Impact of Climate Change on Agricultural Production in Marodijeh and Gabiley Regions (Somaliland)


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ACTIONAID INTERNATIONAL (SOMALILAND)


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El Afweyn
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Gabiley
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Garadag
WAQOYI GALBED
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Xudun
Ainabo
Duruksi
SOOL
Balli Dhig
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SOMALIA
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ACRONYMS

FAO	Food and Agriculture Organization
FGD	Focus Group Discussions
FEWSNET	Famine Early Warning System Network
FSNAU	Food Security and Nutrition Analysis Unit-Somalia
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter-tropical Convergence Zone
M&G	Marodijeh and Gabiley (regions of Somaliland)
MOA	Ministry of Agriculture
MOL	Ministry of Livestock
MOERD	Ministry of Environment and Rural Development
NAPA	National Adaptation Program of Action
PET	Potential Evapotranspiration
SDF	Somaliland Development Fund
SWALIM	Somalia Water and Land Information Management
UNFCCC	United Nations Framework Convention on Climate Change

Executive summary

1. Marodijeh and Gabiley (M&G) regions of Somaliland together produce higher quantities of cereals and vegetables than the total of these commodities produced by other regions of the country. Gabiley region, in particular contributes much more significantly than Marodijeh region. In recent years, the impact of climate change on the agropastoral communities in Somaliland has been felt through unusual recurrence of droughts, frequent floods, appearance of invasive and exotic plant species, increasing land degradation, and declining crop and livestock productivity.
2. The IPCC Fifth Assessment report indicated an increase in temperature of 0.8-1°C has already been observed in East Africa (including Somalia, Somaliland) with projected increase of 2-3°C by 2065. The IPCC report also projected a 20 to 30% increase in precipitation for East Africa by 2065. However, any gains in rainfall may be offset through evaporation by increased temperatures.
3. This study aimed at analyzing and assessing the impact of climate change on agricultural production in agropasstoral areas of M&G regions.Fourteen villages were surveyed for individual house data, and in seven of these focus group discussions were held to obtained detailed information about livelihoods and impacts of climate change.
4. Livestock and crop production are the principal sources of livelihood for the agropastoral communities in the M&G regions. The mean numbers of small stock owned per household are 15, and 16 sheep and goats, respectively. Mean ownership of cattle and camels are 3 and 1.5 per household, respectively. Additionally, each household, on average keeps one donkey and 4 chickens. Each household cultivates, on average, less than 1.5 hectares each of sorghum, maize, and vegetables.The small herd size kept per household and the small area planted, clearly show that these communities have very low economic base, and are very vulnerable to any significant climatic or socioeconomic shocks.
5. Seventy-eight percent of household respondents considered that droughts have become more frequent, while 54% also considered that floods have been more frequent, during the last 20 years. Most household respondents believed that rainfall in their villages has decreased over the last two decades. Additionally, 72% of respondents believed that Gu, the main rainy season, has been starting later than normal during the last 20 years. A majority of respondents also thought that Gu rains have been ending earlier than normal for the last two decades. This implies that most respondents consider that the main rainy season has shortened as a result of climate change. Long-term rainfall climate data to support these assessments are not available for Somaliland.A majority of household respondents stated that sorghum yield, milk production per lactating animal and fodder production per farm all decreased during the last twenty years. Additional impacts of climate change that was stressed by the focus groups included soil erosion and land degradation, decreased volumes of groundwater,

and emergence of exotic, invasive weeds such as *Partheniumhysterophorus*, a serious weed that has spread to all farmland.

6. Overgrazing and deforestation, undoubtedly intensified during the last 20 years and contributed to lower fodder and pasture availability, as well as more soil fertility deterioration with subsequent negative impacts on livestock and crop production. Reduced groundwater levels have affected vegetable and fruit growers in the M&G by restricting the area they could cultivate and lowering yields. All focus groups mentioned that they have observed dropping groundwater levels in their villages. In addition to frequent droughts, this decline in groundwater volumes is also partially due to increased vegetable farms drawing larger water volumes from shallow wells in the ephemeral sand rivers. An increasing human population in these areas has also added greater demand for drinking water, which in the case of vegetable growing locations is sourced from shallow wells in the dry sand rivers.
7. The agropastoral communities in the M&G are particularly highly vulnerable to both climate change and climate variability. The vulnerability of these communities to climate change results from a combination and interactions among multiple factors including dependence on rainfed agriculture, low household incomes, lack of or only low education, poor infrastructure, lack of institutional capacity, poor communication of weather information and absence of planned adaptation strategies.
8. Adaptation strategies employed by these communities to minimize the negative impacts of climate change and climate variability include temporary relocation of livestock to other areas, storing grain harvests, storing sorghum and maize stover for animal feeding during the dry season, diversifying cultivated crops, reducing and/or changing the composition of livestock herds, sharing resources with relatives and neighbors, runoff water harvesting, engaging in casual labor, and migrating to urban areas to seek employment.
9. Somaliland lacks policies and strategies aimed at confronting the challenges imposed on agropastoral communities by climate change, and the country has not yet developed a NAPA (National Adaptation Program of Action). Unless planned adaptation programs are introduced and implemented the vulnerable agropastoral communities in the M&G will face greater food insecurity, conflicts over land and water, and greater migration of the youth.
10. Proposed recommendations include development of NAPA and mainstreaming climate change adaptation, introduction and promotion of drought tolerant and early maturing crop varieties, promotion of crop diversification, incorporation of legumes into the cropping systems, diversification of cultivated crops, development of soil and water conservation measures, development of water harvesting techniques, introduction of drought tolerant fodder species, and farmer training on good production practices.

Acknowledgements

My thanks go to ACTIONAID International-Somaliland for giving me the opportunity to conduct this study and learn more about agropastoralists in Gabiley and Marodijeh regions. I am also grateful toMustafe Ahmed andKhadar Ahmed and the enumerators that assisted me so much during this assignment. Without their help and dedication this study would have been unachievable. I acknowledge the contribution of the focus groups including the village chiefs in providing valuable assistance during the survey and organizing the farmers who gave much of the required information on community livelihoods and trends in climate change. Mr. Mohamed MohamoudGuleed of MOA provided much assistance during the focus group discussions.

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Adan Elmi Abdullahi

Introduction

Concern about climate change has been growing for the last two decades. Climate variability and change are not new phenomena, but the scale of climate change in recent decades is unprecedented. This accelerated climate change is driven largely by emission of greenhouse gases mostly resulting from use of fossil fuels (IPCC, 2007). The IPCC's Fifth Assessment Report(IPCC, 2014) states with high confidence that the Earth's climate is warming rapidly. Climate change and variability pose serious risks to agriculture-dependent communities in Africa, particularly those inhabiting in the semiarid and arid regions of Sub-Saharan Africa. The agropastoral communities in these regions have to cope with highly unpredictable and variable climatic conditions including frequent droughts, floods, land degradation, loss of grazing resources, and outbreak of pests and diseases.Extreme precipitation changesover eastern Africa such asdroughts and heavy rainfallhave been experienced more frequently during the last 30–60 years (Climate Development Knowledge Network, 2014).The adaptive capacity and coping strategies of agropastoral communities in the Horn of Africa are relatively low because of low income, food insecurity, poor infrastructure in the rural areas, and limited institutional capacity.

Agriculture (including livestock) is the main economic activity providing vital livelihoods to more than 60% of Somaliland population. Agriculture is practiced predominantly in the form of agro-pastoralism in the principal crop producing regions of Somaliland (Gabiley, Awdal, and Marodijeh). Agro-pastoralism involves multiple livelihood activities encompassing both livestock keeping, and cereal and grain legumes production, and often also vegetable and fruit production. Agro-pastoralist farmers keep sheep, goats, cattle, and camels in addition to the production of cultivated crops.Basically agricultural production in Somaliland is low-input low-output system.Marodijeh and Gabiley regions of Somaliland together produce higher quantities of cereals and vegetables than the total of these commodities produced by other regions of the country (FSNAU, 2014). Gabiley region, in particular contributes much more significantly than Marodijeh region. This can be attributed to the region's long history of arable farming, its relatively favorable rainfall, the existence of large areas with fertile vertisols, and the availability of groundwater in many parts of theregion (Abdullahi, 2013). Interactions and exchange of farming technology with farmers of the neighboring Oromiya region of Ethiopia has also likely helped Gabiley region farmers continuously improve their farming skills. Some of the popular sorghum varieties grown in Gabiley and Marodijeh regions have originated in Oromiya region.

In recent years, the impact of climate change on the agropastoral communities in Somaliland has been felt through unusual recurrence of droughts, frequent floods, appearance of invasive and exotic plant species, increasing land degradation, and declining crop and livestock productivity. While studies on the impact of climate change in Africa are abundant, studies on the impact of climate change on agricultural production at local context is scarce. The objectives of this study are shown in the next section.

Objectives of the study

This study aimed at analyzing and assessing the impact of climate change on agricultural production in agropasstoral areas of Marodijeh and Gabiley regions of Somaliland. The specific objectives were as follows:

- Assess the impact of climate change on crop production.
- Understand and document the nature of complex interactions and how they affect people at risk of hunger in the coming decades.
- Assess the vulnerability of both rural and urban dwellers as a result of climate change
- Explore local adaptation strategies.
- Examine the effects of climate change on the local early warning systems.
- Map out national support mechanisms to adapt and mitigate climate change.
- Examine the biophysical and socioeconomic effect of climate change on production.
- Recommend mitigation and regulatory measures to minimize negative impacts of climate change on agricultural production and people's wellbeing.

Methodology

The study involved both secondary data collection and primary research. In the secondary research phaseliterature on the impact of climate change on agriculture and rural livelihoods, particularly in the African context, was collected and consulted. For the primary data collection, 14 agropastoral villages were identified as targets for survey data collection with the assistance of ACTIONAID International-Somaliland office in Hargeisa.The selected villages represented both rainfed farmers, who mainly cultivate sorghum and maize, and irrigated vegetables growers. Two types of questionnaires were prepared for collecting primary data in the selected villages: household questionnaire aimed at collecting individual household data and focus group discussions (FGD) guide questions for collecting generalvillage data. Focus group discussions were held in seven of the 14 villages. Nine enumerators were recruited to conduct interviews and record data. In addition, a supervisor who was familiar with the region and its people was engaged to assist the lead researcher in ensuring the smooth implementation of the study. Before commencing the survey, the enumerators were given one day orientation to familiarize them with the contents of the questionnaires and the proper approach of conducting the survey.

The household survey was conducted for four days in the previously identified agropastoral villages. A sample of 12-16 agropastoral households was selected in each village to answer a set of prepared questionnaire (total households interviewed = 193, Table 1), while the lead researcher and the assisting supervisor held focus group discussions in seven villages (Ijara,Abarso, Dhabolaq, Haraf, Elginiseed, Horohaadlay, and Biyomaan). Each discussion group comprised 12 agropastoralists and included the village chief and his deputy as well as those who have lived in the village for a long time and were knowledgeable about livelihood issues and climate trends in the village. Three to four women were included in each focus group discussion. FGD members were also encouraged to comment on any issue that was relevant to their respective villages in an open discussion atmosphere. Additional information was obtained by interviewing key informants from several institutions including Ministry of Agriculture (MOA), Ministry of Livestock (MOL), Ministry of Environment and Rural Development (MOERD), and FAO. Data were processed, analyzed, and summarized using the SPSS statistical analysis package.

Table 1. Agropastoral villages surveyed and sampling sizes per village

	Village	Region	Households surveyed
1	Abaarso	Marodijeh	16
2	Agabar	Gabiley	16
3	Allay baday	Gabiley	15
4	Boqor	Gabiley	12
5	Ceel-giniis	Gabiley	12
6	Daarasalaam	Marodijeh	12
7	Dhalaada	Gabiley	15
8	Gogaysa	Gabiley	12
9	Gogol-wanaa	Gabiley	12
10	Ijaara	Gabiley	15
11	Maluugta	Marodijeh	16
12	Taysa	Gabiley	12
13	Uudaan	Gabiley	15
14	Xidhinta	Gabiley	13
	Total		**193**

Source: Household survey

Description of the study area

The agropastoral villages selected for this study are located within Gabiley and Marodijeh regions of Somaliland (Table 1). These communities have a long history of cultivating crops that parallels that of the neighboring Ethiopian Somali region. Early in the 20th century, settlements were established along the dry rivers in the two regions and farmers began growing sorghum and maize as subsistence crops. Even today, sorghum and maize remain the principal rainfed crops grown in this area with very limited inputs mainly in the form of labor and seed (Abdullahi, 2013). The region's soils vary from sandy and sandy-loam with low water holding capacity and poor nutrient content to heavy clays with high water holding capacity and relatively favorable fertility along the westernmost parts adjoining the Ethiopian border.

Substantial runoff occurs in areas with light textured soils after rainfall events leading to serious soil erosion levels. Soil types in the study area have been classified mainly as vertisols, leptosols and regosols by the soil survey implemented by SWALIM (Vergas and Alim, 2007). Strong winds blowing from the south in the summer aggravate the soil erosion scale in these areas further depleting the land of its top fertile soil. Moreover, the soils in this semi-arid zone are low in organic matter and are deficient in phosphorous and nitrogen (Vergas and Alim, 2007). These two macronutrients are major factors limiting plant productivity in Somaliland. The northern parts of the two regions are mainly rugged terrain with steep hills unsuitable for arable agriculture except in small pockets in dry river valleys where groundwater can be sourced for limited irrigated vegetable and fruit production. Most of the villages in the study area are located in the steep hills of the north and utilize streams at the bottom of the river valleys as major sources of drinking water both for human and livestock consumption as well as growing small plots of vegetables and fruit trees.

The vegetation in the study area is open woodland dominated by drought resistant Acacia species including *Acacia etbaica (sogsog) A. tortilis* (Qudhac), *A. bussei* (Galool),*A. nilotica* (Maraa), and *A. Senegal* (adaad) On the banks of the dry rivers *A. tortilis* and *Zizyphusmauritiana* (Gob) as well as *Euphorbia* shrubs and Aloesare common. Many of the indigenous, palatable grasses have disappeared as confirmed by community elders; remaining grasses include *Tragus berteronianus*, *Setariaverticillata*(Maraboob),*Aristidaadscensionis*, *Cynodondactylon*(Doomaar),and *Cenchrusciliaris* (Guddoomaad). In the southwestern flat plateau of the study area *Eragrostis* sp. (Timahaweenle), *Chrysopogon* sp. (Dareemo), *C. ciliaris* and many *Indigofera* species are present. However, little remains of the original bush vegetation as this has been cleared for farming, both crop and livestock, as well as for small and dispersed human settlements. In the past, livestock were mainly grazed on public lands, but this type of land has been steeply declining throughout the last three decades as can be confirmed by the elders of the communities in the region who have witnessed the land and other natural resources devolution. The shift in land use patterns has been steadily toward privatization for farming leading to accelerated land degradation due to overgrazing practices. Some exotic invasive species including *Prosopisjulifera* (Garanwaa), and *Partheniumhysterophorus* (Kelligiinoole) are causing serious ecological and environmental problems in both regions. The former species is an evergreen shrub or tree with deep root system (Candlelight, 2006), while the latter is a low growing herbaceous weed that has colonized almost all farms in the study area.

Community profile

Summary of profile data for interviewed household respondents are shown in Table 2. The majority of respondents were males, aged 35 years and older. Respondents lived in their respective villages for 29 years on average, and have been farming on average for 21 years. These features were favorable to this study since information on climate change requires a long-term experience in a particular environment. The relatively high proportion of males in the respondents was inevitable because, as can be seen also in Table 2, most households are headed by men largely due to cultural norms and religious teachings. Most respondents had either no education or only completed primary school. Only 12% of respondents completed secondary school education, yet this level of secondary education among agropastoral households is a modest progress considering that about twenty years ago these communities returned to their ruined villages after a devastating civil war that engulfed all Somaliland's region. Among the seven villages where focus group discussions were held, Ijara had the largest population, and highest number of tractors (Table 3). In all seven villages, the number of tractors is quite low compared to the number of farms in each village.Horohadlay, in Marodijeh region, had the highest number of irrigated farms; all farms in this village were irrigated farms. Only Ijara and Abaarso had no irrigated farms.

Table2. Household survey respondent profile (sex, age, education, and household head, years in village and years in farming

Sex		**Education**		**Years lived in village**	
	%		%		
Male	87	None	53	Mean	29
Female	13	Primary	34	Minimum	2
		Secondary	12	Maximum	80
		Tertiary	1		
Age		**HH head**		**Years of farming**	
	%		%		
15-24	6	Male headed	96	Mean	21
25-34	20	Female headed	4	Minimum	0
35-44	32			Maximum	80
45-54	16				
55-64	16				
65+	10				

Source: Household survey

Table3. Basic data from focus group discussions in seven villages in Somaliland

Village	Production base	Households	Population	Farms	Irrigated farms	Tractors
Ijara	Rainfed farming	1700	13600	510	0	7
Abaarso	Rainfed farming	730	5840	1140	0	3
Dhabolaq	Rainfed farming	632	5056	438	25	5
Haraf	Rainfed farming	1337	10696	302	55	2
Elginised	Irrigated farming	200	1600	150	39	0
Horohadlay	Irrigated farming	500	4000	200	200	0
Biyomaan	Irrigated farming	150	1200	100	60	2

Source: Focus group discussions. Population is estimated at 8 persons per household.

Climate of Somaliland

Somaliland's climate is generally described as arid to semiarid with annual rainfall of about 100 mm along the coast increasing to 400 mm on the southwestern part of the country including parts of Marodijeh, Gabiley and Awdal regions. The climate of Somaliland is determinedby the north and south movement of the inter-Tropical Convergence Zone (ITCZ) (Muchiri, 2007). This movement of the ITCZ results in two distinct rainy seasons, Gu, beginning usually at the end of March to early April and running through June, and Dayr (or Karan), a shorter rainy season commencing in late August and ending in October to early November. Gu and Deyr seasons are separated by a relatively dry period from June to August, known as Hagaa, with strong winds experienced over the whole country. Gu rains are observed as the ITCZ moves northward and Dayr occurs as it moves southward (Muchiri, 2007). Southwesterly winds with moist air from the Indian Ocean prevail during the Gu season, considered the main rainy season, while northeasterly winds blowing from the Arabian peninsula with dry air prevail during the Jilal, the main dry season with virtually no rain expected during the latter season. The lesser rainy season, Dayr occurs primarily in the eastern and southeastern regions (Toghdeer, Sanaag, and Sool) of the country, whereas in the western regions (Marodijeh, Gabiley, and Awdal) a similar season but occurring earlier than Dayr, known as Karan is more prevalent. Karan rains are crucial for successful production of cereals as they arrive during the flowering and grain filling stages of late-maturing local sorghum varieties and recharge groundwater to be tapped during the dry season for both human and livestock consumption. Lack of Karan rains usually results in crop failure and prolonged dry season with negative impact on rural livelihoods.

Rainfall in Somaliland including the study area is characterized by high temporal and spatial variability. Low and highly unreliable rainfall is the most serious environmental challenge pastoral and agropastoral communities in Somaliland have faced for decades. Rainfall in the study area highly fluctuates within seasons as well as within years and among locations. The Hagaa is a special hazard to crop producers since it brings strong, dry winds and little or no rainfall and occurs between the two rainy seasons. Few crops or crop varieties such as the late-maturing sorghum varieties can withstand the high evaporative demand resulting from the strong, dry winds of Hagaa coupled with high daytime temperatures, without irrigation.

Long-term, consistent data on rainfall in Somaliland is lacking. During the civil war of the late 1980s all weather stations in the country were destroyed and it took more than another decade to re-establish new functioning weather posts largely due to the efforts of FAO and MOA. Annual rainfall data from 2008 to 2014 for Hargeisa, Gabiley, and Aburin are reported in Fig.1. All three stations are within the target area of this study and the surveyed villages are all within 30 km of at least one of these stations. The data clearly demonstrate the annual rainfall variability in Marodijeh and Gabiley regions of Somaliland. For example, rainfall in Aburin in 2012 was only 189 mm, but in the following year 420 mm of rainfall was recorded at the same station. Similarly, in Gabiley station the 2009 rainfall of 294 mm was followed by 530 mm in the next year. Monthly rainfall data for the three stations from 2008 to 2014 are shown in Table 1. These data also indicate the poor distribution of rainfall within the rainy season. Taking the example of Aburin again, more than half of the total rainfall for 2012 for that station was received in September. Such high rainfall variability within seasons and among years drastically raises the chances and frequencies of crop failure and difficulties in maintaining or raising livestock herds. If Gu rains are low or arrive late, farmers often replant sorghum hoping for good Karan season which can carry their crop to maturity.

The annual Potential Evapotranspiration (PET) exceeds 2000 mm and is even as high as 3000 mm along the coastal areas (FAO-SWALIM, 2012). PET is generally higher than precipitation in all months and in most areas 0.5 PET also exceeds rainfall throughout the year underlying the necessity of irrigation to avoid crop failure. PET decreases towards the areas southwest of Hargeisa including Gabiley region, because of increasing altitude (Hargeisa altitude: 1326 m Gabiley altitude: 1563 m). In Marodijeh and Gabiley regions, highest PET values are experienced during July and August coinciding with the Hagaa season. Data reported by Muchiri (2007) show that the daily mean minimum temperatures for Hargeisa ranged from 12^{o} C in January to 18^{o} C in June, while the daily mean maximum temperatures ranged from 24^{o} C in December to 31^{o} C in June.

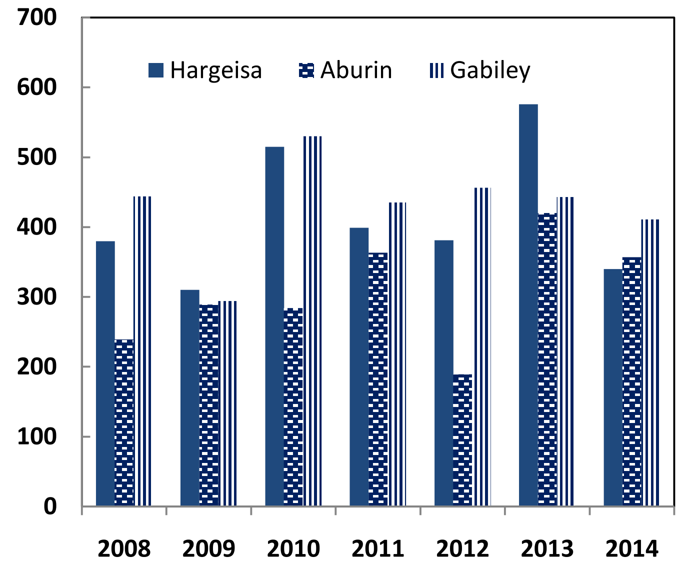

Fig.1. Annual rainfall (mm) in Hargeisa, Aburin, and Gabiley stations from 2008 to 2014 (Source of data: SWALIM)

Table 4. Monthly rainfall (mm) in Hargeisa, Aburin, and Gabiley stations from 2008 to 2014 (Data source: SWALIM)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Totals
Hargeisa													
2008	0.00	0.00	0.00	0.00	77.00	64.00	71.00	76.00	33.50	58.50	0.00	0.00	**380.0**
2009	11.0	0.0	35.50	77.50	35.0	0.0	41.0	34.50	14.50	58.50	2.00	0.00	**309.5**
2010	0.0	17.0	95.0	126.50	80.50	6.0	100.20	39.70	47.10	2.50	0.0	0.0	**514.5**
2011	0.0	0.0	0.0	26.0	163.0	18.0	14.0	93.0	80.50	0.0	4.0	0.0	**398.5**
2012	0.0	0.0	0.0	99.80	51.50	54.50	45.0	59.50	68.50	2.0	0.0	0.0	**380.8**
2013	0.0	0.0	54.50	122.0	34.50	23.0	93.50	57.0	53.50	50.0	88.0	0.0	**576.0**
2014	0.0	0.0	0.0	50.0	56.0	0.0	66.0	64.50	93.0	10.50	0.0	0.0	**340.0**
Aburin													
2008	0.0	0.0	0.0	5.0	7.0	57.0	40.0	50.0	51.0	29.0	0.0	0.0	**239.0**
2009	5.0	0.0	4.0	10.0	68.0	49.0	27.0	29.0	53.00	44.0	0.0	0.0	**289.0**
2010	0.0	41.0	20.0	29.0	92	12.0	17.0	11	62.00	0.0	0.0	0.0	**284.0**
2011	0.0	0.0	0.0	6.0	121.0	34.5	25.5	104.5	53.5	0.0	18.0	0.0	**363.0**
2012	0.0	0.0	0.0	0.0	26.0	0.0	18.5	29.0	115.4	0.0	0.0	0.0	**188.9**
2013	0.0	0.0	49.0	122.0	57.0	0.0	33.0	45.5	57.0	0.0	56.0	0.0	**419.5**
2014	0.0	0.0	0.0	58.0	91.0	0.0	33.0	80.0	82.5	12.0	0.0	0.0	**356.5**
Gabiley													
2008	0.0	0.0	0.0	50.0	68.5	51.0	122.0	61.0	71.0	20.0	0.0	0.0	**443.5**
2009	6.5	0.0	12.5	35.5	16.5	49.0	37.0	74.5	34.5	27.5	0.0	0.0	**293.5**
2010	0.0	67.0	64.0	116.0	91.0	27.5	50.0	55.0	59.5	0.0	0.0	0.0	**530.0**
2011	0.0	0.0	0.0	28.0	93.5	74.0	36.0	115.0	64.00	0.0	24.0	0.0	**434.5**
2012	0.0	0.0	55.5	10.50	103	27.0	81.0	78.0	41.5	16	43.0	0	**455.5**
2013	0.0	0.0	10.5	103.0	27.0	81.0	78.0	41.5	16.0	43.0	43.0	0.0	**443.0**
2014	0.0	0.0	0.0	56.0	93.0	4.0	21.0	128.50	95.0	13.50	0.0	0.0	**411.0**

Cropping practices

Sorghum and maize are the major rainfed crops grown in Marodijeh and Gabiley (M&G) regions of Somaliland. Sorghum cultivation in the two regions dates back to the 1920s when pioneer farmers in this area began sowing sorghum with the use of oxen drawn wooden ploughs (Abdullahi, 2014). These early farmers adopted sorghum production technology from farmers in Hararghe Province of Ethiopia who had a much longer history of sedentary farming than the new Somaliland farmers. The wooden ploughs were made from local trees such as *ZizyphusMauritania* , which grows along dry river banks, with the addition of some iron parts for cutting the furrow. Use of oxen ploughs causes less soil erosion than using tractor drawn ploughs. Because of less grazing pressure and smaller human populations during the early settlement the land degradation rate was minimal. Almost all sorghum varieties grown in the M&G area during those early days were obtained from farmers in Hararghe Province and sorghum varieties currently planted in the M&G are from Ethiopia.Even today, these agricultural linkages between M&G and Hararghe farmers remain strong.

Farmers broadcast seed of both sorghum and maize and cover the seed by passing tractor-drawn disk plows over the seed. Very few farmers till the soil before planting the crops. This method of planting results in variable depth of seed placement, gabs in germination, uneven seedling emergence, irregular plant spacing, and variable plant populations. Farmers do not treat the seed with any fungicides or insecticides before planting. They broadcast seed because they cannot afford to carry out secondary tillage by using cultivators or disk harrows. Additionally, secondary tillage implements are not readily available even for those who can afford it. Moreover, the cost of production increases significantly with implementation of secondary tillage (Abdullahi, 2014).

Elmi-Jama is the major sorghum variety grown in the M&G. This late-maturing, tall variety, takes six months from planting to harvesting. Farmers also plant a shorter variety known as Adan-Gaab which matures in four months. Occasionally farmers plant early maturing sorghum varieties (three months to maturity) imported from southern Somalia. However, Elmi-Jama remains the most preferred sorghum variety in the M&G because of its remarkable tolerance to drought and quality grain as well as its large stover production for animal feeding during the dry season. Maize varieties grown are all open-pollinated yellow maize and include Adday, Assay, and Daba-ka-dhala. Most of M&G grain famers consume their grain production, and only sell the surplus, usually in good years.

Sorghum and maize are mostly planted during the commencement of the rainy season in April. A second planting is implemented in August-September for early maturing sorghum varieties e.g. Adan-gaab (Abdullahi, 2014).On average, less than two hectares of sorghum are planted per farmer per year in rainfed farms and less for maize. Cowpea is not intercropped with sorghum and maize but is planted as sole crop with method of planting similar to that of sorghum. Cowpea beans are used as food and the plant biomass is grazed by animals after harvesting the pods. Sesame is also broadcast planted but few farmers grow this crop as it is a new introduction to the M&G.

In all villages in the study area, vegetables and fruits are also grown either as rainfed and/or irrigated with water from shallow wells, dams, and occasionally berkeds. Production of vegetables and fruits in the M&G regions has increased for the last two decades, and significantly improved crop diversification. These crops provide quick cash to rural households, and improve nutrition for household members. Vegetables grown in the study area include tomatoes. onions, pepper, lettuce, beetroot, carrots, and parsnip, while fruits include oranges, lemon, mandarin, guava, mango, and papaya.

Livelihood sources

Livestock and crop production are the principal sources of livelihood for the agropastoral communities in the M&G regions. Approximately 88% of households own some type of livestock. Livestock numbers owned per household are reported in Table 5. The mean numbers of small stock owned per household are 15, and 16 sheep and goats, respectively. Mean ownership of cattle and camels are 3 and 1.5 per household, respectively. Additionally, each household, on average keeps one donkey and 4 chickens.

Vegetables were ranked as the most important source of livelihood by 47% of household respondents, while 44% ranked grain crops (sorghum, maize, cowpea) as the most important (Fig. 2). Only 26% of respondents ranked livestock as the most important source of livelihood, in contrast to the focus group discussions where livestock were given the first rank by four of the seven villages targeted for focus group discussions (Table 6). Labor wages were most important source of income for only 19% of households. Grain crops and livestock were ranked as the second most important sources of livelihood by 44% and 41% of households, respectively. A majority of households reported wages as the third source of their livelihoods. Less than 7% of households ranked livestock, grain crops, and vegetables as the third sources of income underlying that these sources either come first or second in their livelihood bases. These data clearly indicate that agropastoralists derive their household incomes from mixed activities involving livestock keeping, cultivating grain crops and vegetables, as well as engaging in casual labor. However, the overall indication from these data is that livestock and crops are the two leading sources of livelihood for the agropastoral communities in the M&G as was stated earlier. Vegetables are particularly the main source of income for villages with groundwater for irrigation, whereas livestock remain an important source of livelihood for all villages whether relying on rainfed agriculture or having access to groundwater for vegetable production. Production of grain crops, under rainfed conditions, is a significant source of livelihood in villages with rainfed based crop production (Table 6). Villages relying on vegetables as their major source of income either cultivate no grain crops or only cultivate very areas of these crops. Contrary to assumptions held by many workers both in the public and private sectors, remittance from relatives as a source of income was rated insignificant by all interviewed households and focus groups. Small businesses were also a minor source of income for these communities because the number of households engaged in small businesses, usually small shops, tea and khat (*Catha edulis*) stalls, is quite low.

Fig. 3 shows mean area in hectares planted to sorghum, maize, and vegetables in 2013 and 2014. Maize was assigned the lowest share of area, while sorghum and vegetables were given similar shares of land area. This data show that cultivated area per household is quite low for sorghum and maize, but progress has been made in cultivating vegetables even in rainfed areas. Most of the dependent on rainfed agriculture were not planting any vegetables about 10 years ago. Reliable yield data for these crops could not be obtained because many of these farmers are subsistence farmers who consume much of their produce without paying attentions to the mass or volume of their harvested grains. However, all farmers stated that they are getting less harvest than they used to get in the past.The small herd size kept per household and the small area planted averaging less than two hectares, clearly shows that these communities have very low economic base, and are very vulnerable to any significant climatic or socioeconomic shocks.

Focus groups were asked to rank the importance of constraints to livestock and crop production. For livestock production, they ranked scarcity of fodder as the most serious constraint followed by shortage of labor (Table 7). Scarcity of fodder results from droughts, land degradation, and increased land enclosures. Animal diseases and shortage of labor were ranked as the third and fourth constraints in livestock production, respectively, while livestock prices were the least important constraint. For crop production, droughts, soil erosion, exotic weeds, pests and diseases, and shortage of labor were the important constraints in that order. Low crop prices seemed to be a major concern for villages with irrigation based vegetable production (Elginised, Horohadlay, and Biyomaan). Droughts were not an important constraint for irrigation based villages, apparently because of better access to water than rainfed based villages. However, in prolonged dry seasons or drought years, even farmers utilizing underground water encounter falling water levels and have to cut back the area they could cultivate.

Table 5. Livestock numbers owned per household

	Minimum	Maximum	Mean
Sheep	0	130	15
Goats	0	111	16
Camel	0	70	1.5
Cattle	0	22	3
Poultry	0	50	4
Donkeys	0	4	1

Source: Household survey

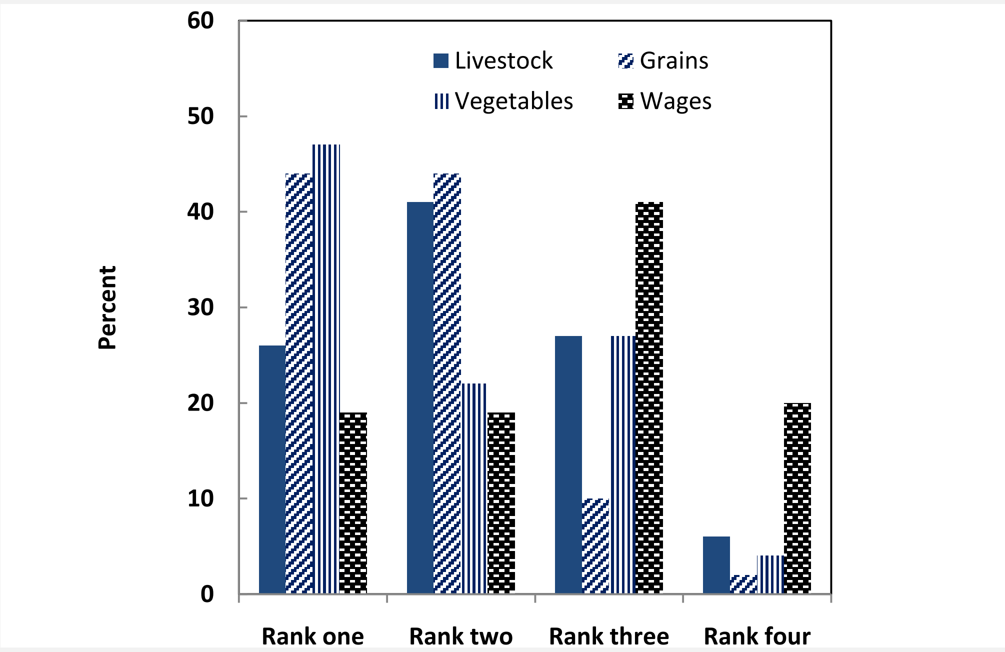

Fig.2. Ranking of livelihood sources by interviewed households. Rank one: most important, rank two second in importance etc. Source: Household survey.

Table6. Livelihood sources ranked with respect to importance in FGD villages. Rank 1: most important, rank 2: second in importance etc. Ins: insignificant.

Livelihood source	Ijara	Abarso	Dhabolaq	Haraf	Elginised	Horohadlay	Biyomaan
Livestock	1	1	1	1	2	2	3
Grain crops	2	2	2	5	3	5	2
Vegetables and fruits	5	5	4	3	1	1	1
Casual labor	3	3	3	2	4	3	4
Small business	4	4	5	4	5	4	5
Remittance	Ins	Ins	Ins	Ins	Ins	Ins	Ins

Source: Focus group discussions

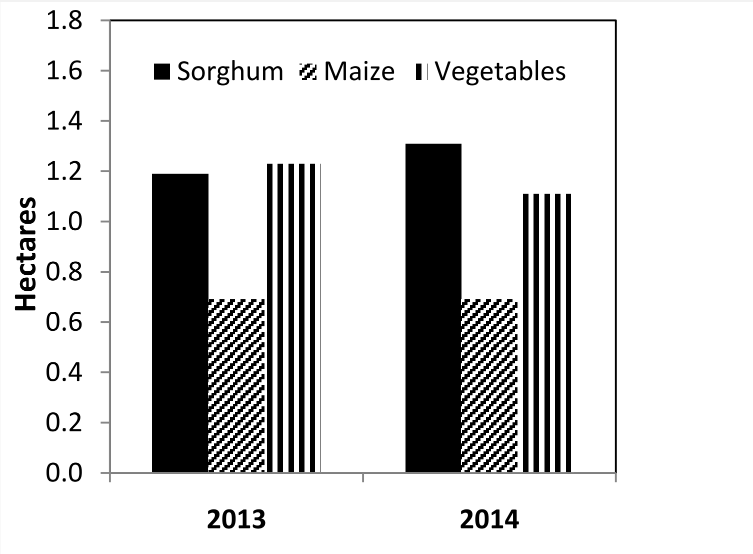

Fig 3. Area planted per household to sorghum, maize, and vegetables in 2013 and 2014 in the M&G surveyed villages. Source: Household survey.

Table 7. Major livestock and crop production challenges ranked with respect to importance in FGD villages. Rank 1: most important, rank 2: second in importance etc. Ins: insignificant.

Livestock	**Ijara**	**Abarso**	**Dhabolaq**	**Haraf**	**Elginised**	**Horohadlay**	**Biyomaan**
Scarcity of fodder	2	1	1	2	1	2	1
Animal diseases	3	4	3	3	3	3	3
Scarcity of water	1	2	5	4	5	5	5
Scarcity of labor	4	5	2	1	2	1	2
Low market prices	5	3	4	5	4	4	4
Crops							
Frequent droughts	1	1	1	4	3	6	4
Soil erosion	3	2	3	1	1	2	3
Exotic weeds	2	3	2	2	5	4	5
Pests and diseases	4	4	4	3	4	3	1
Scarcity of labor	5	5	5	5	6	5	6
Low market prices	Ins	Ins	Ins	6	2	1	2

Source: Focus group discussions

Climate change

Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persist for an extended period, typically decades or longer (IPCC, 2014). Rising fossil fuel burning and land use changes haveemitted, and are continuing to emit, increasing quantitiesof greenhouse gases into the Earth's atmosphere. Thesegreenhouse gases include carbon dioxide (CO2), methane(CH4) and nitrogen dioxide (N2O), and a rise in thesegases has caused a rise in the amount of heat from thesun withheld in the Earth's atmosphere, heat that wouldnormally be radiated back into space(IPCC, 2014). This increase in heat has led to the greenhouse effect, resulting in climate change (IPCC, 2007).An increasing rate of warming has particularly taken placeover the last 25 years, and 11 of the 12 warmest yearson record have occurred in the past 12 years (UNFCCC, 2007).

In recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans. In many regions, changing precipitation or melting snow and ice are altering hydrological systems, affecting water resources in terms of quantity and quality (IPCC, 2014).Climate-related hazards affect poor people's lives directly through impacts on livelihoods, reductions in crop yields, or destruction of homes and indirectly through, for example, increased food prices and food insecurity.

The IPCC (2014) indicated an increase in temperature of 0.8-1°C has already been observed in East Africa (including Somalia, Somaliland) with projected increase of 2-3°C in the mid-term period (2046-2065). The IPCC report also projected a 20 to 30% increase in precipitation for East Africa in the mid-term period (2046-2065). However, rainfall trends in eastern Africa are highly variable both spatially and temporally, and the gain in precipitation increases may be offset by higher evaporation resulting from rising temperatures. The impacts of climate change have already been felt across many parts of eastern Africa including Ethiopia and Somaliland. There are clear indications that climate change has affected agricultural production and food security in eastern Africa. The region has already witnessed recurring droughts and floods with negative impacts of both rural and urban livelihoods. The risks to climate change can further deepen if appropriate and adequate adaptation measures are not implemented. Even if greenhouse gas emissions are significantly reduced, the projected trends and impacts of climate change will materialize, however, adaptation measures can minimize these impacts.

Climate change projections specific to the Somaliland environment are lacking, however, as described above projections for the East African region have been issued by the IPCC. Additionally, some projections have been produced for neighboring countries, e.g. Ethiopia. In contrast to the IPCC's projections for East Africa, since the mid-1970s, spring and summer rains in parts of Ethiopia have declined by 15-20% and substantial warming across the whole country has exacerbated the dryness(FEWSNET, 2012). Climatic models often produce contradictory projections. Some models from the IPCC's fourth assessment report a decrease in annual rainfall in most highland areas of Ethiopia, while other models indicated normal to above normal rainfall (IFPRI, 2012). Rainfall in Ethiopian regions close to Somaliland has declined over the last two decades (IFPRI, 2012). Because of contrasting projections of rainfall for East Africa, conclusions are difficult to formulate, however, as indicated in the next section, the agropastoral community in target study villages consider that rainfall has declined over the last two decades.

Community perceptions on climate change

Community perceptions about trends in climate change over the last twenty years based on individual household interviews are reported in Table 8. Seventy-eight percent of respondents considered that droughts have become more frequent, while 54% also considered that floods have been more frequent, during the last 20 years. Most household respondents believed that rainfall in their villages has decreased over the last two decades. Additionally, 72% of respondents believed that Gu, the main rainy season, has been starting later than normal during the last 20 years. A majority of respondents also thought that Gu rains have been ending earlier than normal for the last two decades. This implies that most respondents consider that the main rainy season has shortened as a result of climate change. Moreover, 79% and 62% of household respondents thought that cold nights and hot days, respectively, have been on the rise for the last two decades.

Community perceptions about climate change according to the focus group discussions held in 7 of the 14 targeted villages for this study conform to those expressed by the individual households (Table 9). All focus groups indicated that droughts have become more frequent, and rainfall decreased over the last 20 years. Six of the seven focus groups also stated that frequency of floods have increased, that Gu rains have shortened (beginning late and ending early), and that the number of cold nights has increased during the last 20 years. They all further considered that the number of hot days has risen. The close agreement of focus groups and individual household respondents on their perceptions about climate change strongly indicates that climate change has occurred in Somaliland.Long-term climatic data for meaningful analysis of climate trends are lacking, and therefore community experiences and perceptions are the best available indicators of climate change.The FEWSNET and IFPRI analysis of rainfall trends in neighboring Ethiopia supports the perceptions expressed by the M&G agropastoralist villages in this study.

Table 8. Community perceptions about climate change over the last twenty years as indicated by household survey respondents. Numbers are in percentages of respondents (n = 193).

	Droughts	**Floods**
Less frequent	18	34
More frequent	78	54
No change	4	12

	Rainfall	**Cold nights**	**Hot days**
Decreased	62	8	14
Increased	28	79	62
No change	10	13	24

	Gu rains begin	**Gu rains end**
Early	12	45
Late	72	26
Normal time	16	29

Source: Household survey

Table 9. Community perceptions of climate trends during the last 20 years as indicated by focus groups in seven villages.

Climate trends	Ijara	Abarso	Dhabolaq	Haraf	Elginised	Horohadlay	Biyomaan
Drought frequency	Increased	Increased	Increased	Increased	Increased	Increased	Increased
Floods frequency	Increased	Increased	Increased	Increased	Decreased	Increased	Increased
Rainfall level	Decreased	Decreased	Decreased	Decreased	Decreased	Decreased	Decreased
Onset of Gu rains	Late	Late	Late	Normal	Late	Late	Late
End of Gu rains	Early	Early	Early	Early	Late	Early	Early
Number of hot days	Increased	Increased	Increased	Increased	Increased	Increased	Increased
Number of cold days	Decreased	Increased	Increased	Increased	Increased	Increased	Increased

Source: Focus group discussions

Community vulnerability to climate change

Vulnerability refers to a low adaptive capacity and little ability to recover from climatic shocks and other environmental or socioeconomic hazards. The agropastoral communities in the M&G are particularly highly vulnerable to both climate change and climate variability. The vulnerability of these communities to climate change results from a combination and interactions among multiple factors including dependence on rainfed agriculture, low household incomes, lack of or only low education, poor infrastructure, lack of institutional capacity, poor communication of weather informationand absence of planned adaptation strategies. In previous sections of this report, the dependence of these communities on crop production and livestock was established. Both crop production and livestock keeping entirely depend on rainfall which is highly variable spatially and temporally in the M&G. Even vegetable growers are affected when seasonal droughts struck because vegetable growers utilize either groundwater drawn from shallow wells and/or earth dams with decreased water volumes during drought yearsand dry seasons. High variability and changes in rainfall levels spell disaster for agropastoralists.

Low household incomes of these communities imply low resilience to climate change and climate variability and limited options in the face of climatic stresses. The capacity of these communities to effectively reduce the impact of climatic stresses on their livelihoods is further restricted by their lack of education. During the rainy season many of the agropastoral villages targeted in this study become inaccessible due to poor roads and vegetable growers cannot deliver their produce to the major markets with subsequent loss of income and increased food insecurity. Somaliland lacks policies and strategies aimed at confronting the challenges imposed on agropastoral communities by climate change, and the country has not yet developed a NAPA. Weather data and early warning information remains usually with few institutions such as SWALIM and is not effectively transferred to agropastoralists adding another dimension to the vulnerability of these communities.

The semiarid environment and fragile soils of the M&G have little resilience to the elements of soil erosion which can be exacerbated by climate change resulting in loss of grazing cover, and crop failure, thereby increasing the vulnerability of the agropastoral communities in these areas to climate change. Widespread land enclosure over the whole country and loss or reduction of free grazing communal rangelands have also contributed to the vulnerability of agropastoralists to climate change and climate variability. Lack or limited options to relocate livestock to other areas when agropastoral areas experience dry conditions contribute to greater vulnerability of agropastoral communities. Another source of vulnerability is the absence of planned adaptation strategies. Adaptation plans that are incorporated into local and national programs can improve community resilience to climatic stresses and extreme weather events and minimize their vulnerability.

Impact of climate change on agricultural production in study area

Assessment of climate change impact by household respondents is reported in Table 10. A majority of household respondents stated that sorghum yield, milk production per lactating animal and fodder production per farm all decreased during the last twenty years. This assessment is agreement with that reported by the focus group discussions (Table 11); however, whereas a majority of household respondents mentioned that household food security improved over the last 20 years, focus groups from the seven villages all considered that it too declined during that period. Questions about household's food security aresensitive questions and some household, may out of pride, tend to indicate that their food security has not deteriorated even though it has. In a focus group discussion, members tend to correct each other until they reach a consensus, and this explains why all focus groups came to the same conclusions regarding the impact of climate change on agricultural production. Long-term data on crop production in Somaliland are not available to compare it with the community assessment. However, agropastoral communities know best about their environment and livelihoods and their assessment is the best reflection of their situation. A study conducted by Candlelight (Candlelight, 2011) in Gabiley region also reported declining crop and livestock productivity in the region.

Additional impacts of climate change that was stressed by the focus groups included soil erosion and land degradation, decreased volumes of groundwater, and emergence of exotic, invasive weeds.Soil erosion and land degradation have intensified over the last two to three decades as a result of multiple interacting factors such as overgrazing, deforestation, proliferation of rural roads, and increased land enclosures as well as increased frequencies of droughts and flash floods. The disappearance of the original free grazing communal lands through widespread land enclosures has intensified pressure on vegetation and pasture resources reducing plant cover and exposing the soil to the major elements of soil erosion (wind and runoff water). With application of neither inorganic nor organic fertilizers in rainfed farms, along with removal of crop stalks after grain harvest from the fields for animal feeding, soil fertility reduction has continued contributing to the declining crop yields. Only vegetable growers occasionally apply limited quantities of animal manure to their fields, and the absence of this practice in rainfed grain farms is a lost opportunity to improve or maintain soil fertility.

Overgrazing and deforestation, undoubtedly intensified during the last 20 years and contributed to lower fodder and pasture availability, as well as more soil fertility deterioration with subsequent negative impacts on livestock and crop production. Land enclosures, and tree cutting for charcoal making were the two major drivers of deforestation in the M&G agropastoral areas. With less pasture growth and more land degradation resulting from overgrazing along with loss of free grazing rangelands to land enclosures, a decrease in livestock numbers and milk yield per lactating animal are expected.MOL veterinary officers pointed to increased incidence of transboundary diseases as a result of climate change. Intensifying overgrazing and deforestation contributed in part to declining crop yields mainly due to poorer soil fertility conditions.

Reduced groundwater levels have affected vegetable and fruit growers in the M&G by restricting the area they could cultivate and lowering yields. All focus groups mentioned that they have observed dropping groundwater levels in their villages.In addition to frequent droughts, this decline in groundwater volumes is also partially due to increased vegetable farms drawing larger water volumes from shallow wells in the ephemeral sand rivers. The number of vegetable farms using water from shallow wells has increased substantially during the last two decades based on historical trends and knowledge of focus groups. An increasing human population in these areas has also added greater demand for drinking water, which in the case of vegetable growing locations is sourced from shallow wells in the dry sand rivers.*Prosopisjulifera*, an exotic invasive tree native to Central America, has in recent years expanded its colonization of the sand rivers displacing the indigenous trees, shrubs, and grasses and disrupting the habitats of many animal species. This deep rooted tree has also likely contributed to the declining groundwater levels by drawing water from deeper soil layers. Its remarkable resistance to drought is attributed to its deep root system (Candlelight, 2006).

During the last 10-15 years exotic weeds have invaded and colonized farmland in the M&G. These include *Partheniumhysterophorus*(Keligii-noole) *, Verbisinaencelioides*(Gabal-daye), *Xanthium strumarium*(Ha-itaaban)*,* and *X. spinosa*(Ha-itaaban)*.* The successful establishment and spread of these species in the M&G agropastoral areas can be attributed, in part, to climate change.Weed species also posesscharacteristics that are associated with long-distance seed dispersal,and some researchers(Hellman et al., 2008) have suggested that they may migrate rapidly with increasing temperatures. Based on information from MOA as well as focus group discussions and observations during this study*P. hysterophorus* is the most serious weed that has invaded Somaliland's pastoral and agropastoral areas. Once it colonizes an area it nearly excludes all other herbaceous indigenous plants from the site because of its allelopathic effects. In eastern Ethiopia, P. hysterophorus is recognized as the most serious weed (Tamado and Milberg, 2000).*P. hysterophoru*s is clearly another recent yield reducing challenge for agropastoral communities in the M&G. It has also affected livestock production by displacing the indigenous palatable species and tainting milk quality with frequent rejections in the main markets of Hargeisa and Gabiley.*Opuntiaficus-indica*, a cactus shrub from South America, has also spread to farmland and rangeland in most western regions of Somaliland during the last two decades replacing many valuable fodder species and forming dense, almost impassable bush. Moreover, the focus groups also indicated an increasing incidence of plant pathogens and insect pests which may be attributed, in part, to climate change. While some pathogens are favored by cool weather, many others thrive under warmer conditions. However, establishment of any meaningful correlations of insect and pathogen increases to climate change require a long-term and rigorous investigations. Such studies are lacking in Somaliland.

The combination of falling rainfall, declining groundwater resources, increased soil and land degradation in an inherently fragile semiarid environment, emergence and spread of invasive exotic plants, shortening of the main rainy season, and diminishing free grazing communal lands, has created serious challenges for the resident agropastoral communities in the M&G. Unless effective adaptation measures and programs are introduced, climate change interacting with the prevailing unsustainable land use systems will translate into greater livelihood risk for these vulnerable communities.

Table 10. Community assessment of impact of climate change on agricultural production in the last twenty years as indicated by surveyed household respondents (numbers are in percentages, n = 193).

	Sorghum yield	Milk production	Food security	Livestock numbers	Fodder production
Decreased	69	58	36	50	57
Increased	0	29	51	42	30
No change	31	13	13	8	13

Source: Household survey

Table 11. Community assessment of impact of climate change on agricultural production in the last twenty years as indicated by focus groups in seven villages

	Ijara	Abarso	Dhabolaq	Haraf	Elginised	Horohadlay	Biyomaan
Sorghum yield	Decreased	Decreased	Decreased	Decreased	Decreased	Decreased	Decreased
Milk production	Decreased	Decreased	Decreased	Decreased	Decreased	Decreased	Decreased
Food security	Decreased	Decreased	Decreased	Decreased	Decreased	Decreased	Decreased
Livestock numbers	Decreased	Decreased	Decreased	Decreased	Decreased	Decreased	Decreased
Fodder production	Decreased	Decreased	Decreased	Decreased	Decreased	Decreased	Decreased

Source: Focus group discussions

Extensive gully formation, west of Dhabolaq village, Marodijeh region

Impact on community livelihoods

Since the agropastoral communities are heavily dependent on crop production and livestock keeping for their livelihoods as clearly indicated in this study, trends in climate change and climate variability will inevitably impact on their livelihoods. The most significant impact expected from climate change processes on these communities is reduced food security as a result of decreasing crop yields and milk production, along with decreasing livestock numbers due to diminishing pasture resources, as well as declining groundwater levels leading to lower irrigation water availability. Declining food production at the household level will also result in higher food prices, which will worsen the food security of both rural and urban residents.

Increased migration, particularly the younger members of the household, is also expected as a result of scarce local employment opportunities. This may lead to shortage of labor at the village and household levels further limiting the household and community food production capacity. Shortage of labor has been cited as a current constraint to crop and livestock production by all focus groups in this study. Increased incidence of some diseases such as malaria in response to rising temperatures has been forecasted by the IPCC (2007). Conflict over the remaining but dwindling communal lands, mostly in the rocky landscape, may increase. Already conflict over land has become more frequent in all regions of Somaliland. With rapidly growing human population, conflicts may also arise over the limited water resources in this semiarid environment. Adaptation programs and interventions to minimize these conflicts are needed.

Adaptations to climate change

Climate change adaptation is defined as adjustments to reduce vulnerability and enhance resilience inresponse to observed or expected changes in climate and associatedextreme weather events (IPCC, 2014).The agropastoralists in the M&G have adjusted to and coped with, climate change and variability to some extent through their experiences.However, these communities have low adaptive capacity due to a multitude of factors including low economic base, low education, inadequate adoption of improved technologies, low and highly variable rainfall, and high dependence on rainfed agriculture. Some of the strategies adopted by these communities to cope with or minimize the negative impacts ofclimate change and climate variability include:

1. Storing food grains for use during the dry season and droughts. Many households, particularly those producing sorghum and maize as rainfed crops keep and save some of their harvest in underground granaries or simply in 50 kg bags for later use. This serves as a safety net in hard times when prolonged dry periods are experienced.
2. Relocation of livestock to areas where better pastures are available. In the past this was an effective measure to save livestock from loss due to droughts, however, free grazing rangelands have been shrinking rapidly in recent decades due to land enclosures and the utility of this strategy is fading fast.
3. Storing crop stalks, particularly sorghum stover, after grain harvest for livestock feeding during the dry season. For many households in the study area, sorghum and other crop stalks for livestock feeding are equally important to the grain harvested for human consumption. Livestock provide households with milk that is exchanged daily for cash to buy other essential family needs.
4. Sharing resources with relatives and neighbors. Somaliland's agropastoral and pastoral communities are well known for their culture of sharing resources in times of hardship with the more disadvantaged and vulnerable households. Shared resources include fodder and pasture, drinking water, and food for human consumption.In general, this culture is deep-rooted in all peoples of Somaliland including urban dwellers.
5. Diversifying cultivated crop plants. Crop diversification has improved in recent years in the M&G area. During the last ten years, farmers have been increasingly growing cowpea, and sesame in addition to their major rainfed crops (sorghum and maize). Additionally, many rainfed farmers have started cultivating vegetables such as onion, tomato, and pepper under rainfed conditions with some success when rainfall is favorable.
6. Reducing livestock number and/or changing herd composition. In the face of declining grazing resources, and disappearing free communal lands, many households are keeping smaller herd sizes or are keeping fewer cattle and more sheep, goats, and camels than before. Cattle, because of their poor tolerance to drought, inability to browse trees and shrubs, and higher demand for drinking water compared to goats and camels, are less favored by most households.
7. Water harvesting. Many households have constructed small water ponds, the base and sides covered with plastic sheets, around homesteads to harvest runoff water. This

simple, low cost technique of water harvesting has been found to be very beneficial to agropastoral communities saving them time spent fetching for water in distant places.Berkeds, cemented open underground water reservoirs, are fairly common in the agropastoral and pastoral areas but are much more expensive than the more recent plastic-covered ponds. While the latter is affordable to almost all households, the former can be constructed only by the relatively wealthier members of a village.

During severe droughts, many households migrate with their livestock in pursuit of pasture and fodder to other regions including the Somali state of Ethiopia, which has a long border with Somaliland. The northern areas of M&G are rugged, rocky terrain with scarce grazing resources, with high temperatures in most months of the year imposing physical and physiological stress on livestock.Sale of livestock to buy essential household needs is a common practice in these communities and is a major reason for maintaining livestock as a household asset. During prolonged dry season, sale of livestock saves the household from impending starvation. Borrowing from relatives or neighbors in periods of scarcity is another coping mechanism often utilized by agropastoral communities.Many household members migrate to urban areas to seek employment or engage in casual labor as a coping mechanism during droughts or other environmental shocks. The adaptations discussed above are all autonomous adaptations in response to manifestations of climate change and climate variability without assistance from government or other non-governmental institutions. Planned adaptation programs tailored to address the challenges of climate change are lacking in the M&G regions.

Conclusion

The agropastoral villages in the M&G surveyed in this study derive their livelihoods from livestock, cultivating sorghum and maize under rainfed conditions as well as producing vegetables and fruits as cash crops. The livelihoods of these communities have been increasingly affected in recent decades by more frequent droughts, flash floods, declining groundwater resources, and spread of invasive, exotic plant species in their farmland. The communities indicated that over the last two decades, their food security has worsened as a result of droughts, shortening rainy season, land degradation, and reduced availability of fodder and pasture. Low household income, lack of proper education, and poor rural infrastructure, as well as lack of institutional capacity, make these communities particularly vulnerable to climate change and climate variability. Various adaptation measures are employed by these communities to minimize with the negative impacts of climate change including sharing resources with relatives and neighbors, relocating livestock to other zones in drought episodes, harvesting runoff water, engaging in casual labor and small businesses, and migrating to urban areas.

Unless, planned adaptation measures are introduced and implemented, the agropastoral communities in the M&G will face further food insecurity, increased conflicts over scarce land and water resources, and increased migration. Approaches to adapt to climate change include introduction of drought tolerant and early maturing crop varieties, diversification of cultivated crops including legumes, soil and water conservation measures, and runoff water harvesting as well as generating other sources of income.

Recommendations

To enhance the adaptive capacity of the agropastoral communities in the M&G, improve their resilience, and reduce their vulnerability to climate change and climate variability, the following recommends are suggested:

- Develop a National Adaptation Program of Action (NAPA). This should be led by Somaliland government, particularly the Ministry of Planning and National Development. The UNFCCC has programs to facilitate and assist in this regard for developing countries.
- Introduce governmental and institutional programs geared towards climate change adaptation.
- Establish a NAPA coordinating committee including government, NGOs, and UN agencies.
- Introduce and promote the adoption of drought tolerant crop varieties.
- Introduce and promote the adoption of early maturing crop varieties that can take advantage of the shortening rainy season.
- Promote the diversification of cultivated crops, ensure the incorporation of legumes into the cropping system, and promote planting of different varieties of the same crop species.
- Develop soil and water conservation measures to minimize the observed accelerated land degradation.
- Promote the cultivation of drought tolerant fodder species for improved livestock feeding and productivity. Inclusion of leguminous fodder species can contribute to improved livestock nutrition and enhance milk production.
- Introduce agroforestry into the farming system. Soil fertility can be improved by planting rows of leguminous shrubs and trees within the cultivated food plants.

- Train farmers on understanding and adopting improved cropping practices and other improved technologies.
- Determine the optimum planting dates for the various crops and crop varieties to comply better with shifting rainy seasons.
- Develop and promote rainwater harvesting technologies.
- Introduce efficient irrigation systems to reduce farmers’ dependence on rainfed farming.
- Improve rural infrastructure
- Introduce and promote food preservation and processing technology
- Improve gender equity and household education.

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