

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

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).

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 changes over eastern Africa such as droughts and heavy rainfall have 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 agropastoralism 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.

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 determined by 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 Dayr 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.

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 have emitted, and are continuing to emit, increasing quantities of greenhouse gases into the Earth's atmosphere. These greenhouse gases include carbon dioxide (CO₂), methane (CH₄) and nitrogen dioxide (N₂O), and a rise in these gases has caused a rise in the amount of heat from the sun withheld in the Earth's atmosphere, heat that would normally 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 place over the last 25 years, and 11 of the 12 warmest years on 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.

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.

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.

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 information and 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 years and dry seasons. High variability and changes in rainfall levels spell disaster for agropastoralists.

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.

Climate Generally, Somaliland has an arid to semi-arid climate, with four seasons. The first main rainy season of Gu occurs between April and June, when around 50-60% of rain falls. The second rainy season is called Deyr (from August to November) and accounts 20-30% of total rainfall. The two dry seasons are Jilaal and Hagga, which occur between December and March and July and August, respectively (Table 1). The amount of rainfall received annually reduces further to the north except for areas around Sheikh, Hargeisa and Borama that receive between 500 mm and 600 mm

per year [4]. While the area around Erigavo receives up to 400 mm annually [5]. The northern coastline is characterized by low rains of less than 100 mm per year. The rest of Somaliland receives an annual rainfall of 200-300 mm [4]. In the higher altitudes of the mountains and plateau areas temperatures vary considerably with the seasons, with a mean annual temperature of 20-24°C, while the coastal region has mean annual temperatures of 28-32°C.

Soils Soil types of Somaliland closely follow its geomorphology and are characterized by poor structure, high permeability, low moisture retention ability and inadequate internal drainage [6]. Moreover, soil erosion has been a major challenge as a result of land clearing, cutting trees for charcoal production and overgrazing of livestock. Gully erosion is also another major challenge to both rain fed farming land and grazing land and has made large parts of farming land in Somaliland unproductive and is spreading at an alarming rate

Land Use In Somaliland, land is mainly used for livestock production and rearing or mix farming (crop and livestock production). Most of the regions in Somaliland are dry and cannot support rain fed agriculture except for small pockets of land in the areas around Hargeisa, Gebiley and Borama that receive amounts of rainfall that can support rainfall dependent agriculture. The eastern regions of Togdheer, Sool, and Sanaag are almost exclusively relying on livestock raising [6]. The coastal grasslands are used for extensive livestock grazing especially in the dry season as water is more available in these areas than in the wood land [6].

Results For the past decades, Somaliland has seen an increase in hazardous events such as droughts, flash floods, massive land degradation, and invasion of alien species. However, drought remains the only major disaster causing huge damages to its populations and the economy. Currently, drought conditions still prevail in most parts of Somaliland particularly in the eastern regions which had a poor rainfall performance in the previous Deyr and Gu rainy seasons. In some areas of Sanaag, Togdheer and Sool regions, drought conditions have persisted even longer and spread to western regions of Somaliland. Therefore, in order to understand why intense dry and below normal rainy seasons in 2016 turn into crises in 2017, we need to look beyond the shortage of rain.

Based on Palmer, In general, drought is a complex phenomenon, which varies every time in terms of its onset, intensity, duration and geographical coverage and causes a serious hydrological imbalance. In Horn of Africa, drought and its consequences (degradation of environmental and natural resources), continues persistent largely due to climate changes, increased human population, inadequate institutional capacities, civil unrest and high poverty levels in the region [3]. In Somaliland, which lies in an arid and semi-arid environment, is frequently experienced recurrent episodes of drought which has become serious natural hazards. It affects large proportion of the population in a number of ways such as causing loss of life, crop failures, food shortages which might lead to malnutrition, health problems and mass migration. The most seriously affected areas are eastern regions namely Sanaag, Sool and Togdheer. These regions face frequent reduction of water and moisture. However, in the current drought (2015-2016), most of the regions of Somaliland suffering the worst drought in several decades which represents the most severe food security emergency. Two consecutive seasons (Gu and Deyr) of significantly below average rainfall in Somaliland have resulted in failed crop production, depletion of grazing resources and significant livestock mortality. Pastoralists and agro-pastoralists who occupy the vast majority in Somaliland are hardly meet basic water requirements during the current drought and the problem will most likely get worse due to the climate change. Pastoralism has been the major livelihood of Somaliland whereby populations with their livestock follow seasonal migration patterns depending upon rainfall and pasture availability. Nevertheless, for the past decades, there has been a dramatic changes in the socio-economy of the pastoral population as a result of the recurring droughts and massive change

of land use, which in turn had negative impacts on availability of fodder, and thus adversely affecting livestock production.

The non-endemic Palaearctic species in Somaliland (i.e., those found in the Guban) are all associated with the arid conditions of the Saharo-Sindian fringe; none of them is anywhere associated with wet or forest conditions and none of them appears able to withstand the full severity of the true desert. Any spread of the desert areas would, therefore, restrict their range and if the restriction took place where it might be expected to (an extension of the Nubian Desert) the Somali populations would be cut off from their northern relatives. The present climatic trend which, with fluctuations, has been in operation since the last Pluvial is towards increased desiccation and *Coluber rhodorhachis* appears already to have been fragmented in the manner suggested; there appears to be a distributional gap of several hundred miles between populations in Lower Egypt and in Eritrea-Somali-land.

Climate Seasons Somaliland

| | |
|----------------------|------------------|
| Gu (rainy) | April-June |
| Hagaa (dry) | July-September |
| Day (rainy) | October-November |
| Jiilaal (dry) | December-March |

Historical Developments water preservation

Prior to the existence of berkads⁹ three water sources were available to satisfy human water needs in Somaliland:

- Rainwater collected in balleys,¹⁰
- Water collected from toggas¹¹ if available,
- Shallow wells located close to some of the main towns (e.g. Odweyne).

Berkads are privately owned water source. In particular, within the project region berkads are the main water source. Deep wells can only be found in some of the major towns, such as Hargeisa. Previously during Jilal¹² people had to migrate long distances in order to find enough water and fodder for their livestock, a typical, environmentally sound, pastoral behaviour, but very laborious. Once water became scarce, herds were moved towards areas with shallow wells or water was brought from these wells by camel. Before the construction of berkads, people especially in the Haud Region¹³ mainly owned camels instead of goats and sheep due to their ability to survive without water over a relatively long period of time. Goats and sheep were only kept in areas with a sufficient availability of water, i.e. areas with shallow wells or toggas. For people living in the south of Togdheer Region along the border to Ethiopia this meant that they had to move as far as Odweyne¹⁴ for water. From Gocondhale¹⁵ this took up to four days while one camel could carry four traditional water containers (25 litres each). Despite time and transportation constraints this was done at least every two weeks during the dry season. During the rainy season people had to set off about once a month to fetch water.

Lack of Good Planning and Time-Pressure

At present people are in a hurry: they want to have water as easy and as quickly as possible. Consequently people decide to build a berkad without proper planning and instead hire a contractor. In the past people carefully planned berkad construction and spent a long time on finding an adequate construction sight, on selecting excellent materials, and on choosing skilled masons

The construction process of a berkad is usually divided into four phases

- a) Planning,
- b) Digging of a hole,
- c) Collection of materials and finding skilled labour, and
- d) Construction.

The duration of construction work depends on

- a) The size of the berkad,
- b) Good preparations, and
- c) The financial situation of the owner.

About 6 weeks to three months are needed for the construction of a berkad once the materials are available. According to information given a berkad can cost about 1500 US\$ or 3000 US\$, depending on its size and the quality of the materials. To give an example, a shop-owner in Khatoumo would have to sell his shop in order to be able to afford a berkad. The berkads are the only means of water preservation.

Recent developments have shown that the overall situation is changing rapidly. Private Construction activities of berkads have increased. However, one major hindrance to actual improvements in living conditions is the lack of sufficient expertise and know-how in berkad construction. Extremely poor water quality in rural areas in combination with very low hygiene awareness and little knowledge of the effects of contaminated water cause serious health problems.

Background

In Somaliland, majority of the communities depend on pastoralism as a main source of livelihood. The communities therefore follow seasonal migration patterns depending upon rainfall and pasture availability for the sustenance and survival of their pasture. Nevertheless, for the past decades, there has been a dramatic change in the socio-economy of the pastoral population as a result of the recurring droughts and massive change of land use, which in turn had negative impacts on availability of fodder, and thus adversely affecting livestock production.

Somaliland has an arid to semi-arid climate, with four seasons. The first main rainy season of Gu occurs between April and June, when around 50-60% of rain falls. The second rainy season is called Deyr (from August to November) and accounts 20-30% of total rainfall. The two dry seasons in are Jilaal and Hagga, which occur between December and March and July and August.

For the past decades, Somaliland has seen an increase in hazardous events such as droughts, flash floods and massive land degradation. However, drought remains the single most important disaster causing huge damages to its populations and the economy. Currently, drought conditions still prevail in most parts of Somaliland particularly in the eastern regions which continue to experience poor rainfall performance. The most affected parts of the country are Sanaag, Togdheer and Sool regions, where drought has persisted for longer periods and spread to some parts of the western regions of country.

It is still projected that the situation is expected to become even more pronounced in the coming years due to the effects of climate change. Drought is one of the most complex natural phenomena and causes adverse effects on lives of the communities, taking a huge toll on the population and their main source of livelihood. This is especially so for pastoralists who depend on their livestock for survival. It is estimated that the communities' in Togdeer, Sool and Saanag regions have lost over 60% of their livestock in the last 3 years of recurring drought

The available evidence from the past studies clearly show that the Somaliland is very likely to face extreme and widespread droughts in the future. The vulnerability is likely to increase due to fast growing populations, increasing water demands and degradation of land and environmental resources.

The recurring drought has continued to deplete the natural sources of water that have served the communities for years. Water scarcity is therefore one of the biggest challenges facing the communities in Somaliland especially the ones in the eastern regions. Many of them have resorted to fetching water from potentially contaminated sources. This has contributed to high incidents of water and hygiene related illnesses.

In a survey conducted recently in the regions, respondents indicated that open wells in dwellings were the main sources of drinking water for 75% of those surveyed in the Sool regions, whereas they were the main source for only 14% of those surveyed in Sanaag. Instead, the majority of those surveyed in Sanaag, 53%, sourced water from open public/community wells. More respondents, 12%, in Sanaag responded that they obtained water through a covered public/community well than those in Sool, none of whom responded similarly. Covered wells were also rare in the two regions. 18% of respondents in Sool counted water trucks as their main source of water, while only 4% did so in Sanaag. Studies have also indicated that during prolonged dry seasons, when the Berkads became dry, both people and livestock travel long distance in search of water. People obtain drinking water by excavating shallow wells in the stream and similar to open Berkads, the hygiene is very poor. Hence, waterborne and water related diseases are common. In Burao town, in Togdeer region, where one of the boreholes is proposed for drilling, over 60 percent of the residents of the town rely on unimproved sources of water supply, for example, water trucking and private vendors. Recently, the public health has reported some cases of AWD/Cholera where the cause of death was attributed drinking unimproved water.

Of those 60 percent are included the lowest income bracket and they buy water from the private suppliers. Low income groups spend more money buying potable water compared to the public utility water supply.

JUSTIFICATION

Somaliland is located in one of the most disaster-prone regions of the world and is regularly faced with recurrent drought, floods, cyclones and conflict-driven emergencies. In the eastern regions of, Togdheer, Sanaag and Sool regions, there were 7 droughts in the last 35 years, 6 of them were experienced in the last 15 years (Inter-agency assessment report, 2016).

Given the fact that three regions of Togdeer, Saanag and Sool suffer from perennial poor rainfall; and as a way developing a long term sustainable solution to the water stress in area, and given the potential of groundwater availability, drilling of boreholes is the most viable option for addressing the water stress in the regions.

The eastern regions in Somaliland and especially Saanag and Sool regions continue to suffer from recurrent drought. This situation has increased the vulnerability of the communities as they have lost most of their livestock which is their main source of livelihood. The situation is exacerbated by the fact that the two regions also continue to experience occasional inter clan fighting which is often triggered by competition for available pasture and water resources. Drilling of the two boreholes will not only contribute to providing important water sources that can support the water needs of the communities during drought and harsh climatic conditions, but also contribute to reducing risk factors leading to conflict.

The fact that the region is also perceived to be far away from the capital, the three regions feel marginalized and cut off from services and opportunities that come from proximity to the capital. Drilling of the two boreholes will contribute in pacifying this feeling of marginalization. Majority of the IDPs displaced due to drought are from Togdeer, Sool and Saanag region, and the drilling of these two boreholes will contribute to mitigating against further displacement of populations in the area.

Scarcity of water in the two regions has forced communities to resort to the use of unsafe water sources thus exposing themselves to the risk of contracting preventable water and hygiene related diseases. Drilling of the two boreholes will offer opportunity to the benefiting communities to have a chance for better access to potable water, and thus reduce the incidents water related diseases. Last year, Togdeer region, especially burao town was badly affected by AWD incidents. At the peak of the outbreak, over 100 new cases were being registered on a daily basis.

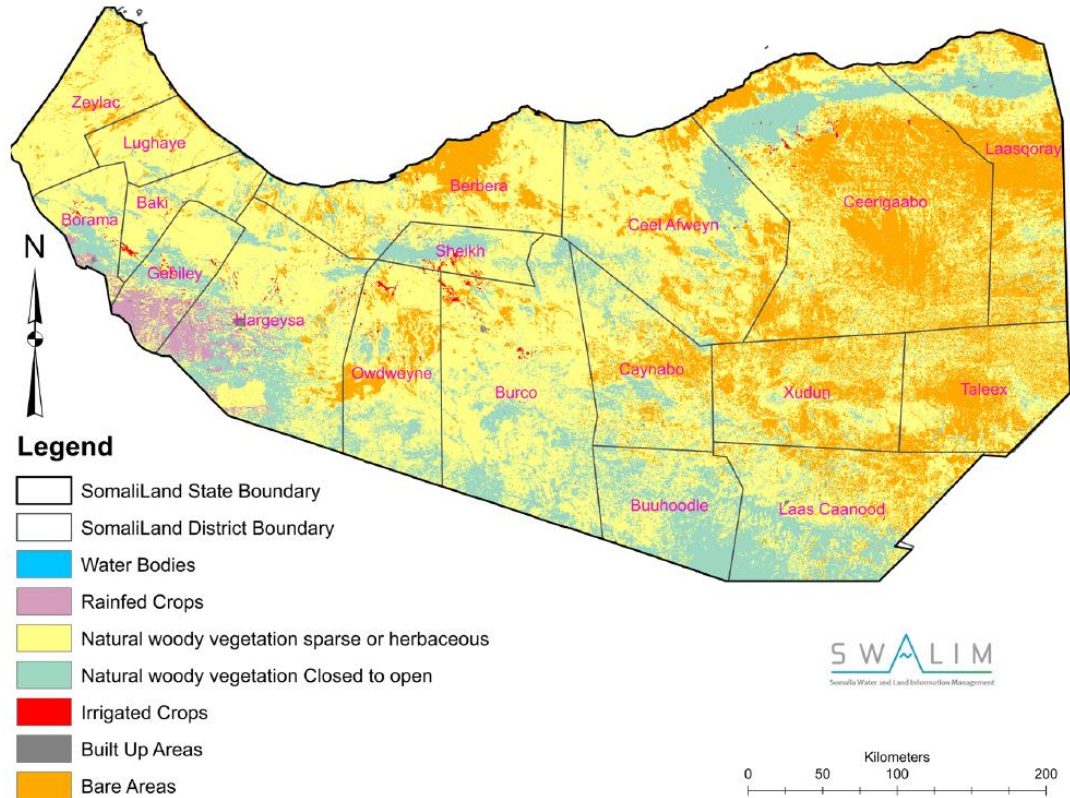
Description of the Somaliland climate and natural resource base

Somaliland is located in the Horn of Africa, with an area of 137,600 km² and a population of about 3.80 million people. It is estimated that approximately 11% of the population lives in rural areas, 34% is nomadic, 2% is internally displaced persons (IDPs) and the remainder (53%) reside in major towns (MoNP&D 2017).

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

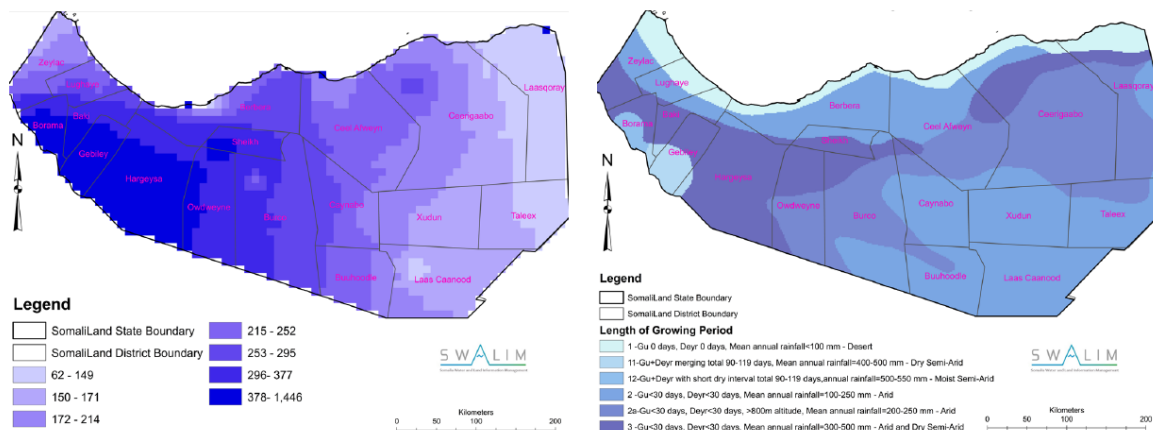
Temperatures are generally high throughout the year, with the maximum being 36–38°C in the coastal areas (Basnyat 2007). Rainfall has bimodal distribution, with the first main rainy season, *Gu*, occurring between April and June and the second, *Deyr*, from August to November. The two dry seasons are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

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



Land cover of Somaliland.

Figure 2: Rainfall maps of Somaliland.



Source: FAO SWALIM