the emergence of enclosures.



Source: Google Earth

Charcoal production

Charcoal production offers a new income source, especially for settlers who cannot rely on livestock production anymore. It is also an activity that young people pursue to get the necessary cash to buy chat (khat). In the east of Somaliland, the charcoal is exported to Saudi Arabia. One way to stop this phenomenon is to offer people alternative sources of energy as well as alternative sources of incomes. Alternatively, stronger land tenure security could incentivize more sustainable management of tree resources.

Reduction in tree cover has important knock-on environmental impacts, such as decreased water infiltration and increased run-off, accelerated soil erosion and land degradation. However, the narrative of loss of tree cover could not be corroborated through historical satellite images. This does not mean that the dynamic does not exist per se, but just that the comparison of freely available satellite images that have been taken during different seasons make it difficult to truly compare tree cover. More in-depth remote sensing studies would be needed to get a definite answer to this.

Land degradation and soil and water conservation

Land degradation is driven by several factors:

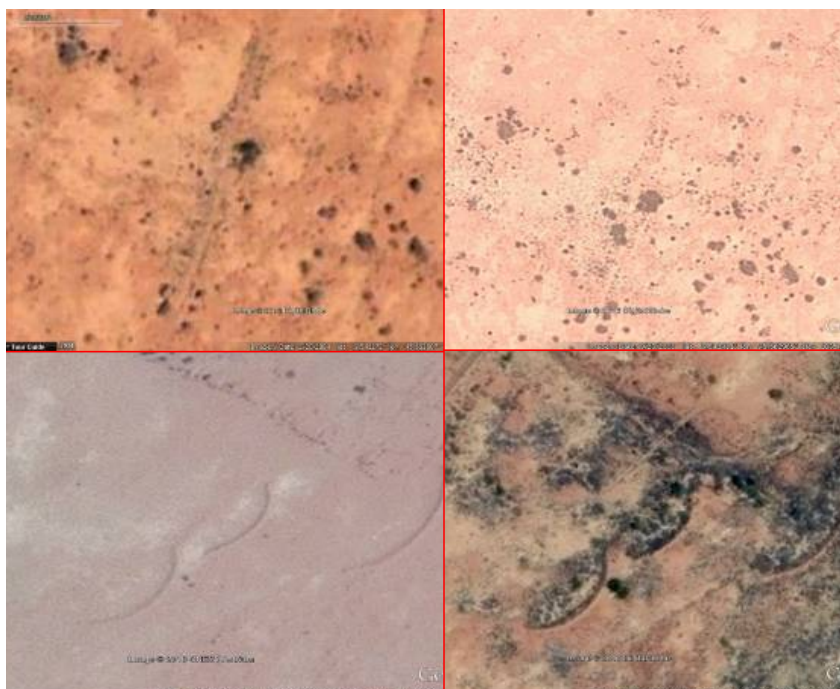
- Somaliland has many slopes. Its terrain is prone to erosion leading to natural soil degradation
- Deforestation, which accelerates run-off and erosion
- Increased numbers of roads, which accelerate run-off

Soil and water conservation is one way to address land degradation, as for example the half-moon techniques shown in Figure 13 shows. Note that this half-moon interventions are found in enclosures and not on communal land.

Soil and water conservation interventions aim at reducing run-off. This is important as accelerated run-off reduces the time that water has to infiltrate the soil. Soil infiltration is the easiest way to store and conserve water by maintaining soil moisture or regenerating underground aquifers that can be tapped in the dry season.

Also, when water does not infiltrate and flows on the surface more quickly, more floods are experienced. Somaliland has a National Environment Research and Disaster preparedness program that has an early warning system for sharing information about floods and droughts.

Figure 13: Examples of soil and water conservation interventions.



Half-moon (top left 2004, top right 2011, bottom left 2013, bottom right 2015). Source: Google Earth

Climate change and the lack of rangeland management

Every person interviewed mentioned that droughts used to come every 7–10 years or so, whereas nowadays droughts are longer and occurs almost every 2–3 years. All stakeholders are convinced that climate change is already visible.

Many stakeholders mention that the combination of population growth and climate change puts unprecedented pressures on the rangelands. In the past, rangelands could recover without much concern, but today this is not possible without effective rangeland management, which typically combines soil and water conservation techniques, such as the use of bunds, terraces, half-moons or reservoirs, reserves zones and rotational grazing that allow rangelands time to recover.

All the stakeholders working for ministries felt that the management of communal rangelands should be planned and enforced by the national government. However, the government lacks means to enforce such laws and plans. Our data did not give any information about the opinions of other stakeholders about this.

Invasive species

Only the Ministry of Livestock mentioned the problem posed by *Prosopis*, an invasive species that is reducing the quality and quantity of forages. The plant decreases the quality of pastures, reducing the carrying capacity of the affected area. Meroni et al. (2017) show that *Prosopis* is mainly found along dry riverbeds and peri-urban areas based on a detailed satellite images from Landsat. In both areas, *Prosopis* was planted to restore deforested areas. This is probably why a simple analysis of satellite images from Google Earth does not show deforestation but *Prosopis*.

Urbanization

Population growth has contributed to urbanization, which comes with positive and negative effects.

Often, young people decide to give up on the pastoral life and go in search for better lives in urban areas. This leads to less young labour to support pastoralists in moving their animals, one reason why elderly people will then also give up on pastoral lifestyles.

Among young people who move to urban areas, some find decent employment, and others do not. The unemployed urban youth survive on charcoal production and sale and other small jobs and often get addicted to Khat. On the other hand, the young people who get decent urban jobs play a key role in their community. Employed youth act as a sort of insurance for their relatives who remained in the pastoralist lifestyle. Indeed, during droughts, the employed youth support their communities with remittances.

Figure 14: Outgrowth of Dhahar in 2002 and 2012.



Source: Google Earth

Identified climate change adaptation strategies

Several climate change adaptation strategies came up during discussions in phases I and II of this research. These were put in two categories, the adaptation strategies that are implemented at household level and that are already observed on the ground and landscape adaptation strategies, that will need some coordination to be implemented.

At household level the following adaptation strategies are already observed.

1. Timely selling of livestock, so that only few animals are affected by drought and cash is available for survival.
2. Increased interconnection between rural and urban areas, as urban household members send remittances to support their relatives during droughts.
3. Change in species, moving away from keeping cattle to goats and sheep.
4. Leaving the pastoral lifestyle and pursuing activities that provide alternative incomes such as charcoal production, crop, feed and fodder production, and dairy farming.

At the landscape and national level, stakeholders, mainly from the ministries, suggested two adaptation strategies that could be implemented in future to improve the state of natural resources.

1. Improved rangeland management
2. Land tenure policy

Improved rangeland management has many components, referring here mainly to closing certain critical pastures during the rainy season to allow them to recover, and growing more fodder for pastoralists to use in the dry period. However, while there is an understanding of what could work, the same stakeholders say that the government does not have the means to implement these measures. This is also critical for the maintenance of biodiversity that is foreseen in the National Biodiversity Strategy and Action plan (Ullah and Gadain 2016).

Very little was shared about the upcoming land tenure policy because it is still under development by the Ministry of Environment and Rural Development and the FAO. Yet, some patterns could be identified from the stakeholder discourses in phases I and II, suggesting that the policy is expected to regulate land tenure in urban areas and define communal land that cannot be claimed.

These adaptation strategies reflect well the Somalia National Adaptation Programme of Action to Climate Change (Somalia Ministry of National Resources 2013), that also focuses on sustainable land management including forest management and water resource management including plan development and the construction of new infrastructure as well as disasters management, which consists of early warning systems and relief fund.

Discussion

Two immediate reflections result from this research. First, given the landscape dynamics identified in this research, what are possible interventions to improve the status of natural resources and support the transition in adapting to climate change? Second, this report has made use of freely available high-resolution satellite images in a very simple way. This technology is about to bring new products that are both opportunities and threats in the Somaliland context. Therefore, this discussion has two separate sections, the first putting the identified dynamics into context and the second relating to issues of land-use planning.

Implications of the landscape dynamics

As these results show, the pastoralist lifestyle is under strain, and it should be noted that this data was collected prior to the acute drought and famine of 2017. Not only is climate change reducing the availability of biomass needed to sustain the livestock sector, human behaviour also reinforces the negative trends in biomass availability.

This report identified several of these reinforcing behaviours that further increase pressure on land and the pastoralist community. First, in rangelands, the increased number of animals leads to decreased biomass to support the livestock sector. This can be partially addressed by managing the rangelands and/or the animals. Second, the increasing number of enclosures around settlements and water points is blocking traditional pastoral routes heightening the pressure on the pastoralists. In order to avoid conflicts, land-use planning needs to be developed making use of the synergies between the different and sometimes conflicting landscape functions so that a multifunctional landscape can emerge.

Rangeland management

At the core of self-enforcing landscape dynamics is the increased number of livestock making use of rangelands which are in turn being degraded due to the significant pressure of these animals. Increasing the biomass production of degraded rangelands is to a certain extent possible through the sustainable management of these areas. Firstly, managing access to the rangelands during different seasons avoids overgrazing and allows for resting during the grass-growing season. Secondly, soil and water conservation interventions when implemented correctly can restore degraded land as they improve water holding capacity and in the long-term will provide more biomass. The soil and water conservation interventions can range from tree planting, to terraces, soil bunds, trenches or half-moon constructs. The suitability of these interventions is very context specific, and the benefits of these interventions are generally only seen when different interventions are simultaneously implemented in a watershed (Prager and Pfeifer 2015). The territorial diagnostic report of the land resources of Somaliland (Ullah 2016) acknowledges this and suggests that the methodology of the Land Degradation Assessment in Drylands Programme/World Overview of Conservation Approaches and Technologies should be used. It also points to a certain number of trust funds that could support the addressing of this resource degradation.

Land-use planning: Towards transhumance corridors and parks

Competing claims on land coming from urbanization and settlements driven by population growth and climate change are putting the pastoral production system under pressure and are going to intensify in the upcoming years. If these competing claims are not addressed in a meaningful way with the respective stakeholders, conflicts will emerge.

Conflicts between sedentary agriculturalists and pastoralists are increasingly an issue at the fringe of drylands across Africa. To address these potential conflicts, West African countries have been working together to develop a pastoral plan that consists of fixed pastoral routes marked on the ground with paint and creation of so called pastoral parks, common grazing lands that are declared public access areas. In these parks no cropping can take place. These often have infrastructure such as purpose-built water points and vaccination areas (Alidou 2016; Ayantunde et al. 2014). This is a significant undertaking as every route and park needs to be negotiated with local stakeholders. In some places, for example the Bama commune in Burkina Faso, cropland needed to be expropriated in order to ensure that the 30 m wide route can take pastoralists through the cropping area (personal communication), which required negotiations at all levels including national and international (GRAF 2014). Many routes are now marked and in use.

Somaliland could develop a similar plan to make sure that pastoral routes are kept open and at the same time allowing for land enclosures for those who have decided to settle. But the development of such a plan is likely to be a huge undertaking, as corridors through emerging settlements have to be planned in a participatory manner, engaging both pastoralists and settlers. However, because enclosures are currently illegal, no expropriation of land is needed, so it should not be difficult to enforce such corridors.

Combining top-down and bottom up approaches

Managing rangelands sustainably and the people who rely on them is very complex and cannot be successful if top-down and bottom-up approaches are not combined and used complementarily. Top-down approaches should set the 'rules of the game', clarify what the right of use of the land is through guiding principles or a general land-use plan. An example of how this can be done is the Burkina Faso case, where there is a top-down agreement that pastoralists have the right to cross the areas and there exists the legal environment to set up these routes.

However, how the local governance of the rangeland, i.e. how the rules are implemented on the ground, such as which areas are closed, who gets access at what time and on what conditions, can only be enforced through bottom-up approaches that engage all stakeholders on the ground. Indeed, participatory processes enable taking the local contexts into account and foster sustainable agreements among the different stakeholders that will allow enforcement of the agreed rules. Developing a sustainable participatory rangeland management process is not a simple enterprise. Flintan and Cullis (2010) propose a guideline with 12 steps on how to implement a successful participatory rangeland management process that encompasses three major stages, namely, (i) investigating the participatory rangeland management; (ii) negotiating the participatory rangeland management and (iii) implementing the participatory rangeland management. In the Burkina Faso example, the pastoral routes were developed through a participatory process that engaged all stakeholder on the ground. Though overall the transhumance routes are a success, there are locations where different stakeholders are still in conflict.

The potential and threats of satellite images

This report made use of freely available historical satellite images that were assessed to identify some of the landscape dynamics. Some of these images used were high resolution with a high degree of accuracy that allowed an investigation of human patterns on the ground. In addition, more advanced work on satellite images is quoted in different sections of this report, revealing previously unknown information from the sky. The report also highlights the opportunities and challenges offered by the use of satellite imagery in understanding pastoral systems that are worth reflecting on.

The most recent satellites such as World-view 4 and Geo-eye 2 from DigitalGlobe or Pleiades from Airbus now offer satellite images with 30x30 cm resolution and might allow for applications that could disrupt traditional approaches to earth surveillance for dryland areas worldwide. Indeed, these high-resolution images offer unprecedented views of earth in a near real-time manner and for instance enable assessments of the development of settlements in pastoral areas. These technologies are currently being used in Sudan to identify refugee settlements through crowd-sourced image identification (DigitalGlobe 2013) and they could be used to verify whether land-use plans are respected, such as if the corridor is kept free of (illegal) closures. It is yet unclear to what extent these new satellite images enable the recognition of individual animals. Only a few trials have been undertaken (Yang 2012) and semi-automated classification tested (Terletzky and Ramsey 2014). There is ongoing research and hope that these technologies will enable the counting and tracing of animals in drylands in coming years. If that happens, these technologies could be a game changer in allowing communities to check if they are able to enforce rangeland management rules. Moreover, service providers to pastoralists could obtain better market information about the size of the veterinary medicine market, an area which is often poorly served due to the need for vaccine cooling facilities.

But new technologies also often come with risks. Pastoral communities have developed their own communication systems over centuries. There are reasons why many of these information systems are closed, i.e. information is not public. Therefore, a better understanding of information flow patterns in pastoral communities and which information can be released to whom and at what resolution will be important before transforming satellite images into digital products accessible to different stakeholders in Somaliland.

Conclusions

This report describes the multiple and competing claims on land in Somaliland which have been exacerbated by climate stress in conjunction with other factors such as population growth, urbanization and the lack of natural resource management systems. The multiple claims are mainly emerging in proximity to water sources. Customarily, pastoralists rely on traditional water points and on the surroundings for feed and fodder for their animals. The pressure on natural resources has increased due to a lack of land-use policy leading to the absence of guiding principles on how to address these multiple claims, and the lack of participatory rangeland management leading to conflicts between pastoralists and other land users.

Increasingly pastoralists who have lost their animals are choosing to settle in rangelands. This blocks the transhumance routes and herders' access to water vital to their livelihoods. Settlers' intensive production of crops and fodders in enclosures also damages the herders' adaptive capacity. This is exacerbated by the practice of harvesting trees around the settlements to make charcoal, which further degrades communal pastures. As such, there is increasing potential for conflict between pastoralists and settlers. This report has identified the landscape dynamics that are influencing the landscape functions that support the livelihoods of both pastoralists and settlers. However, it is important to identify mechanisms for a more equitable distribution of benefits, an often overlooked element of ecosystem service analyses (Lakerveld et al. 2015). The report also reviewed upcoming digital products that might act as rangeland management tools. Understanding how livestock-related ecosystem service functions interact with provisioning functions (crop production), regulating functions (erosion control) and cultural functions (Somali pastoral lifestyle and identity) is essential in better exploring which of these functions can be combined in a multifunctional landscape. This information will be important for the development of policy to improve and implement land management strategies in the face of climate change.

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