

The impact of climate change and adoption of strategic coping mechanism by agro-pastoralists in Gabiley region, Somaliland

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Edited by: Ahmed A. Elmi, PhD

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Candlelight for Health, Education & Environment (CLHE)

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Table of Contents

Acknowledgement	2
1. Introduction	4
1.1 Background	4
1.2. Objectives	5
Overall objective	5
Specific Objectives	5
1.3 Research questions	5
2. Methodology	6
2.1 <i>Description of the study area</i>	6
2.1.1 <i>Location</i>	6
2.1.2 <i>Climate</i>	6
2.1.3 <i>Soils</i>	7
2.1.4 <i>Land Use and Land Holding Size</i>	7
2.1.5 <i>Population</i>	7
2.2 <i>Data Collection</i>	7
2.3 <i>Limitations</i>	7
3.0. Results and Discussion	9
3.1 <i>Total land size under cultivation</i>	9
3.2. <i>Climate variability and change</i>	9
3.1.1. <i>Rainfall fluctuations</i>	9
3.1.2 <i>Temperature variability</i>	10
3.2 <i>Impacts of climate change</i>	10
3.2.1 <i>Impacts on crop production</i>	10
3.2.2 <i>Impacts on livestock production</i>	12
3.2.3 <i>Droughts</i>	12
3.2.4 <i>Flooding</i>	13
3.2.5 <i>Impacts on water availability</i>	13
3.2.6 <i>Impacts on the community</i>	14
3.3 <i>Climate change adaptation by agro-pastoralists</i>	14
3.3.1 <i>Change in cropping pattern</i>	14
3.3.2 <i>Soil and water conservation</i>	15
3.3.3 <i>Herd diversification</i>	16
3.3.4 <i>Deepening of shallow wells and runoff water harvesting</i>	16
3.3.5 <i>Migration</i>	17
4. Conclusion and Recommendations	18
Conclusion	18
Recommendations	19
References	21
Annex 1	22



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Executive Director

Candlelight for Health, Education & Environment

1. Introduction

1.1 Background

Climate change is an environmental, social and economic challenge on a global scale (Mendelsohn et al., 2006). Climate change can be exacerbated by anthropogenic factors (human induced actions) such as unsustainable use of land, broad scale deforestation, major technological and socio-economic shifts with reduced reliance on organic fuel, and the accelerated uptake of fossil fuels, among others (Millennium Ecosystem Assessment, 2005).

Despite worldwide coverage of climate change impact, there is inter and intra-sectoral variation in vulnerability depending on location, adaptive capacity and other socio-economic and environmental factors. In Africa, a continent that has contributed the least to the factors that lead to accelerated climate, its impact is believed to have been enhanced. This has been attributed to the continent's low adaptive capacity, over-dependence on agricultural sector, marginal climate and existence of many other stressors (Collier et al. 2008). The negative consequences of climate change in Africa are already affecting the communities living across the width and breadth of the continent. Frequent flooding, recurring droughts, extreme weather conditions, and shift in marginal agricultural systems are few of its apparent impacts.

In Somaliland, adverse impacts of climate change include recurrent droughts, increased biodiversity loss, species migration and encroachment of invasive plants, increased rural urban migration, changes in the vegetation types, soil fertility loss, and increased infestation of crop by pests and diseases and increased health risks.

Rain-fed farming has progressively been in practice in the study area for over a century now. Intensification in agriculture, both horticultural and rain-dependant farms has however been on the rise in the past two decades as a result of prevailing stability in Somaliland. This is mainly due to the fact that pure pastoralism has been losing its significance in the wake of land use changes induced by climate change for dual production. Therefore, the predominantly livestock based production system has gradually been shifting into a mixed livestock-crop production system. In fact, this change in land use for dual production purpose is a strategy developed in order to adapt with the change in climate and moreover to look for alternative livelihoods which can sustain incomes. The main reason for the change in livelihoods is frequent occurrence of recurrent drought that has jeopardized the sustainability of cattle dominated livestock production system. Though subsistence rain fed agricultural production is the dominant system in most parts of Gabiley region, there are also significant small scale irrigated agricultural production most of them located in

Arabsiyo district. This irrigation system is mainly used for growing cash crops such as tomatoes, lettuce, pepper, papaya, mango, oranges etc.

During the past two years, Candlelight for Health, Education and Environment (CLHE), conducted two other case studies focusing on how climate change is impacting the pastoral communities and environment as whole in the different ecological zones of the country. The case study is, however, the third and the last of a series of works on climate change and therefore is aimed at discussing the impact of climate change and adoption of strategic coping mechanism by agro-pastoralists in Gabiley region.

1.2. Objectives

Overall objective

To understand and document climate change impacts and how communities in Gebilay region are coping with those changes.

Specific Objectives

- To assess community perception on climate change;
- To assess the impacts of climate change on agro-pastoral communities and their respective livelihoods;
- To document how the communities are adapting to those changes.
- To recommend policies for practical changes and interventions that could lead to the proper understanding of climate change and strengthening communities' coping mechanism and improving livelihood conditions as well.

1.3 Research questions

The study questionnaire was designed to address the following research questions:

1. What changes in climate pattern were experienced in the past two decades?
2. How do agro-pastoral communities perceive the change in climate?
3. What are the impacts of climate change on livelihood systems in the study area?

2.

Methodology

2.1 Description of the study area

This study was conducted in some agro-pastoral areas of Gabiley region. Details of the study areas (location, climate, soil, land use, population, etc.) are discussed hereinafter:

2.1.1 Location

Gabiley Region is located in the western part of Somaliland, about 32 km due west of Hargeisa. It borders Marodijeeh region in the East, Awdal region in the West, Ethiopia in the South and parts of Awdal in the North. Most of the inhabitants in the region are agro-pastoralists. The topography of the region is characterized mainly by plains and thickets dominated by *Acacia Etbaica* ('Sogsog') at a plateau ranging between 1200-1500 metres above the sea level. The region is hilly in its northern fringes and open plains towards the Ethio-Somaliland border. The study area lies between Arabsiyo (40 km due west of Hargeisa) and covers the districts of Gabiley, Dila, Alleybadey and Tog-Wajaale (Fig 1)(Please refer to the colour spreads).

2.1.2 Climate

Rain fall fluctuation and drought occurrence

The semi-arid environment of Somaliland is generally characterized by four alternative wet and dry seasons during the year. March-May Spring (Gu') and September-November Fall (Dayr) are the wet seasons. June-July Summer (Xagaa) and December-February Winter (Jilaal) are dry seasons alternatively occurring between the wet seasons. Gulf of Aden coastal area gets 'Xays' rains in Winter season and occasionally Western inland and Golis mountain ranges get 'Karan' rains in Summer. Rain fall is erratic and highly variable in space and time. Its occurrence, intensity and distribution are highly unpredictable at any given season. Periodic drought occurs when the expected amount of rain fails or becomes below normal in one or both wet seasons. Rainfall data records, though discrete in nature, from 1896 to 1985 in the Somali habitat of the Horn of Africa indicates to expect 'short drought' roughly once in every 3 years (failure rainfalls in either one of the two wet seasons) and 'long drought' in every 10 years (failure of both wet seasons) (Elmi 1991, 1993). This natural phenomenon of quasi historical drought occurrence has not repeated itself in the past 20 or 30 years. In fact, such periodic droughts have seemingly evolved into aperiodic droughts since 1980s up to date, to be specific, perhaps an effect of the unfortunately worsening global climate change as believed by many.

2.1.3 Soils

Most soils consist of layers of weathered parent materials which have been affected

to some degree by climate, drainage and vegetation cover with dominant soil types ranging from Calcisols to Gypsisols. In fact, Fluvisols and Leptosols are also found with a limited coverage in the area (Venema, 2007).

2.1.4 Land Use and Land Holding Size

The major land use systems in the study area are agro-pastoralism, small-scale fruit and vegetable cultivation on alluvial fields along the dry rivers (togs), and livestock production.

Rain-fed agriculture is found in what is considered as the sorghum belt of Somaliland, practiced in combination with livestock production. This type of land use is vital for the economic activities and livelihoods in the study area. The main rain-fed cereal crops cultivated are sorghum, maize and cowpeas.

Cultivation of irrigated fruit trees and vegetables is a cash-oriented activity in the area; fruit trees grown include citrus, guava, papaya and mango and vegetable crops such as lettuce and tomatoes. Supplementary water for irrigating crops, livestock watering and human consumption is obtained from shallow wells along dry river beds, deep wells and earthen dams scattered in the study area. Types of livestock raised are cattle, shoats (sheep and goats) and camels.

Goats and sheep are grazed mostly on sloping areas, whereas cattle and camels are grazed in flatter areas (Venema, 2007). Sedentary agro-pastoralism is a common practice. Hay production from enclosures is widely practiced and is used for feeding animals during the dry season and any surplus is sold to livestock traders.

2.1.5 Population

In the absence of an official census it is difficult to guess the population in Gebilay, Wajaale, Dila, Allay Baday and Arabsiyo districts. The area is, however, filled with densely populated network clusters with almost no breathing space in between.

2.2 Data Collection

The data was collected through:

1. Primary interviews using structured questionnaires. The questionnaires were administered to randomly selected households from the villages in five districts (Arabsiyo, Gabiley, Dila, Tog-Wajaale and Alleybaday) of Gabiley region;
2. Focus group discussions;
3. Direct observations;
4. Secondary data on population, climate, among others were obtained from Gabiley Region Agricultural Office and literature review;
5. Discussions with the Regional Agriculture officers

2.3 Limitations

Due to lack of properly functioning meteorological stations in region, it was not

possible to get consistent and quantitative climate data. Therefore, the data in this report regarding climate were collected from the communities during the focus group discussions.

Delay of the major Spring (Gu') rainy season during the survey period inconvenienced the data collection activity in such a way that the communities were busy with urgent matters dictated by circumstances during the dry season such as livestock watering and feeding. This means more information could have been extracted without the unfortunate occurrence of the drought.

3.

Results and Discussion

3.1 Total land size under cultivation

There are 37,600 rain-fed farm plots and 7,500 small scale irrigated farm plots. The average cultivated land holding size per household in the case of rain-fed farming is 8 Ha whereas the sizes of irrigated farms range between 1 and 1.5 ha. Thus, the total size of the land under rain-fed agriculture is 300,800 ha and 11,250 ha under irrigated agriculture. In fact, the farm sizes are measured in local units called Qooddi and 5 Qooddi is equivalent to 1 ha (Gabiley region Agricultural Office, Personal Communication).

3.2. Climate variability and change

This section of the survey discusses rainfall and temperature fluctuations in the study area. In order to understand the climate variability in the area, the agro-pastoral communities were asked about the observed changes in these two major climatic factors (rainfall and temperature) since 1991.

3.1.1. Rainfall fluctuations

A rainfall pattern in the study area is one of the most important determining factor shaping agro-pastoral production systems and livelihoods in the study area. Agro-pastoralists interviewed believe that rainfall has highly varied over the years, both temporally and spatially. The study area has experienced a highly variable climate and with shifts in rainfall patterns in terms of quantity and frequency over the past two decades with dire consequences on livelihoods. Respondents in all areas visited reported change in rainfall patterns characterized by decrease in its quantity and frequency. Occurrence of aperiodic droughts and flash floods lately experienced, not only in the study area of Gabiley region but in most regions of Somaliland,, could be attributed to climate change. Of particular mention are two recent events in 2008 and 2010 whereby flash floods caused destruction in many areas in the region, namely Tug Wajaale, Alley baday, Faraweine, Gabiley, Arabsiyo and Magaalo-cad, causing disruption of livelihoods and extensive loss of property as well as livestock.

Table 1: Agro-pastoralists perceptions on rainfall variability over the past 20 years.

Rainy seasons	Rainfall				
	2010	2005	2000	1995	1990
Gu (Main rainy season)	Good*	Poor	Normal / average	Good	Good
Karan (Short rainy season)	Poor	Poor	Normal / average	Normal / average	Good

Source: Group discussion. (*) in the above table, "Good" means above normal rainfall.

In all the districts except Arabsiyo where irrigated agriculture is prominent, agro-pastoralists practice rain-fed agriculture and thus unpredictability of rainfall is, therefore, the most consequential change, both in terms of its onset and quantity (when present either average or insufficient in most cases these days).

3.1.2 Temperature variability

While the rainfall is decreasing and becoming unpredictable, the temperature level has also been rising. There was a consensus among respondents that the temperature has increased during the past twenty years. Changes in temperature and rainfall as well had a negative impact on livelihoods as these had contributed to making shifts in the ideal planting calendar and conditions. On the other hand, rise of temperature also causes high soil moisture loss, consequently affecting plant vigor and performance, resulting in the stunted growth of crops and pasture. Many agro-pastoralists mentioned that it is becoming problematic to use the traditional cultivation calendar they were accustomed to in the past. In the study area, where cereal crops comprise a significant portion of the food stock, an increase in temperature, especially when accompanied by low amounts of rainfall, proves to have detrimental effect on food/crop production.

3.2 Impacts of climate change

Frequent recurrence of aperiodic droughts and occasional flash floods may be attributed to the climate change. Recurrent drought is reducing livestock numbers, causing the depletion of water sources; decreasing agricultural yields, and causing an overall decline in both livestock and agricultural production. Drought conditions have always been a recurring feature in the long history of pastoral production in the region. But while it has been a common understanding in the rural areas that droughts used to occur once in every ten years, it is important to note that the occurrences of such cyclic droughts during the past 30 years or so were becoming more frequent and more hard-hitting than ever before¹.

3.2.1 Impacts on crop production

In many parts of the study area it was observed that most of the agro-pastoralists practice rain fed farming with batches of irrigated agriculture mostly in Arabsiyo district. Droughts and delays in the onset of rains have made the farm lands become drier and difficult to plough, caused stunted growth of crops and slow germination of seeds resulting in early wilting of the crops. In all the districts where rain-fed agriculture is well established, harvests have diminished; in some cases, because of water shortages induced by higher temperatures that cause high evapo-transpiration, in others because of disturbed crop cycles.

The trend of crop production in the rain fed agriculture indicates a general decrease in yield due to mostly below normal rainfall. Data collected from Gabiley Region Agricultural Office, indicates that crop yield, for example sorghum and maize, and has been decreasing per hectare of land every year since 2007. Furthermore, it has become

¹ *Impact of Climate Change on Pastoralism in Salahley and Bali-gubale Districts of Somaliland, Candlelight Study (2010)*

difficult to grow maize due to insufficient moisture (Table 2). The major reasons for the reduction of cereal crop yields are: a) low amount and short rainy period; b) shift in time of rainy season causing discrepancy in the cropping calendar; 3) soil fertility loss due to erosion by water and inappropriate agricultural practices; 4) invasive weeds (*Parthenium hysterophorus*) and pests such as worms (“Dirxi”) affecting both maize and sorghum. Following the unpredictable nature of the rainfall, the cultivation of cereal crops in most parts of the rain fed agriculture has become highly opportunistic.

Table 2: Sorghum and maize yield per ha. dependant on rainfall amounts.

Locality	Sorghum yield (Ton/ ha)			Maize yield (Ton/ ha)		
	Poor rains	Normal rains	Good rains	Poor rains	Normal rains	Good rains
Habaaswayn	0.3	1.2	1.6	0	1.3	1.8
Aburiin	0.3	1	2	0	1	2.1
Taysa	0.3	1.4	2	0	1	2
Bus	0.2	0.6	1	0	0.6	1
Galooley	0.4	1	2	0	1	2

(Source: Gabiley Region Agricultural Office)

Small scale irrigated horticultural crop production is one of the main source of income for the communities in Arabsiyo town and most of the farms are located along the seasonal water courses (Tog).

Diseases of horticultural crops are becoming ubiquitous in the small scale irrigated farms of Arabsiyo district. Though it needs further study, agro-pastoralists relate this new phenomenon observed on the crops to the climate change. They added that these diseases are being observed during the periods of higher temperatures.

The data shows an increase of infestation of pests and diseases of both cereal and horticultural crops in the area. A pest infestation of stem borer ‘Dhuunqabad’ is repeatedly occurring every year now. This pest with its disastrous effect mainly affects maize and sorghum and is usually active during the in early growth stages. In the case of small scale irrigated agriculture, where vegetable and fruit crops are mainly produced, agro-pastoralists listed the following afflictions as a threat to their production system: Aphids (Quddeeye), curl leaf (Qallajiye) and root drying (Dabo-madoobeeye). These diseases do not affect either all vegetables or fruits. For instance, Dabo-madoobeeye mainly affects tomatoes; Quddeeye impacts both tomatoes and salads, while Qallajiye is a disease which mainly affects citrus fruits (Table 3).

Moreover, according to the community respondents, these horticultural crop diseases occur from time to time with higher infestation and damage when there is a remarkable rise of temperature. Thus, it seems that these ‘diseases’ favor hot weather condition.

Table 3: Climate change related horticultural diseases

Diseases (Local name)	Affected Crops	Method of Control
Dabo-madoobeeye	Tomatoes	Chemicals
Qoddeeye	Tomato and salads	Chemicals
Qallajiye	Citrus fruits	Chemicals

On the other hand, agro pastoralists noted that poor soil fertility due to soil erosion caused by heavy rainfall is also another attribution for the reduction of cereal crops yields in the study area. Despite the fact that the rainfall is low in its amount, it is intense and erosive when it drops for that short duration - causing massive soil erosion.

3.2.2 Impacts on livestock production

Livestock, together with crop production, comprises the main source of income for the agro-pastoralists in the study area. Delay in the onset of rains accompanied by short and insufficient rains cause pasture deficit resulting in livestock mortality, increasing their susceptibility to diseases and poor livestock body condition due to long distance travel in search of water and pasture. This resulted in reduced household incomes from livestock and livestock products.

In the past, diversity of available forage has allowed agro-pastoral households raise different types of livestock in different combinations - cattle, sheep and goats or camels, goats and sheep or all. Cattle and sheep are primarily grazers, while camel and goats are normally browsers. Cattle production dominated in agro-pastoral livestock production. As pasture condition deteriorated over the years, agro-pastoral communities shifted from fewer cattle to more camel production with shoats to sustain subsistent households' income.

It may be worthwhile to mention that there is a decrease of herd size per mushrooming household but increase of overall number of livestock production at community level. But this requires further detailed studies to come up with an overall impact of climate change on livestock diseases.

3.2.3 Droughts

The impact of the recurring droughts has also been triggering movements of stockowners and their animals to longer distances in search of better grazing areas. During the data collection it was observed that many agro-pastoral households were moving with their camels towards the coastal areas in search of water and pasture. At only one water point in Tog-Wajaale district, the borehole was serving for large number of livestock that even some of them were coming from very remote areas. According to the town residents, the borehole was serving day and night to water all the livestock.

Drought is not only causing damage to the pastoral livelihoods but also it reduces

the resilience of the communities to shocks and makes them highly vulnerable to food insecurity. Moreover, the number of livestock and the quantity of crop yield are decreasing, keeping the agro-pastoral communities become more food insecure. Recurrent drought intervals reported in figure 2 (*Please refer to the colour spreads*) supports the aperiodic nature of nowadays drought occurrence in contrast to the 19th century's quasi predictable periodic droughts discussed earlier in this report (under section 2.1.2) as quoted HERE FOR REFRESHMENT, "Rainfall data records, though discrete in nature, from 1896 to 1985 in the Somali habitat of the Horn of Africa indicates to expect 'short drought' roughly once in every 3 years (failure rainfalls in either one of the two wet seasons) and 'long drought' in every 10 years (failure of both wet seasons) (Elmi 1991, 1993). This natural phenomenon of quasi historical drought occurrence has not repeated itself in the past 20 or 30 years. In fact, such periodic droughts have seemingly evolved into aperiodic droughts since 1980s up to date, to be specific, perhaps an effect of the unfortunately worsening global climate change.

3.2.4 Flooding

Flood disasters occurred in Alleybedey, Faraweine and Tog-Wajaale districts during the spring season in 2010. Agro pastoralists in those areas reported that the floods had claimed the lives of many livestock, destructed germinated crops and farmlands, caused soil erosion and in some other areas caused silting of crop lands. The floods have also destroyed houses and caused the displacement of agro-pastoral communities and even killed some people in the villages along its path. According to the interviewees, this was the second time they did experience floods of that intensity since 2008 and probably not repeating in the recorded history of the region. An important anthropogenic factor that might have contributed to the floods is the deforestation and soil erosion in the elevated grounds of the upper catchment areas.

Candlelight has intervened in 2010 in the floods mitigation efforts in Gebilay region, particularly Alley-baday, Faraweine and Magaalo Cad. The total number of households affected by the floods was 2696. It was reported that the flood had claimed the lives 6 persons (only in Allay Baday district), killed more than 4500 livestock and destroyed nearly 190 farm plots.

3.2.5 Impacts on water availability

The decrease in rainfall amount across the rainy season significantly impacted the water points and rain fed agricultural production systems. According to the interviewees, water levels of shallow wells in the dry river beds are getting deeper while the productivity of the small scale irrigated farm plots are decreasing. However, despite of the apparent reduction of rainfall, it is also true that water extraction from seasonal water courses for irrigation purposes has increased with surge costs.

The low amount of rainfall has had an impact on water availability as well as agricultural production. Overall, it has led to increased vulnerability in food and

water security, with direct effects on health (mainly mal-nutrition and water-borne diseases). It has become apparent from the interviews and the focus group discussions that continued rainfall deficits in the past twenty years or so has created a dire situation in water quantity and access as well as production of rain fed crops. Moreover, the unpredictability of rainfall has made overall agro-pastoral production, the main source of income together with livestock, difficult and undependable.

3.2.6 Impacts on the community

All the above mentioned impacts of climate change have direct or indirect bearing on the well being of agro-pastoral communities in the study area. The interviews and focus group discussions reflected that climate change and its resultant reduction in crop yield and livestock production had reduced agro-pastoralists' resilience to climatic shocks and at the same time leading them to persistent impoverishment. Moreover, many agro-pastoralists have become more dependent on food aid and remittances sent by family members in towns or living abroad, while others drift to the urban areas as internally displaced persons (IDPs).

3.3 Climate change adaptation by agro-pastoralists

The climate change impacts discussed above paint a fairly negative outlook on the livelihoods of agro-pastoral communities. Current and projected impacts of climate change are, and can continue to be, lessened through strengthened agro-pastoral resilience through adoption of viable adaptation strategies and risk management measures, which could eventually enable them to overcome the current and projected impacts of the climate change. The main adaptations and coping mechanisms that can be observed in the surveyed communities include diversification of income source and supplementary livelihoods e.g. mixed cropping (cereal, horticulture) and reactivation of traditional support systems during the periods of hardships.

3.3.1 Change in cropping pattern

Mono-cropping (i.e. growing the same crop year after year on the same land), instead of rotation of crops, has been practiced since the start of agriculture in the area over a century ago (Peels, C. V. A. 1900 first impression. 1986). However, because of the low amount of rains and recurrent drought causing crop failure, agro-pastoralists have shifted their production system to mixed cropping (cereals, horticulture), crop diversification and inter cropping (cereal, legumes). Sorghum and maize were the two major crops grown in mono-cropping but currently they grow sorghum and cowpea mixed on the same plot of land. Agro-pastoralists have mentioned that they undertake crop rotation between cereals and legumes. The main reason for the diversification of crops is attributed to the change in the quantity of rainfall which is low and short in its duration at times of raining. This implies that, the rain falling per a given growing season is not adequate for the growing season for most of the crops.

Crop diversification was observed in many areas and varies with the availability of water and distances of farm lands from the water sources. Consequently, the strategies

adopted by communities in Arabsiyo district, here there are sand storage dams and shallow wells for irrigation, differ from the rest of the districts in Gabiley region, where crops are extensively produced in rain-fed areas (Fig 3) (*Please refer to the colour spreads*).

The local sorghum variety Elmi-jama is one of the types preferred by agro-pastoralists in the study area. This is due to its capacity to provide better yields compared to other varieties and its resistance to drought, pests and diseases.

Furthermore, in order to facilitate germination of the seeds, agro-pastoralists in the study area practice change in planting calendar by sowing, for example, maize seeds early before the onset of the rain, for the seeds to germinate soon after the rain have started. Since the duration of the rainfall is getting shorter than before with diminished quantities, the communities are undertaking this practice of early sowing in order to maximize the survivability and maturity of the plants during the growing season.

On the other hand, the interviewed communities in Arabsiyo district indicated that they have already reduced the production of cereal crops and shifted to the production of horticultural cash crops such as tomatoes, lettuces, cabbage, papaya, banana, lemons, mangoes, oranges and guava. One farmer in Arabsiyo mentioned that, with better access to Hargeisa market, horticulture production offers better income compared to cereal production. In order to increase water available for irrigation, livestock watering and for domestic use, runoff water is nowadays stored in plastic sheets put in holes dug in the ground. Fig 4. (*Please refer to the colour spreads*).

Surface irrigation, the simplest form of irrigation where water flows across the soil surface through earthen canals into irrigating basins (Fig 4), is popularly used in the study area. Great loss of water was observed to occur mainly because water is lost unnecessarily in the earthen conveyance canals and due to improper time of application as the habit of irrigating farms during hot hours when evaporation rate is quite high.

3.3.2 Soil and water conservation

One has to be innovative to overcome the survival hardship living in arid or semi-arid environment. Agro-pastoralists in the study area have, therefore, come out with soil and water conservation techniques in addition to the ponds lined with plastic sheets for run-off water harvesting.

In response to the diminishing volume of rainfalls within the months of every single rainy season and associated water loss of scarcely available precious liquid through run-off eroding fertile top soil and dumping it in the sea, the communities in the study area have started constructing soil and water conservation structures within their farm lands with the aim of harvesting more water and increasing ground infiltration and

soil moisture content. Therefore, these structures not only help the agro-pastoralists' to conserve the soil but also increase the moisture content. Fig 5: *(Please refer to the colour spreads)*

3.3.3 Herd diversification

As a result of recurrent droughts and shortage of livestock feed, especially grasses, agro-pastoral communities in the study area have shifted the composition of their livestock species from cattle dominated to shoats (sheep and goats) and camel husbandry. As discussed earlier, in the past, the number of cattle kept per household was larger due to the abundance of grazing. Camels and goats, as browsers, are resistant to droughts compared to cattle; their milk is also greatly preferred in local markets (due to their lower fat content); therefore, cattle numbers per household has been falling.

However, there is a different scenario in terms of livestock diversification in the case of small scale irrigated agriculture in Arabsiyu district. The agro-pastoral communities in this district prefer sheep and camel than goats as livestock. According to the participants in the group discussion, this is mainly because goats feed on vegetables and young fruit trees causing damage to cash crops. This implies that any future adaptation strategy which considers livestock diversification should look for the local production system and communities' preference.

Following the shortage of livestock feed, pastoralists in the study area indicated that they have enclosures for fodder/pasture production in communal grazing lands. The harvest is plied and stored as a reserve to serve as supplementary feed for lactating cows and camels during the dry season when there is feed shortage. Excess hay is sold to livestock traders.

3.3.4 Deepening of shallow wells and runoff water harvesting

With the increase in climate variability and declining rains in the study area, agro-pastoralists have observed a change in the water table level of hand dug shallow wells. The resulting fall of water levels urges farmers to continuously deepen the depth of the wells in pursuit of the water table. The interviewed community members responded that they deepen their shallow wells to depths as deep as 15 m. It is also important to mention here that there are risks inherent to the deepening of shallow wells and many lives are lost when well cavities cave in. In some cases, the petrol-driven water pumps are unable to draw water from the deepened wells, and in most cases the process reduces the useful life of water pumps.

In Gogol-wanaag village of Arabsiyu district where irrigated agriculture is practiced, it was observed that agro-pastoralists have already adopted various rainwater harvesting techniques such erecting bunds with great heights. They also use, like many other communities in the country, plastic sheeting to harvest runoff water. Machine-dug surface water catchments (Balleys) which store large quantities of rain water are also becoming a popular feature in the region.

As discussed earlier, another innovative technique which became popular in all rural areas is the harvesting of run-off water in small hand dug ponds lined with plastic sheeting. Rainwater runoff is channeled into the pond and then used for irrigation, watering animals and for other domestic purposes (Fig 6) *(Please refer to the colour spreads)*.

3.3.5 Migration

Migration is one of the most common coping strategies practiced by pastoral and agro-pastoral communities during the period of feed and water shortages. When such resources are critical, agro-pastoralists in the study areas migrate with their livestock, particularly camel, towards the mountainous areas and as far as coastal areas (Fig 7). They usually move with their camels while the shoats remain in the homestead areas. This is mainly because camels travel long distances and need more feed than goats.

Figure 7 illustrates a herdsman migrating to the coastal areas in search of better browse/pasture for his camels. Note the baby camel carried on the back of the herdsman. This is wonderful but a real symbiotic relationship between the two in which one can hardly survive without the other. It is a true portrait of mutual live saving interdependence between the herder and his herd, not only camels but all his livestock (cattle and shoats) *Fig 7. (Please refer to the colour spreads)*.

4.

Conclusion and Recommendations

Conclusion

As is true in all the regions of the country, there is no consistent and reliable documented meteorological data for Gabiley region for reasonable tracking of the climate change. Respondents interviewed during the study period, however, believed that there has been significant change in the rainfall and temperature patterns for the last twenty years. Likewise, the general perception of the people is that both rainfall and temperature have highly been fluctuating for decades now became unpredictable with less rainfall in shorter duration and warmer temperature over year now than usual.

Extreme weather conditions such as floods and frequent aperiodic droughts, attributed to the climate change, are recent experiences of agro-pastoralists.

Studies conducted by Candlelight in the past have revealed detailed impacts of climate change on the pastoral production system². Similarly, along the same line, is intended to disclose how climate change is impacting the livelihoods of agro-pastoral communities in general and specifically in Gabiley region. The most striking climate pattern threatening agro-pastoralist livelihoods is the low quantity of rainfall and its short duration. Current agro-pastoralists perceive that the change in climate is already affecting their livelihoods (income sources: crop/livestock production)

Though agriculture has a recent history in the studied areas, there is significant knowledge about crop cultivation within the agro-pastoralists. In response to the livelihood threats attributed to the climate change, agro-pastoralists in the study area have already adopted various adaptation techniques such as crop rotation, mixed cropping, changing planting calendar, soil and water conservation, run-off water harvesting structures, changing livestock composition, and switching crop species from cereal crops to horticulture, where water for irrigation is available. Small-scale irrigated cash crops are one of the main sources of income for the farming communities in Arabsiyo district. Surface flood irrigation at around midday is in practice. Neither this type of irrigation nor the time of its application is appropriate for the following simple reasons: (1) huge loss of water because of difficulty in figuring out optimum application, (2) unnecessary soil saturation; (3) highest evaporation rate at midday, and (4) plant irrigating at midday scorching heat.

On the other hand, livestock diversification to help reduce vulnerability of species to the impacts of climate change is also another strategy in the livestock husbandry.

² *Impact of Climate Change on Pastoral Communities of Salaxley and Balli-Gubadle Districts of Somaliland, (2010), Candlelight Study.*

Agro-pastoralists have shifted their production from cattle dominated husbandry to camel and goat production. Even though, agro-pastoralists are practicing adaptation strategies locally, there are still risks of pests and diseases that damage their crops.

Runoff water harvesting within the farm plots have been observed for the purpose of irrigating horticultural crops, watering animals and for domestic use. Though these farm ponds are lined inside with plastic sheeting, they are not covered and because of high evaporation rate in the area especially during the dry season much of the water will be lost.

Recommendations

Individual attitude towards the use of land resources and the decisive actions collectively taken and repeatedly practiced in the process of development are keys to strengthen agro-pastoral resilience to effectively tackle and eventually overcome the impacts of climate change.

The need for a strong and organized early warning system is crucial for the agro-pastoralists to get information about the upcoming weather shocks and take actions accordingly in order to minimize the disaster as early as possible. This should be supported by proper weather forecast and quantitative data from meteorological stations. Thus, it is indispensable to strengthen the meteorological station in Gabiley district so as to provide reliable and timely weather information on a daily basis.

Though this survey generated information on the impacts of climate change on crop production and livestock husbandry, but further detailed studies are needed for in-depth understanding of the impact of climate change on the spread of livestock diseases, pests and diseases of crops and human diseases.

There is a clear gap on how to safely use pesticides among agro-pastoralists. Therefore, concerned line ministers and NGO's involving in the area of agriculture need to consider trainings not only on integrated pest management techniques but also on introducing organic farming to sustain agriculture and manage land as well. Agro-pastoralists of the studied areas also lack improved varieties of crops that adapt to the change in climate in their locality. Thus, it is important to conduct on-farm experimental researches on the adaptation trial of some improved crop varieties developed in similar agro-ecological zones.

Most of the agro-pastoral communities are practicing soil and water conservation in their plots of land. This has to be strengthened and widely spread over areas so as to cover bigger areas. Therefore, government line ministers together with other stakeholders (NGO's and UN agencies) should consider and support for up scaling of soil and water conservation techniques to conserve soil and water at a watershed level.

It was observed in the field that there is clear gap on irrigation water management in the study areas. Therefore, in order to utilize the scarce irrigation water properly and efficiently, governmental and NGO's should look for trainings on irrigation water management (time of application, irrigation interval, and amount of water to be applied which should be determined based on the crop water requirement and so on). Moreover, water resources management should be integrated in that it should be balanced as much as possible among the different uses of water such as irrigation, livestock watering, household consumption etc.

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Annex I: Photos

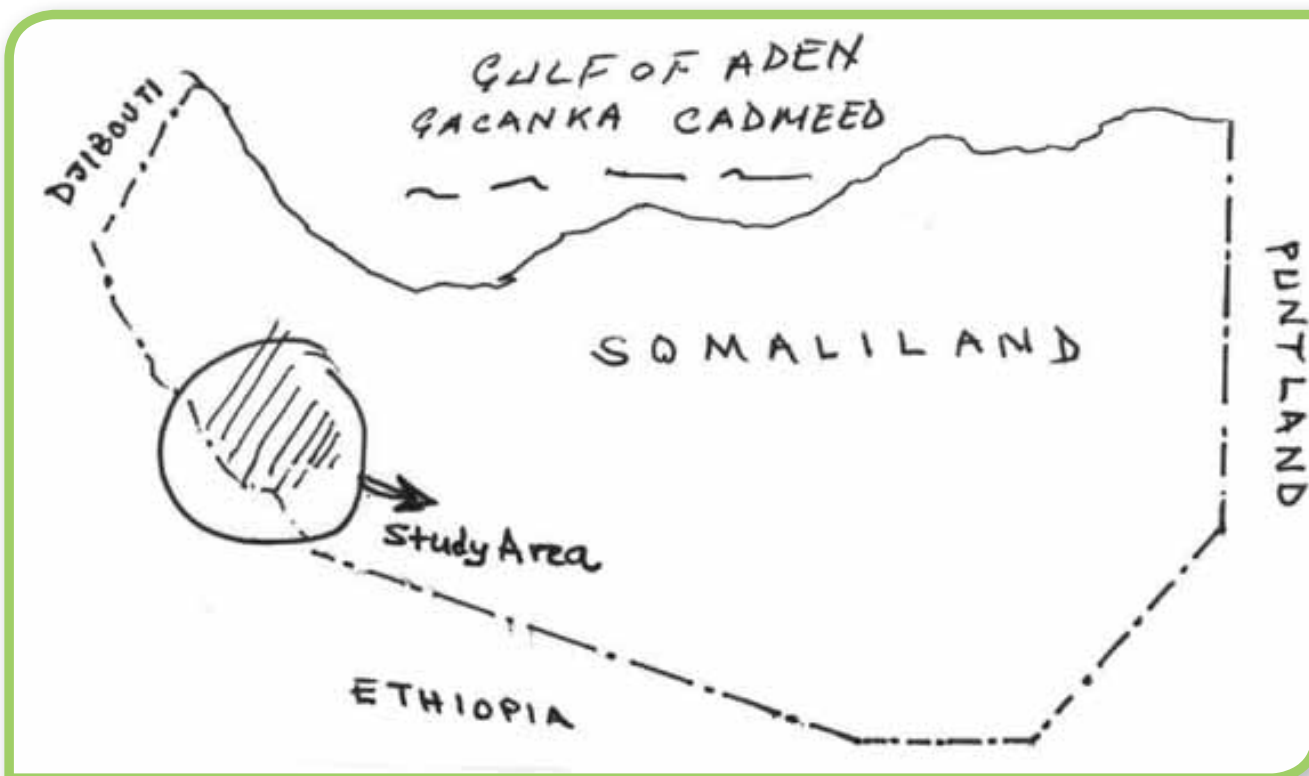


Fig 1 Location map of the study area

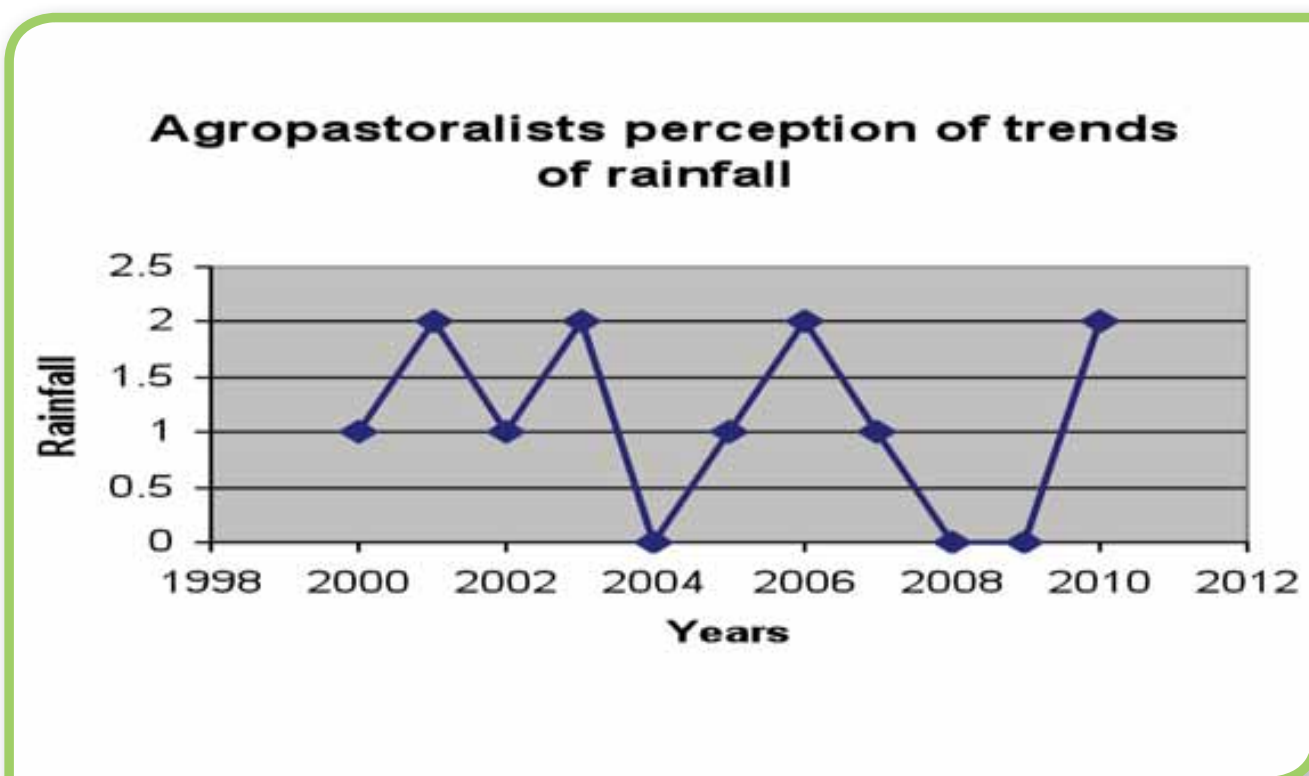


Fig 2: Trends in drought occurrence since 2000 (Rainfall amount scored as: 0=Poor (Drought year); 1=Normal/average and 2=Good rainfall). (Source: Group discussions)



Fig 3 Salads cultivation in small scale irrigated vegetable farm in Arabsiyo



Fig 4. A farm in Arabsiyo: a lot of water can be lost in the conveyance canals



Fig 5: Soil bund in Dila district



Fig 6 Runoff water harvesting in Gogol-wanaag village

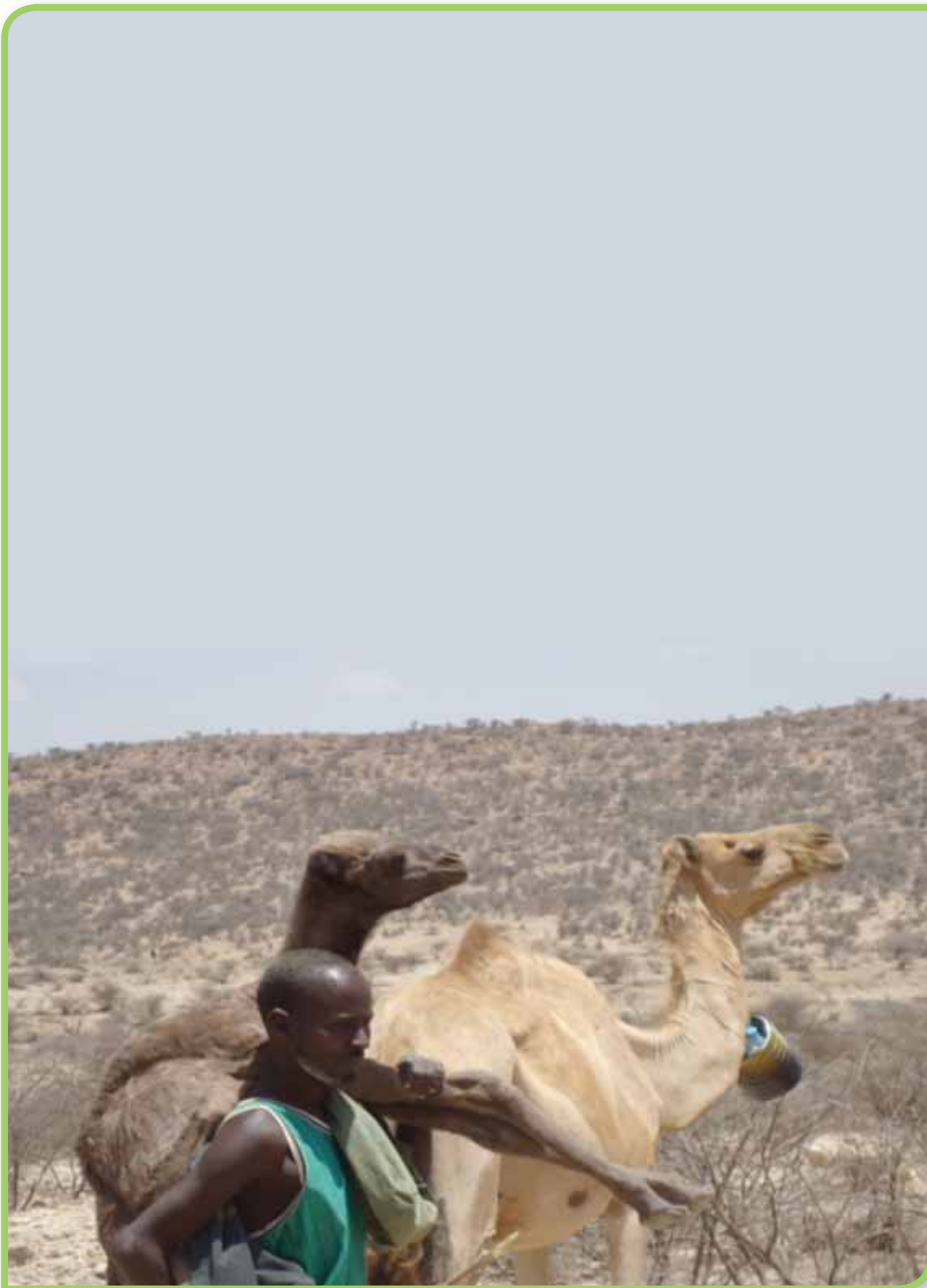
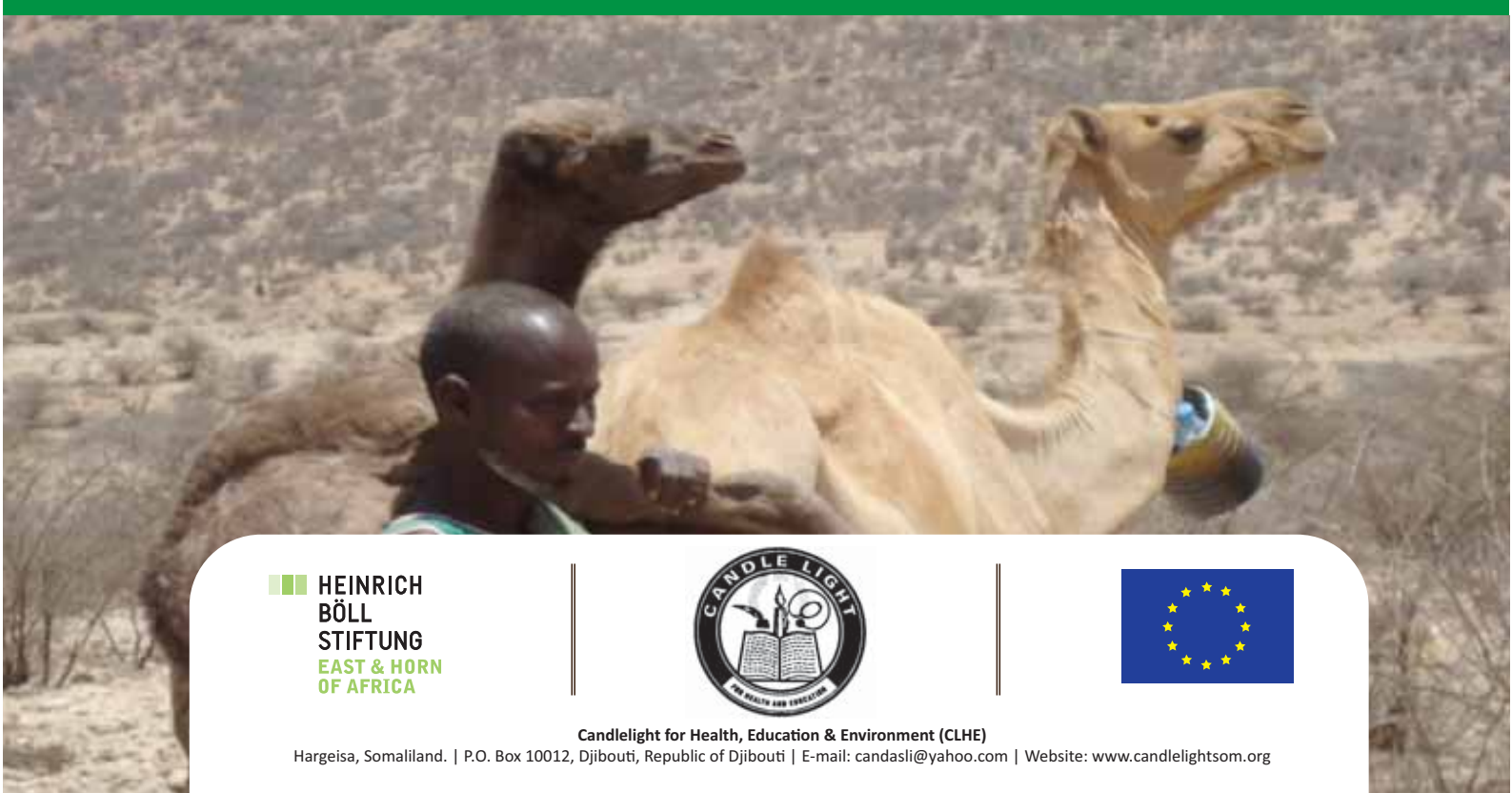
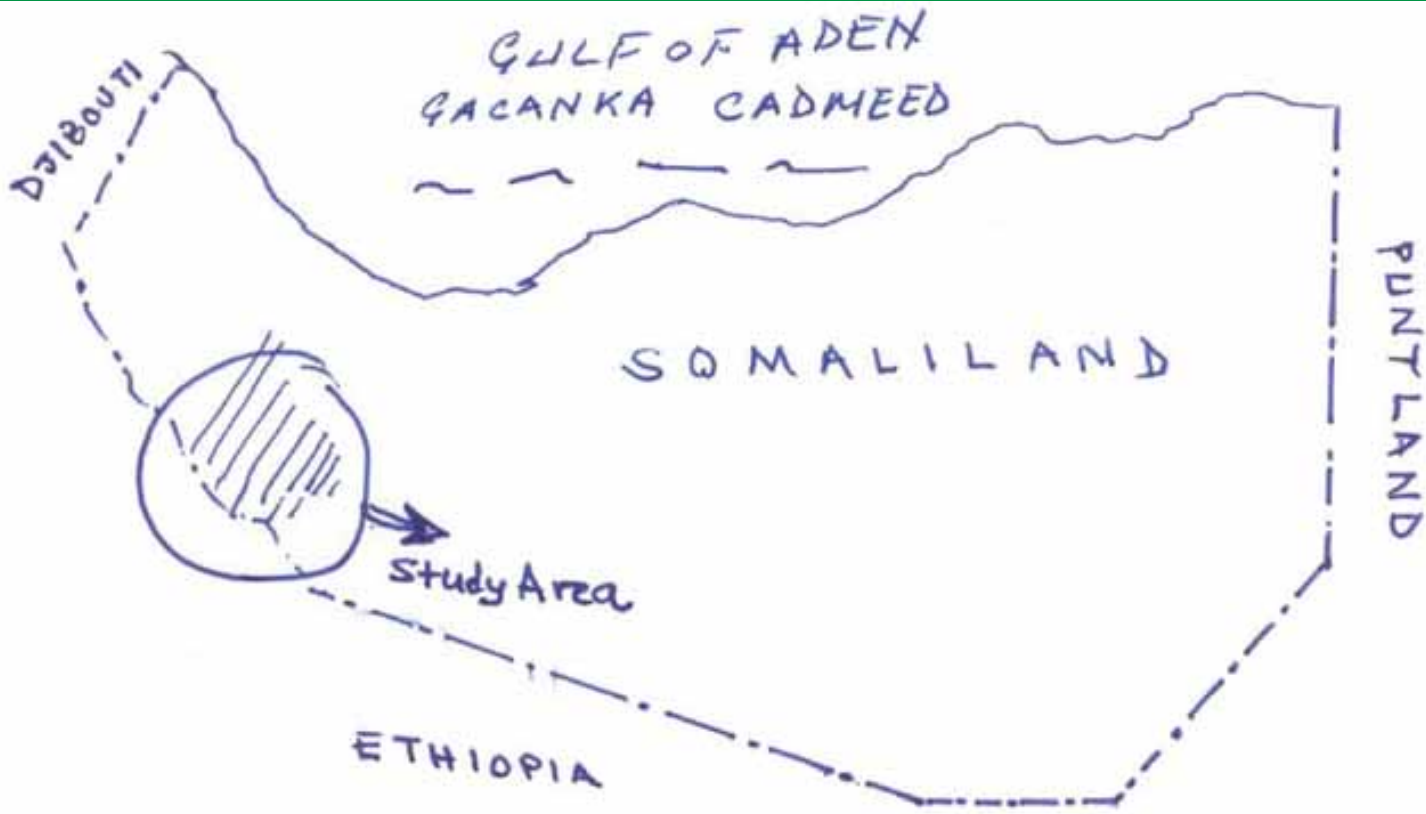


Fig 7. A herdsman carrying a baby camel on the move to Gulf of Aden coast in pursue of better pasture



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