Report on Historical Climate Baseline Statistics for Somaliland, Puntland, Galmudug and Hirshabelle Vol 4

ICPAC
IGAD Climate Prediction & Applications Centre

ACKNOWLEDGMENT

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Analysis of climate change data and drafting of the report was made possible with inputs from Linda A. Ogallo and Abdirashid Jama.

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1. INTRODUCTION

The world is experiencing a change in temperature and precipitation patterns, in fact, all reports by the Intergovernmental Panel on Climate Change state that the global temperatures are increasing. Eastern Africa historically has recorded extremes in both rainfall and temperature with increasing recurrences droughts and floods (Ogallo Linda et al. 2017; Omay et al., 2016; Sabiiti, et al., 2016; Awange, et al., 2007; Kinguyu, Ogallo L. A. and Anyamba 2000; Ogallo L. A., 1993; among many other authors). In fact according to Intergovernmental Panel on Climate Change (IPCC 2014) East Africa has experienced an increase in the frequency of drought and floods in the last 30-60 years.

In Sub-Saharan Africa which is largely inhabited by pastoral and agro-pastoral communities, climatic hazards has led to loss of rural livelihoods and income. Vulnerability for these communities has been attributed to poverty and reliance in rainfall. These communities also have limited access to information and technical support and financing for adaptation options hence responding to local climate variability and predictions is very limited (Haile, 2005; Cooper, et al., 2008; Connolly-Boutin & Smit, 2016; Ogallo, Linda et al. 2017). Therefore, enhancing the capacity of communities to cope and adapt to climate variability and change helps to build the resilience of communities and their livelihoods that are climate sensitive.

Annual evapotranspiration in drylands of arid and semiarid lands (ASALs) usually exceeds rainfall. Agricultural productivity is also limited by poor availability of moisture thus affecting the food and nutrition security of populations. Prolonged and widespread drought is a recurrent feature of the ASALs that is exacerbated by climate change phenomena, advancing desertification and ecological degradation. IFRC (2011) reports that most pastoral communities in the ASAL region are overwhelmed by the realities of the modern day as they search for safe paths through the periods of recurring drought. Traditional pastoral routes, national park fences and farm enclosures limit access to grazing and water points, and pursuing what there is can lead to violence. Increase in regional conflict has left the arid lands awash with weapons, and neighbouring tribes are well armed.

Enhanced desertification in the Horn of Africa's dry-lands is another key challenge in the region. The harsh ecological circumstances of the ASALs contribute to severe hardships amongst the affected communities, including poverty, hunger, malnutrition, dislocation and conflicts over natural resources both within and across boundaries in the region. The vulnerability of the Horn of Africa's Arid and Semiarid Lands has been especially evidenced over the last decades by the occurrence of drought induced famine in many parts of the region, notably in the early 1980s and most recently in 2011, when millions of people were affected by drought causing untold suffering and death of both livestock and human populations.

The Horn of Africa overall consists of fragile ecosystems that are highly vulnerable to climate change, and thus the livelihood strategies undertaken by dryland communities are equally fragile and vulnerable in these regards. The task of building resilience to climate change and supporting community adaptation to climate change is thus linked closely to the sustainable management of natural and productive resources.

The IGAD Drought Disaster Resilience and Sustainability Initiative (IDDRSI) strategy states that due to this interplay of factors, “efforts to increase the capacity of communities and households in the ASALs to cope with and adapt to greater prevalence of drought events requires a holistic approach that addresses the need for information (including climate information and information on climate resilient practices), access to appropriate technology, capacity building, new livelihood opportunities and a supportive policy regime”.

The Rural Livelihood’s Adaptation to Climate Change in the Horn of Africa – Phase II (RLACC II) is a multinational program that covers Somalia and Sudan. The Somalia project targets Puntland (Bari and Nugaal regions), Somaliland (Awdal region) and Galmudug and Hirshabelle. The project is expected to improve the resilience of pastoral and agro-pastoral communities to climate change in the HoA through: (i)introducing of adaptation strategies to reduce the negative impacts of climate change and strengthen the capacity of pastoral/agro-pastoral households to cope with climatic hazards, (ii) enhancing the capacity of communities to not only absorb shocks, but to also effectively adapt their livelihoods to harsher climatic conditions, (iii) helping pastoral and agro-pastoral households manage drought risks, (iv) supporting community-led initiatives to protect, conserve and restore natural resources in a sustainable and climate-resilient manner, (v) strengthening the participation of pastoral communities in planning and implementing activities pertaining to their development.

In order to effectively achieve its objectives, baseline climate data and information that is easily accessible to the users is key in the development of effective adaptation practices. The users must also be able to understand and appreciate the significance of these baseline data as well as basic weather and climate concepts such as normal, above normal, below normal, risk management, among other terms. Analysis of the baseline climate was therefore one of the first major activity of the project to support the project objective. Baseline climate data analysis for the project sites was undertaken by organizing a workshops for representatives from the department of meteorology in Somalia under support of climate scientists from ICPAC.

This project report provides a summary of the Climate Baseline Statistics for Somaliland, Puntland, Galmudug and Hirshabelle as derived from the workshop on area specific analysis of climate data. The analysis generated and mapped location-specific basic statistics including mean, trends, Maximum and Minimum temperatures as well as other space- time climate characteristics that are required to provide local climate risk knowledge including those required for climate change adaptation and mitigation.

The other products created during the workshops included rain-fed cropping start, progression and end of season, number of rain days, seasonal rainfall distribution in space and time, probability of damaging dry spells and or storms occurring including when, where and for how long, and percentile of precipitation, and related seasonal water balance variables, seasonal peak, etc. These climate baselines will serve as information material for all components of the project as well as the partners and stakeholders.

2. THE STUDY SITE

Somalia is part of the Greater Horn of Africa which also includes Kenya, Sudan, South Sudan, Uganda, Ethiopia, Eritrea and Djibouti. It is bordered by Djibouti to the North-West, the Gulf of Aden to the North, the Indian Ocean to the East, Kenya to the Southwest and Ethiopia to the West (Ogallo, Linda (2018); ICPAC, IGAD & WFP, 2017). Somalia is largely a pastoralist community; with over half the population keeping livestock as their main source of livelihood (Little, 2004). The locations of the three study areas as shown in **Figure 2-1**.

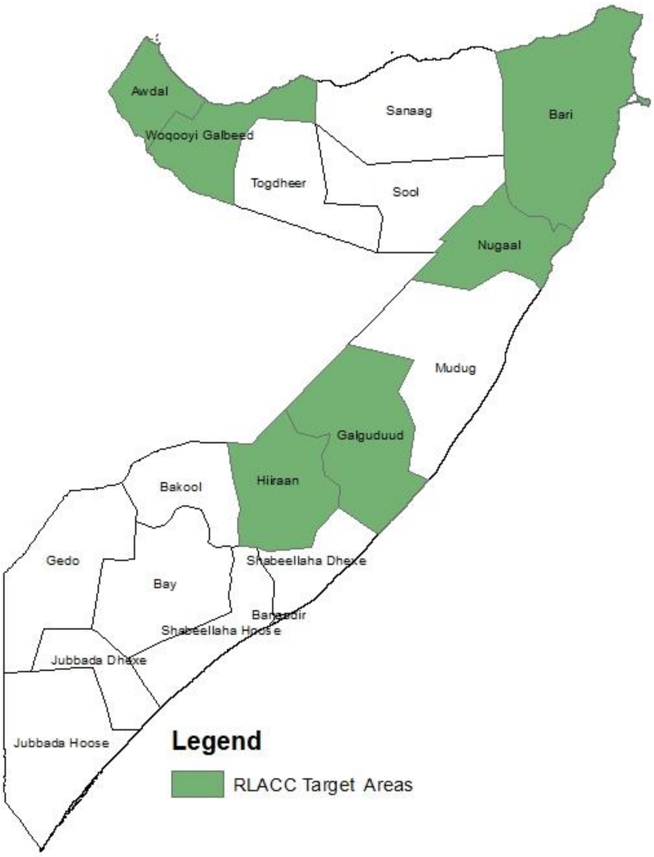


Figure 2-1 RLACC II project Sites

2.1 DATA

The RLACC project sites for the intervention were identified based was their position in the transhumance corridors. Due to the seasonal transhumance nature of pastoralists, the project's benefits will not be limited to the project sites and their surroundings. Country station data from the National met and the Somalia Water and Land Information Management Project (SWALIM) together with satellite rainfall data was used in the study from the Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) dataset (CHG, 2016). CHIRPS is a global dataset (50° S-50° N, 180° E-180° W), with a resolution of 0.05°, ranging from 1981 to near-present gridded precipitation time series. CHIRPS data are produced by scientists at the University of

California, Santa Barbara (UCSB) Climate Hazard Group (CHG) and the U.S. Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center. The data was developed to support the United States Agency for International Development Famine Early Warning Systems Network (FEWS NET)

3. BASELINE STATISTICS

Several baseline climate products including maps were generated. Examples of the products presented in this report include:-

i. Mean Annual Rainfall;
ii. Extremes in Mean Annual Rainfall
iii. Monthly and Seasonal Rainfall Distribution;
iv. Inter-annual Variability/ Anomalies;
v. Rainfall Trends;
vi. Rainfall Intensity;
vii. Onset, Cessation dates and Length of Growing Period; among many other basic statistics.

3.1 Mean Annual Rainfall

Mean annual rainfall represents the expected total amount of rainfall at the specific location in a year. Since most of socio-economic activities in the area are rain dependent, information regarding the mean annual rainfall baseline statistics (**Figure 3.1-1 to 3.1-4**) are presented in this section. The maximum and minimum extremes which are extremely important climate variables for the development of effective climate resilient strategies for any location are also represented (**Figure 3.1-5 to 3.1-12**).

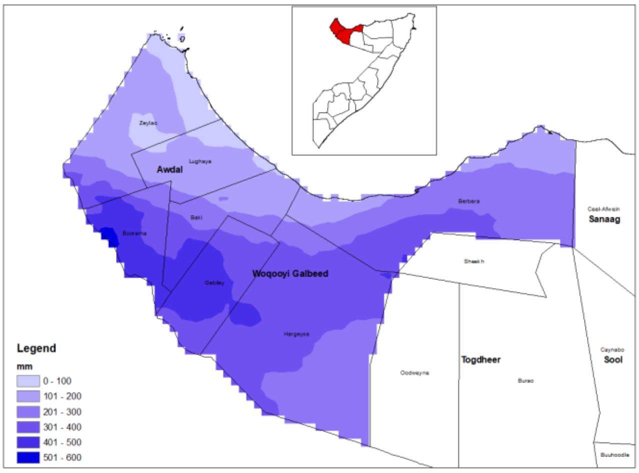


Figure 3.1-1 Mean annual rainfall 1981-2010 Awdal and Woqooyi Galbeed, Somaliland

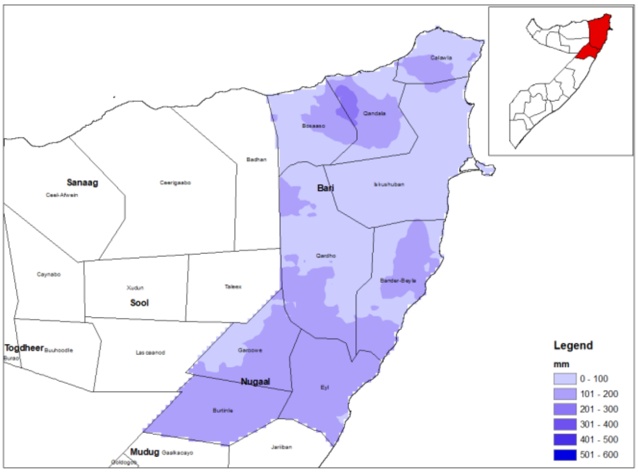


Figure 3.1-2 Mean annual rainfall 1981-2010 Bari and Nugal, Puntland

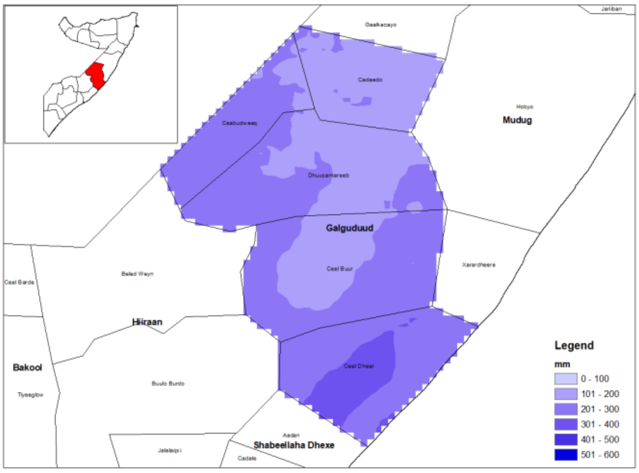


Figure 3.1-3 Mean annual rainfall 1981-2010 Galmudug

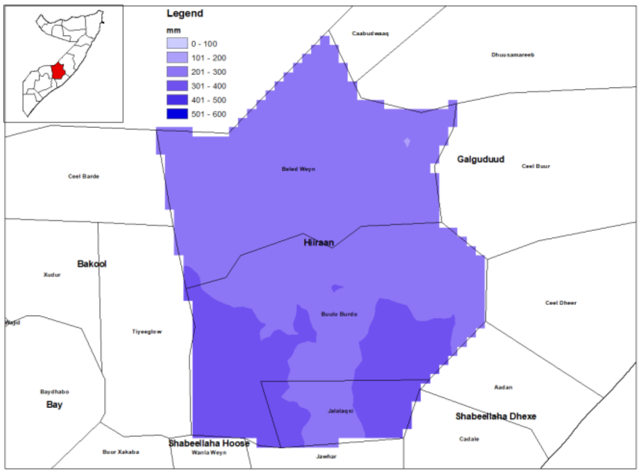


Figure 3.1-4 Mean annual rainfall 1981-2010 Hirshabelle

Figure 3.1-1 and 3.1-4 shows that rainfall at the project sited generally receive not more than 500mm in a year. The largest variability is seen at the site in Somaliland where parts of Boorama and Gabley avarage between 400mm - 500mm of rainfall, parts of Barbera receiving an average of 200mm- 300mm of rainfall while parts of Zeylac and Lughaya averaging 100mm of rainfall annually. The sites in Hirshabele is generally homogeneous with most of the site receiving within 200mm – 300mm of rainfall. Sites in Puntland generally receives the least amount of rainfall with most of the region receiving less than 100mm of rainfall in a year. Galmudug state generally receives an average of 200mm, however some parts of Ceel D Heer receive between 300mm - 400mm of rainfall.

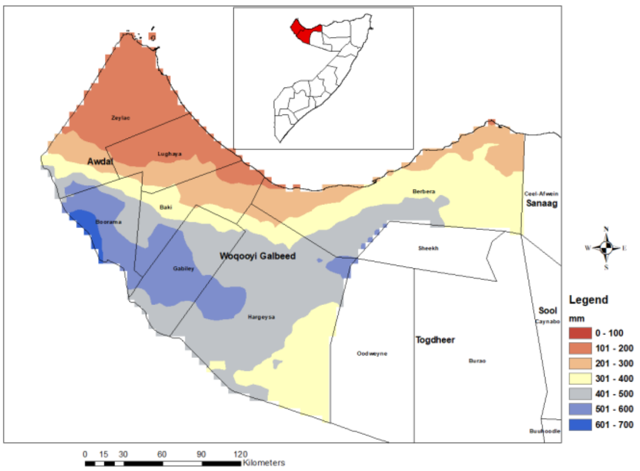


Figure 3.1-5 Annual maximum rainfall extremes 1981-2010 Awdal and Woqooyi Galbeed, Somaliland

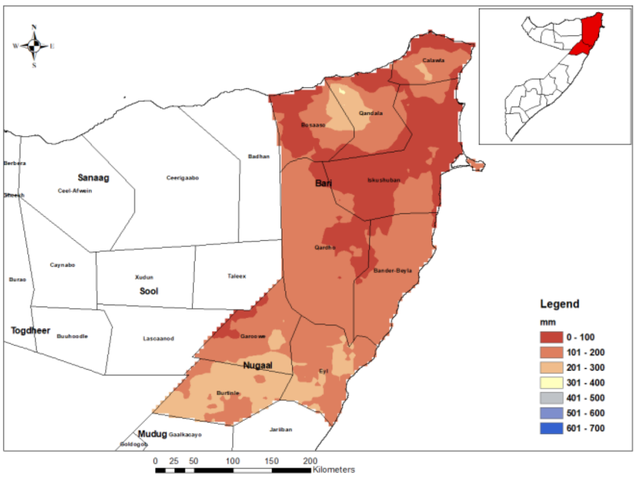


Figure 3.1-6 Annual maximum rainfall extremes 1981-2010 Bari and Nugal, Puntland

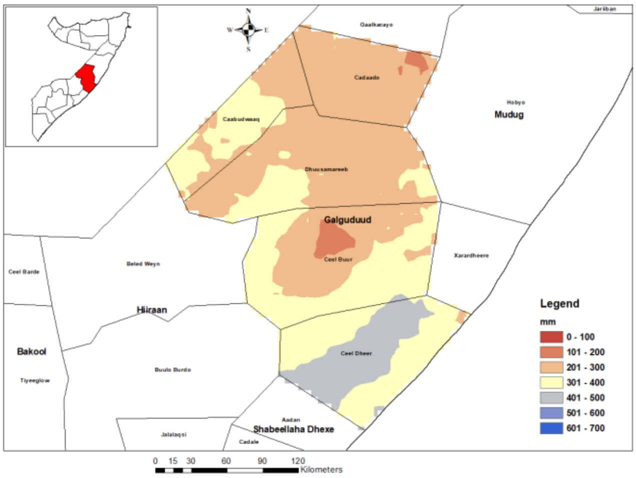


Figure 3.1-7 Annual maximum rainfall extremes 1981-2010 Galmudug

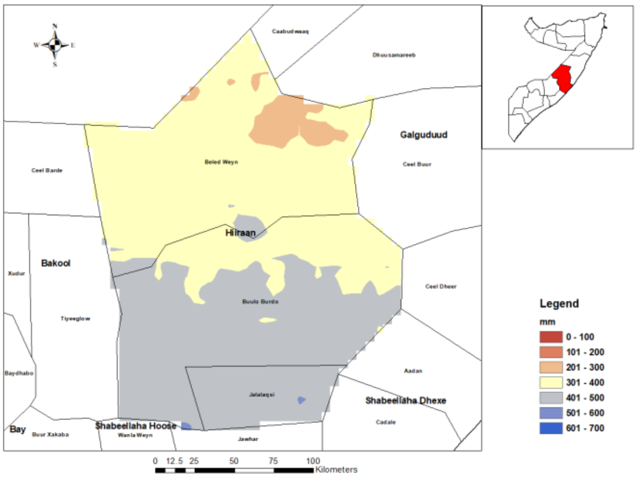


Figure 3.1-8 Annual maximum rainfall extremes 1981-2010 Hirshabelle

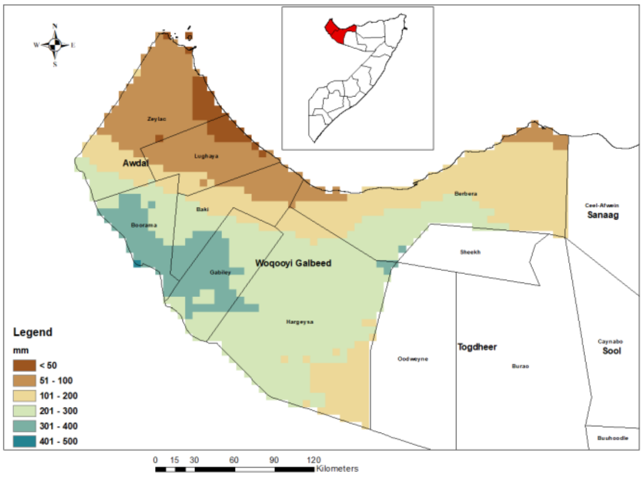


Figure 3.1-9 Annual minimum rainfall extremes 1981-2010 Awdal and Woqooyi Galbeed, Somaliland

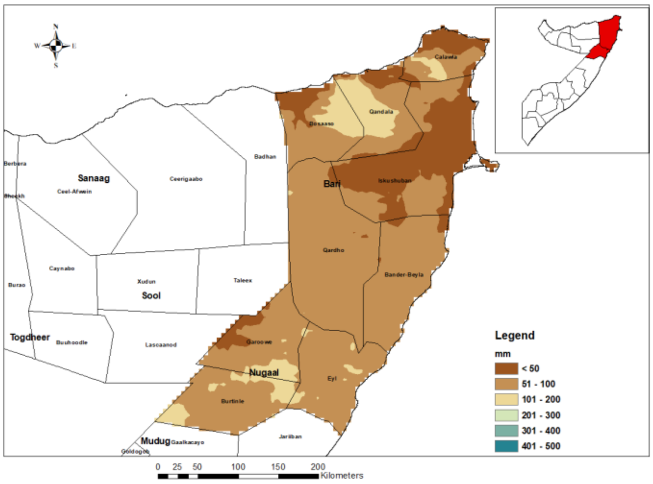


Figure 3.1-10 Annual minimum rainfall extremes 1981-2010 Bari and Nugal, Puntland

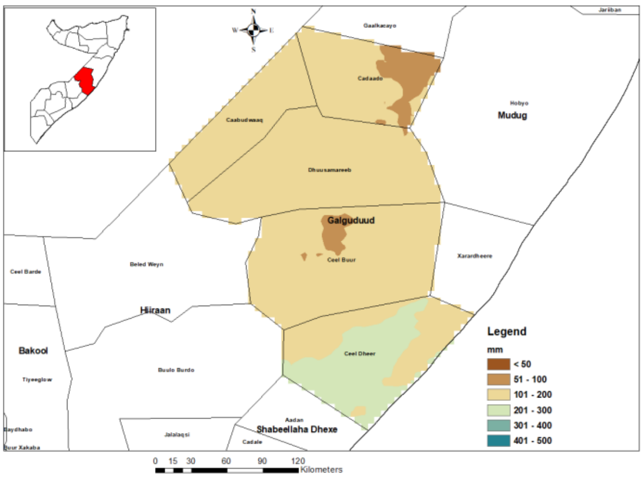


Figure 3.1-11 Annual minimum rainfall extremes 1981-2010 Galmudug

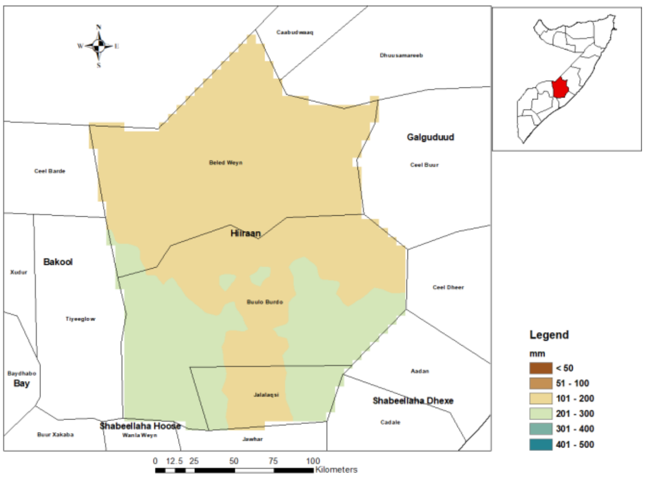


Figure 3.1-12 Annual minimum rainfall extremes 1981-2010 Hirshabelle

Climate extremes can have a severe consequences on social and economic systems, which makes analysis of rainfall extremes important for planning. **Figure 3.5-8** shows the rainfall amounts in the wettest years. In the administrative region of Awdal in Somaliland, parts of Boorasma receive 600-700mm of rainfall in its wettest years while parts of Zeylac receive 100-200mm of rainfall. Northern parts of Galmudug states receive 200-300mm of rainfall, while in the southern region, parts of Ceel D Heer receives 400-500 mm annually in its wettest year. In Hiirshabele states some parts of the region receive 300-400mm of rainfall while some parts receive 400 - 500mm of rainfall. The Bari and Nugal region in Puntland is the dries of the four sites generally receives about 100-200 mm of rainfall in the wettest years with some parts of Bari receiving less than 100mm of rainfall. **Figure 3.9-12** shows the rainfall amount in the driest years at the four sites. Hishabelle, Galmudug and Somaliland generally receive100-200mm of rainfall in the driest years. In Somaliland however, parts of Boorama and Gabiley however receive 300-400mm while other parts in Zeylac and Lughaya receiving less than 100mm.

3.2 Monthly and Seasonal Rainfall Climatology

Figure 3.2-1 presents the mean monthly rainfall based on rainfall station data in Beletweyne in Hirshabelle State. Somalia has two rainfall seasons, from April to June (Gu) and October to November (and sometimes September) (Deyr) (FGS, 2013). The highest amounts of rainfall seems to be April, May, October and November, while some rainfall is received in March, June, September and December.

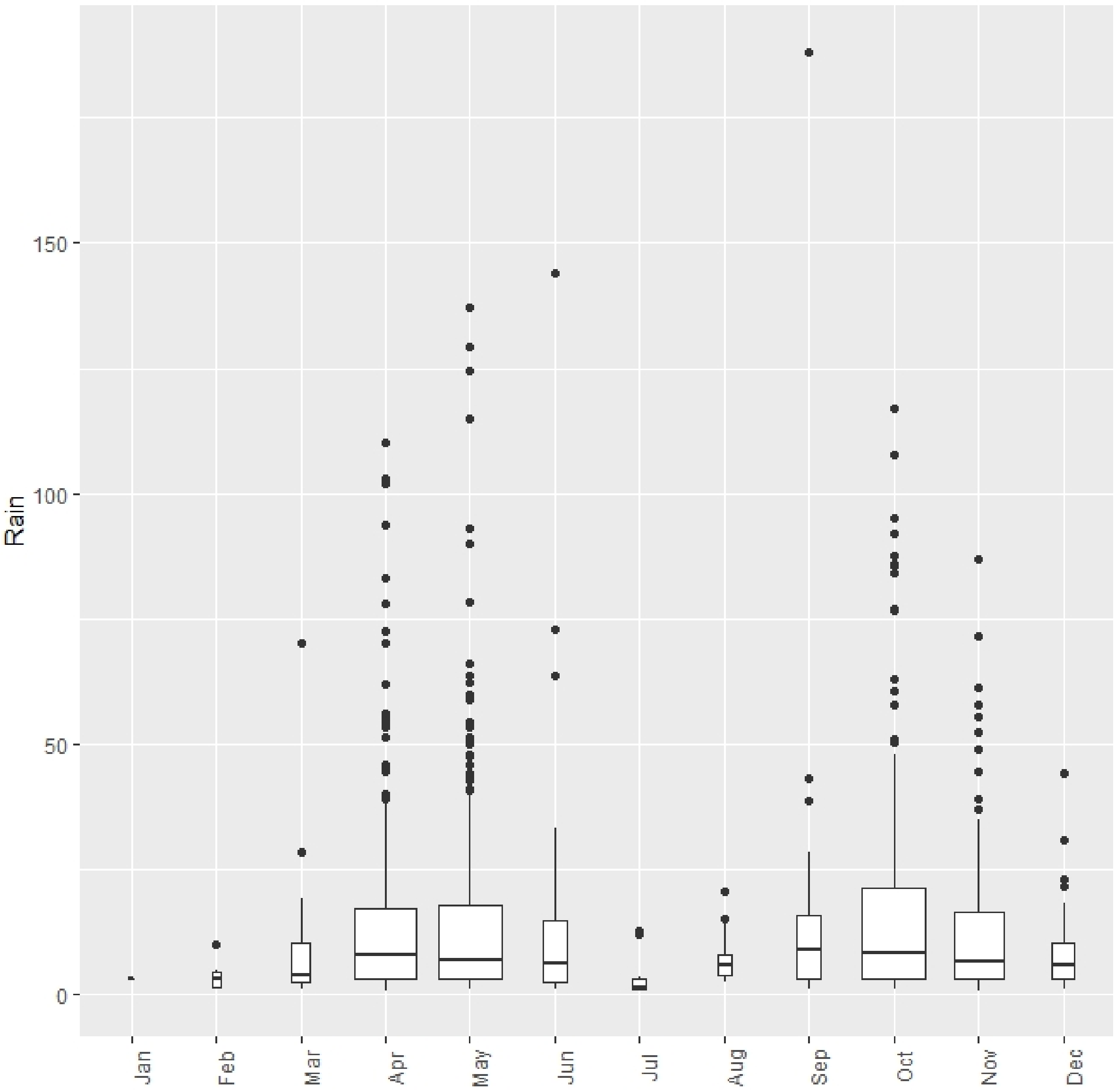
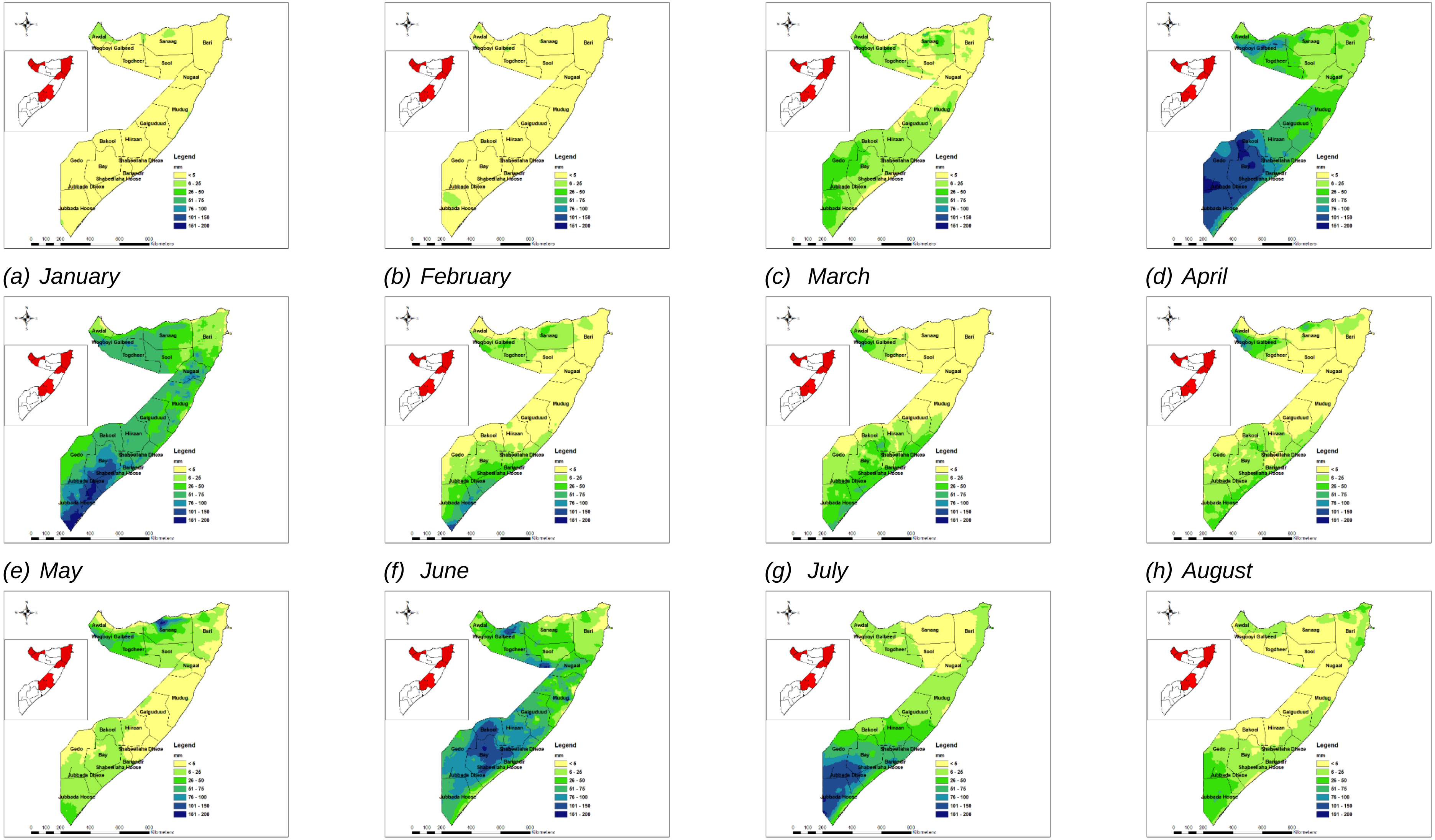


Figure 3.2-1 Monthly rainfall from Weather stations in Beletwayne (1944-2019)

Monthly rainfall distribution is shown in **Figure 3.2-2**. Results show that Galmudug and Hirshabelle receive more rainfall in the month of March than they do in June. Awdal in Somaliland also receives a more rainfall in the month of March than it does in June. Somaliland and Puntland both receive rainfall in the month of September, and some areas on all for sites receive rainfall in December. The seasonal data was therefore analysed for March to June (MAMJ) and September to December (SOND).



(a) January
(b) February
(c) March
(d) April
(e) May
(f) June
(g) July
(h) August
(i) September
(j) October
(k) November
(l) December

Figure 3.2-2 Monthly rainfall in Somalia

The spatial distribution of the Gu season for March - May (MAM) and October - December (OND) seasons are shown on **Figure 4.2-2** to **4.2-4**, while percent of the specific season contribution to annual rainfall is shown in **Figure 4.2-5** and **4.2-6**. The figures also highlight significant spatial rainfall differences even within the individual seasons that must be considered while developing climate resilient policies for the county.

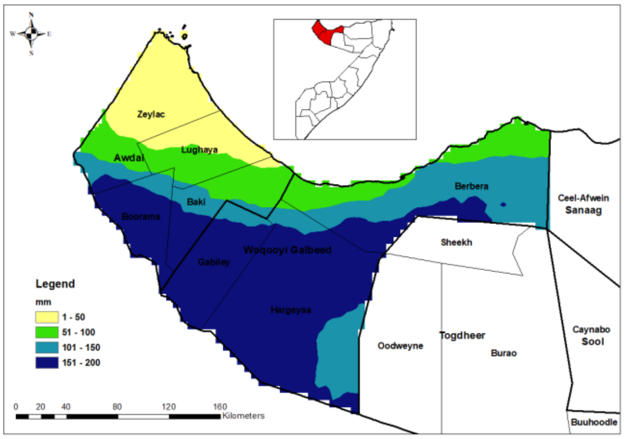


Figure 3.2-3 March – June (MAMJ) seasonal rainfall (1981-2010), Somaliland

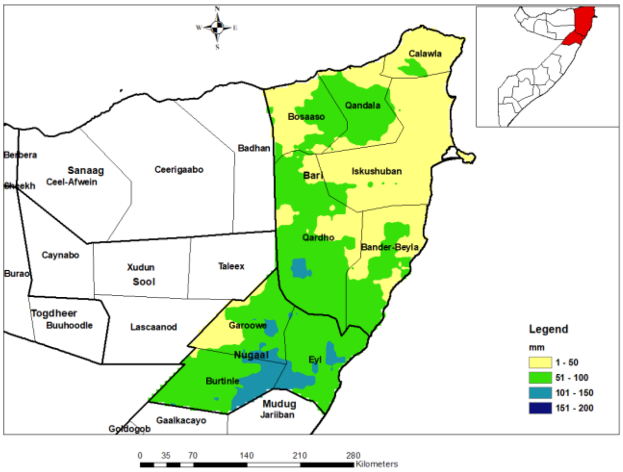


Figure 3.2-4 March – June (AMJ) seasonal rainfall (1981-2010), Puntland

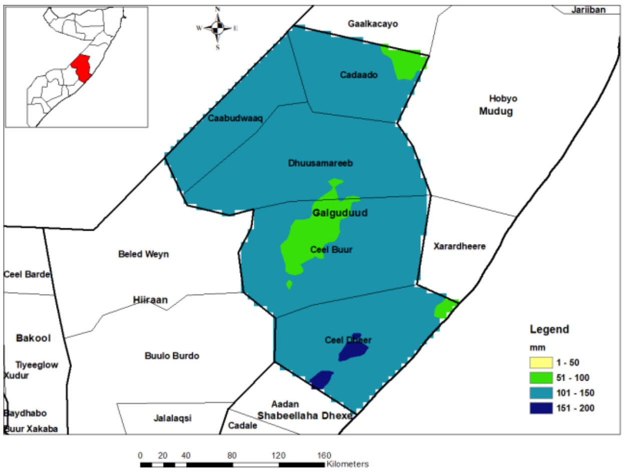


Figure 3.2-5 April – June (AMJ) seasonal rainfall (1981-2010), Galmudug

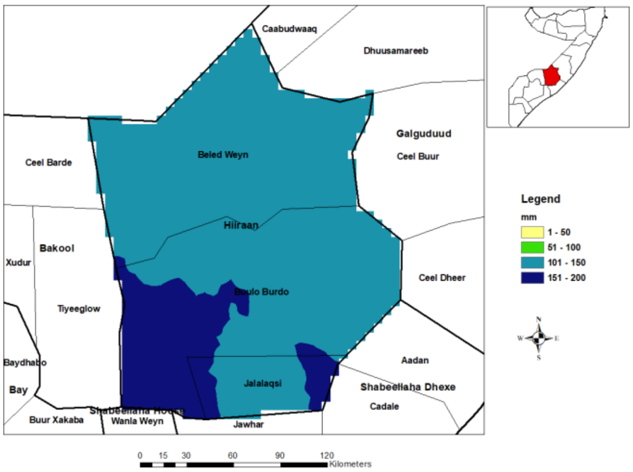


Figure 3.2-6 April – June (AMJ) seasonal rainfall (1981-2010), Hirshabelle

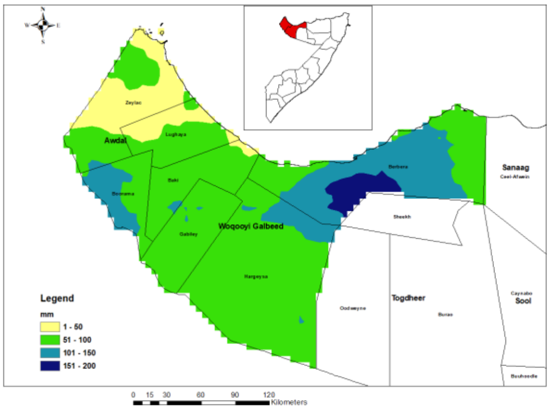


Figure 3.2-7 Sept – Dec (SOND) seasonal rainfall (1981-2010), Somaliland

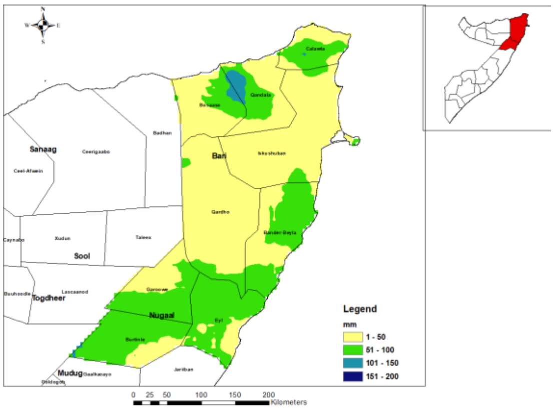


Figure 3.2-8 Sept – Dec (SOND) seasonal rainfall (1981-2010), Puntland

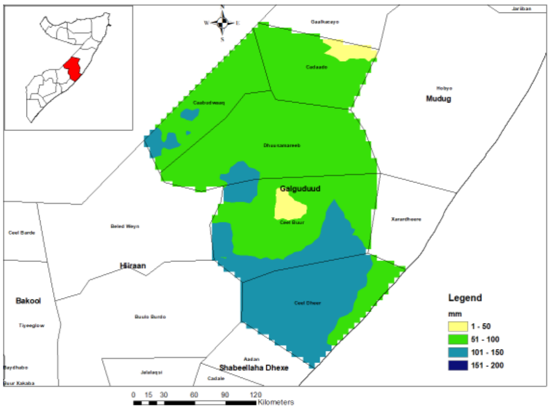


Figure 3.2-9 Sept – Dec (SOND) seasonal rainfall (1981-2010), Galmudug

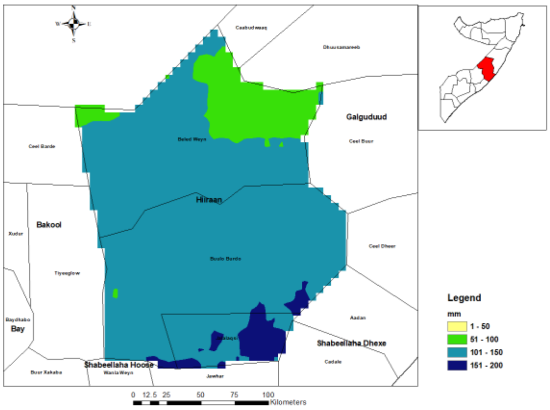


Figure 3.2-10 Sept – Dec (SOND) seasonal rainfall (1981-2010), Hirshabelle

The *Gu* season generally receives more rainfall in Somalia than the *Deyr* Season as shown in **Figure 3.2-10 and 3.2-11**. *Gu* season generally contributes over 50% of the annual total in Somalia, however some parts of Bari and Nugal in Puntland have over 50% of the annual total in the *Deyr* Season.

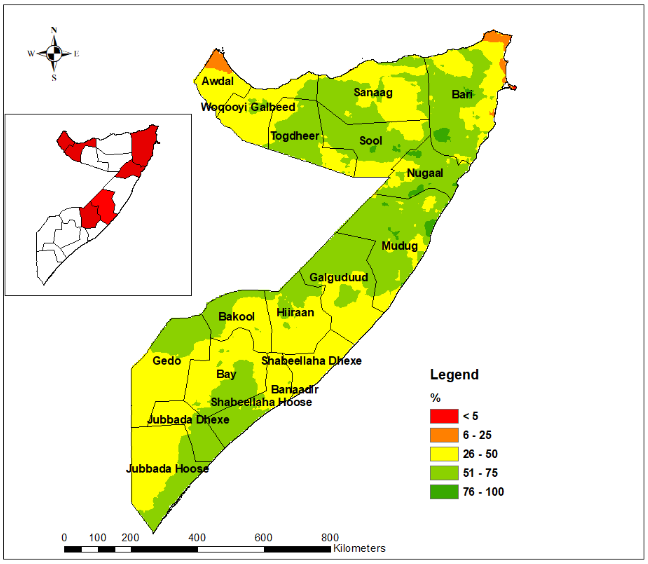


Figure 3.2-11 Seasonal Contribution of Gu (Apr – Jun) to annual total

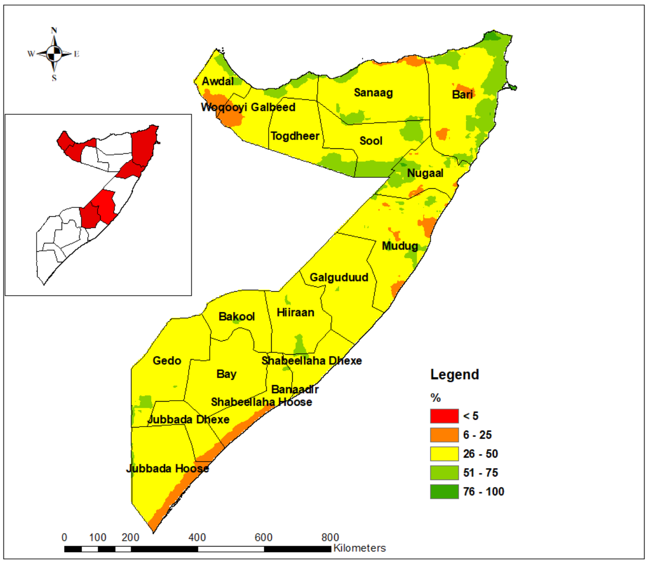


Figure 3.2-12 Seasonal Contribution of Deyr (Sept - Dec) to annual total

3.3 Inter-annual Variability

The rainfall anomalies for each season was derived by comparing the observed with the long term mean and standard deviation and the results represented in **Figure 3.3-1 – 8**. The figures indicate year to year variability of rainfall at all locations. The recurrences of high and low rainfall amounts are reflective of repetitions of excessive and deficit rainfall often associated with floods and droughts.

Some of these extremely wet and dry years occurred during El Niño / La Niña (ENSO) and negative / positive Indian Dipole years (Gedefaw, et al., 2018; Eshetu, Johansson, & Garedew, 2016; Hagos , Tesfaye, & Duncan, 2014). The standard El Niño / La Niña is represented by Oceanic Niño Index (ONI) quantified from mean Sea Surface Temperatures (SST) anomalies in the Niño 3.4 region (**5ºN-5ºS, 120º-170ºW**).

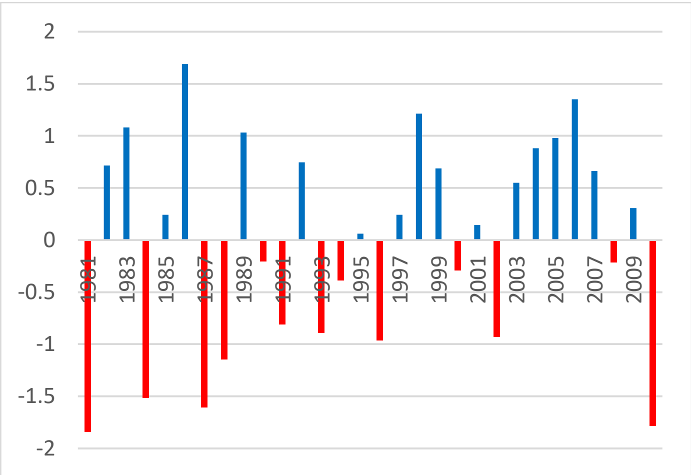


Figure 3.3-1 Rainfall anomaly in March to June (1981–2010), Somaliland

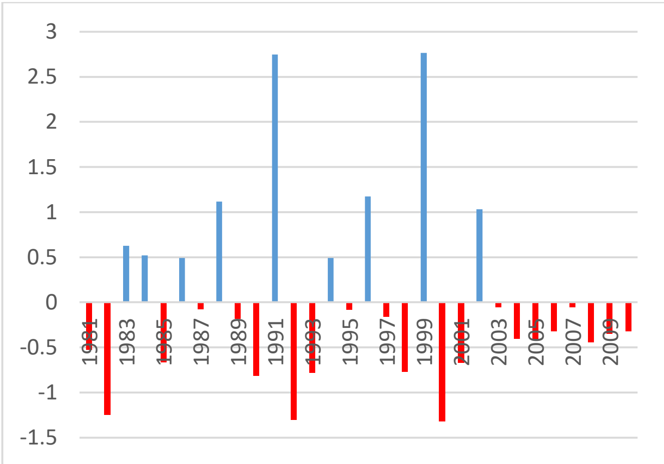


Figure 3.3-2 Rainfall anomaly in Sept to Dec (1981–2010), Somaliland

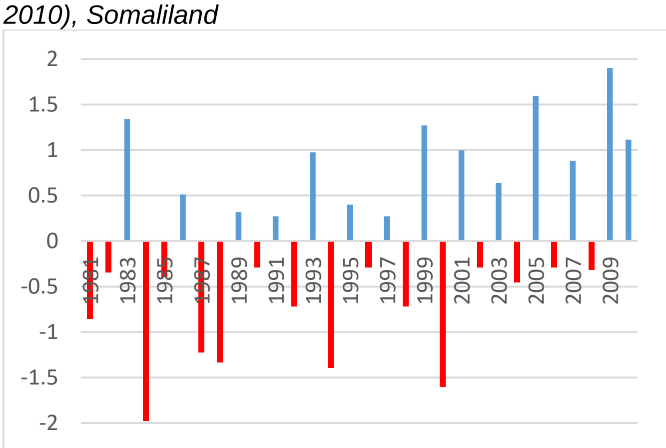


Figure 3.3-3 Rainfall anomaly in March to June (1981–2010), Puntland

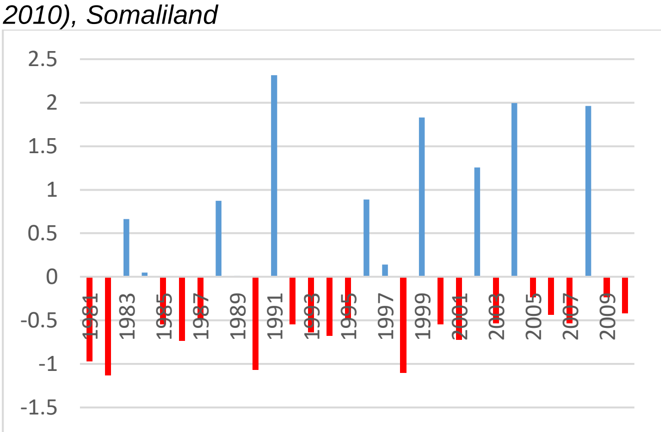


Figure 3.3-4 Rainfall anomaly in Sept to Dec (1981–2010), Puntland

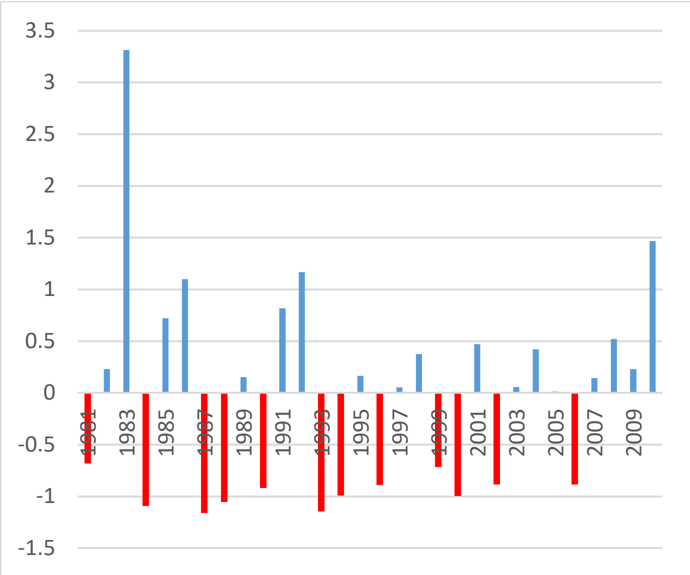


Figure 3.3-5 Rainfall anomaly in March to June (1981–2010), Galmudug

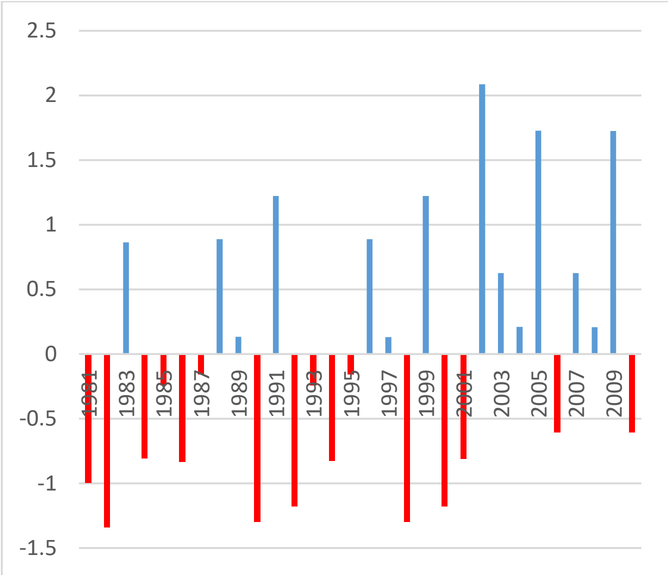


Figure 3.3-6 Rainfall anomaly in Sept to Dec (1981–2010), Galmudug

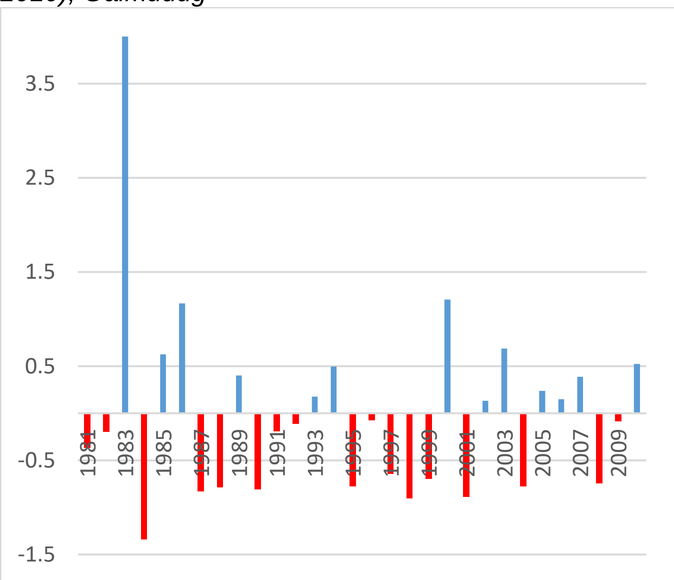


Figure 3.3-7 Rainfall anomaly in March to June (1981–2010), Hirshabelle

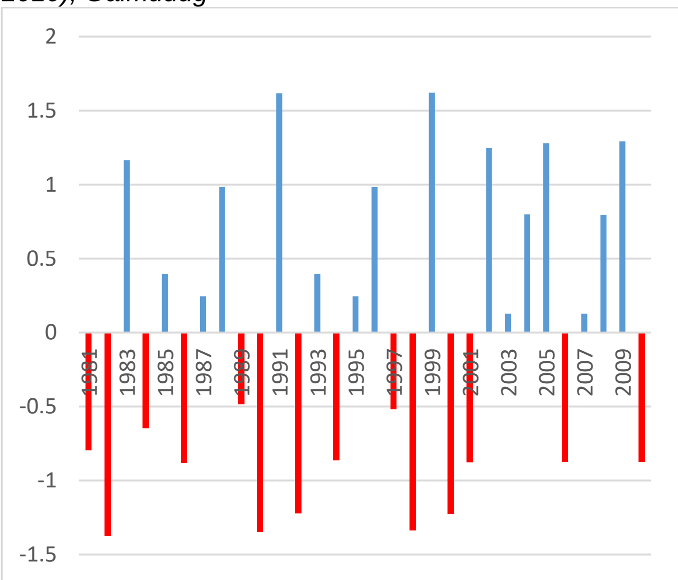


Figure 3.3-8 Rainfall anomaly in Sept to Dec(1981–2010), Hirshabelle

Global annual patterns for El Niño / La Niña years and IOD events during the years examined in this report are shown in **Figure 3.3-9 and Table 1 and 2.** The graphs in **Figure 3.3-1-8** shows significant extreme rainfall persisting over many years during some El Niño years, while the opposite is true for La Niña years. In general both ENSO and IOD had significant impacts on the county rainfall more evident impacts in OND season. This calls for more research to enhance ENSO/IOD and County rainfall anomalies teleconnection knowledge. In

Somalia most studies have indicated below/ above normal rainfall associated with El Nino / La Nina (Ogallo L. A., 2018; Ogallo, Ouma, & Omondi, 2017; Funk, Husak, & Michaelsen, 2013; Hutchinson , 1992).

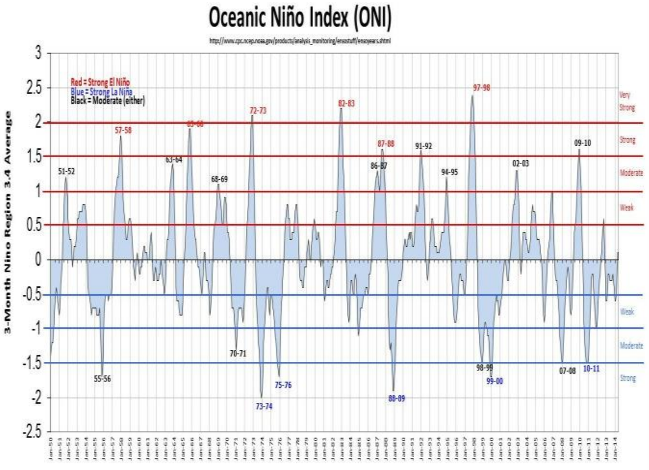


Figure 3.3-9 El Nino/ La Nina index quantified by Nino 4.3 ONI index (NOAA)

Table 1: Major +IOD Years, 1960 - 2016*(NOAA)*

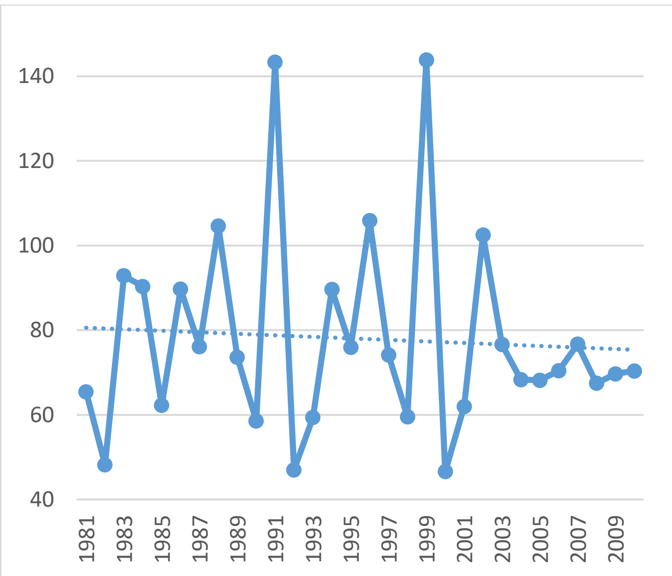
1961	1963	1972	1982	1983	1994
1997	2006	2012	2015		

Table 2: Major -IOD Years, 1960-2016 (NOAA)

1960	1964	1974	1981	1989	1992
1996	1998	2010	2014	2016	

3.4 Rainfall Trends

Trends define the long term pattern of the rainfall time series at the specific location. Negative/positive trends indicate decreasing/increasing mean rainfall tendency (**Figure 3.4-1-8**). Results show that the rainfall trend varies spatially and seasonally. Somaliland, Galmudug and Hirshabelle seems to have experienced a negative trend in the *Gu* season and a positive trend in the *Deyr* season. Puntland on the other hand seems to be experiencing a positive rainfall trend in all seasons. The observed trends are however not statistically significant.



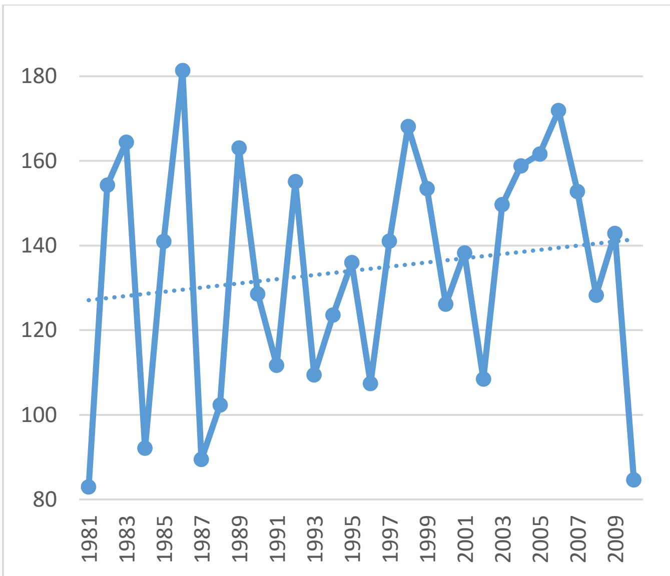


Figure 3.4-1 MAMJ Rainfall totals in March to May Season at the Somaliland site

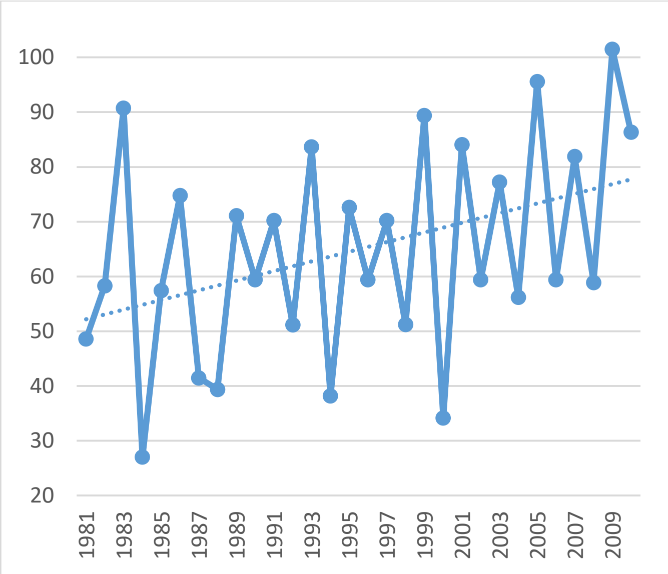


Figure 3.4-2 SOND Rainfall totals in Sept to Dec Season at the Somaliland site

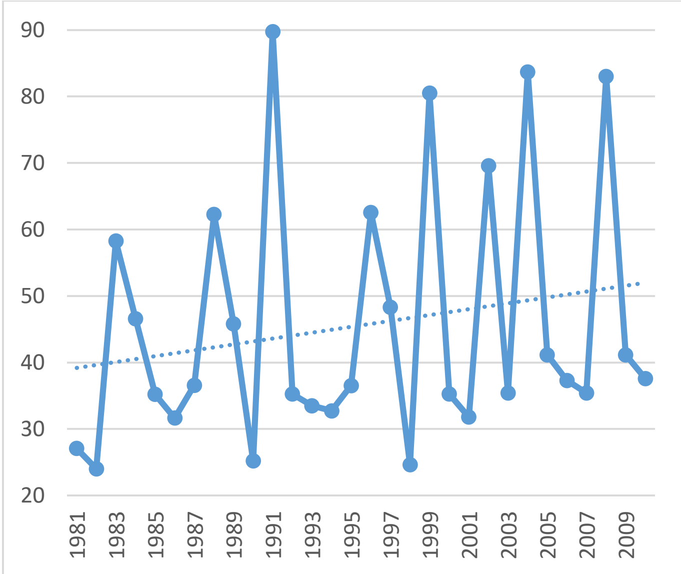


Figure 3.4-3 MAMJ Rainfall totals in March to May Season at the Puntland site

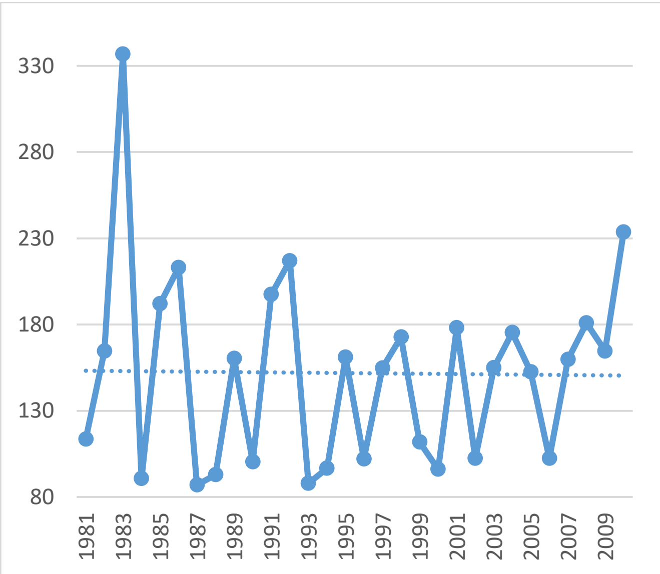


Figure 3.4-4 SOND Rainfall totals in Sept to Dec Season at the Puntland site

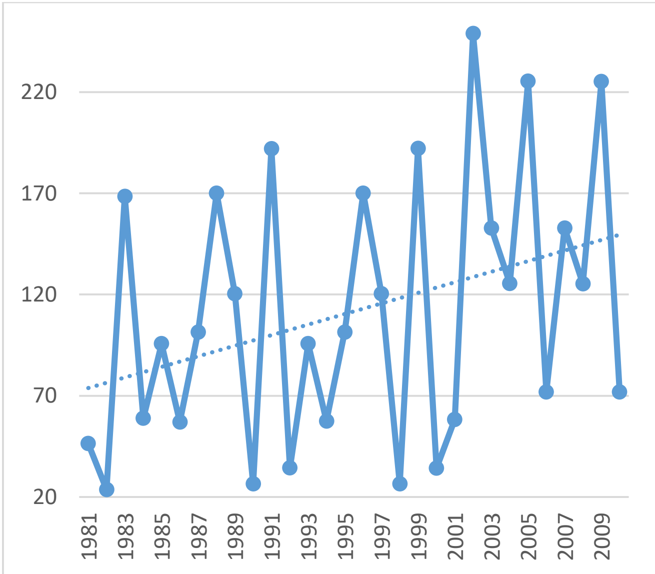


Figure 3.4-5 MAMJ Rainfall totals in March to May Season at the Galmudug site

Figure 3.4-6 SOND Rainfall totals in Sept to Dec Season at the Galmudug site

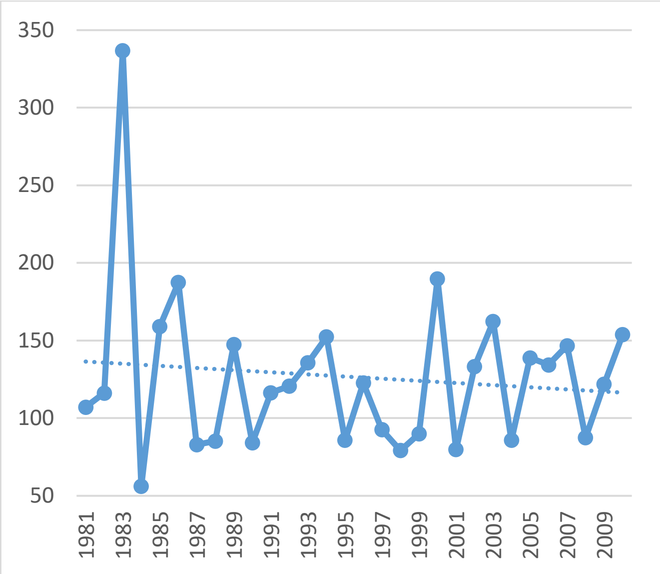


Figure 3.4-7 MAMJ Rainfall totals in March to May Season at the Hirshabelle site

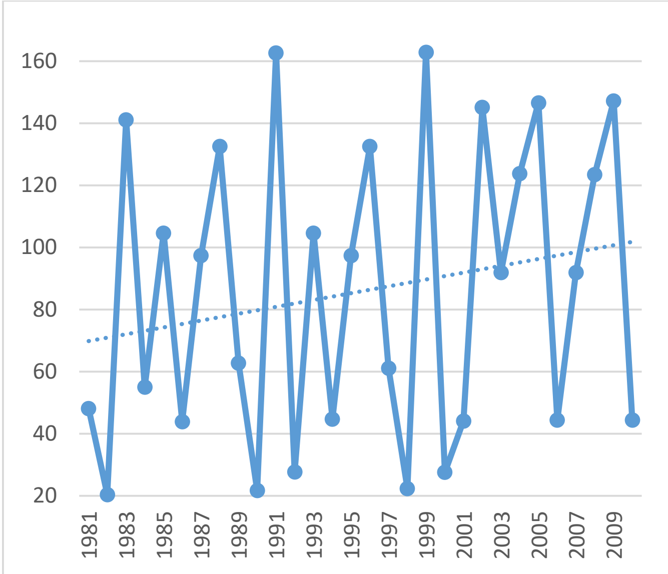


Figure 3.4-8 SOND Rainfall totals in Sept to Dec Season at the Hirshabelle site

While the average trend for a region is important for regional planning, location specific trends play an in important role in helping communities make long term plans. Figure 3.4-8&9 shows a plot of the long term rainfall from a rainfall station in Beletweyne, which shows that while the area is experiencing a generally negative trend during the *Gu* season, the location is experiencing a slightly positive one.

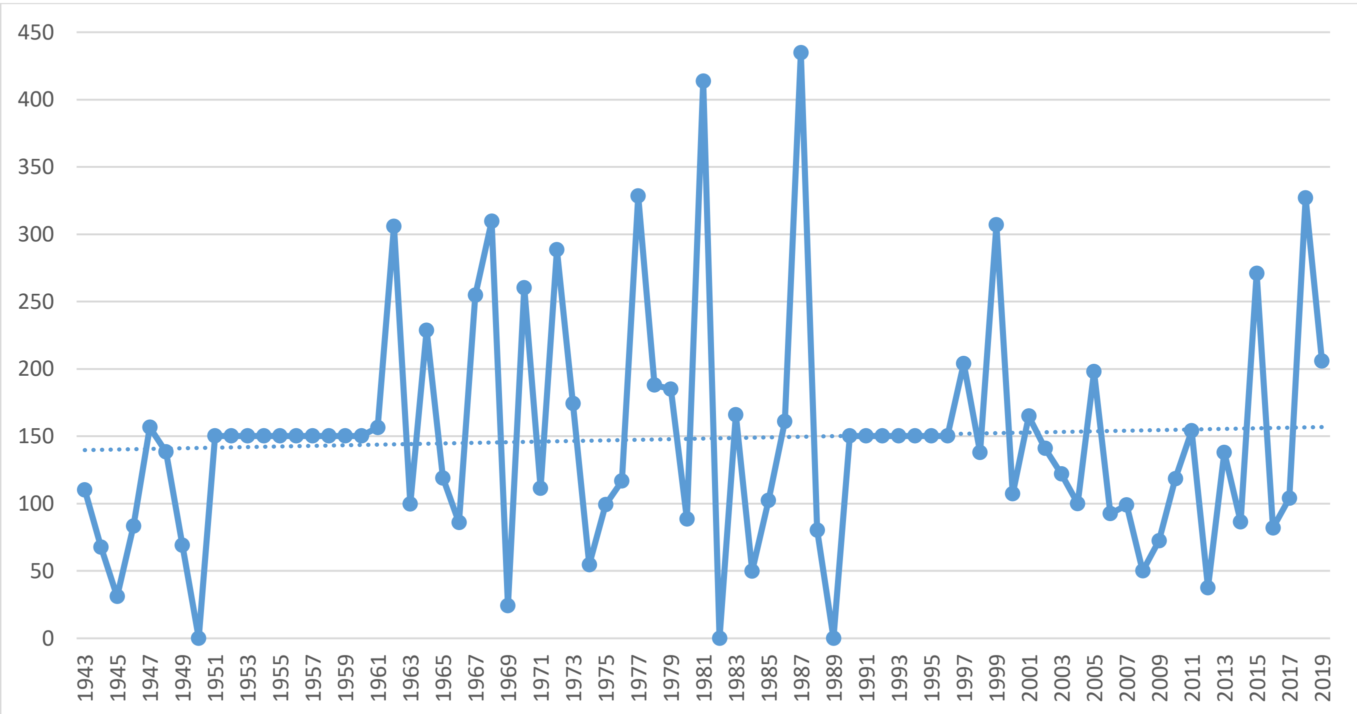


Figure 3.4-9 MAM Rainfall totals in March to May Season Beletwayne (data from rainfall station, missing data from 1951-60 and 1990-96 was substituted using the long term mean)

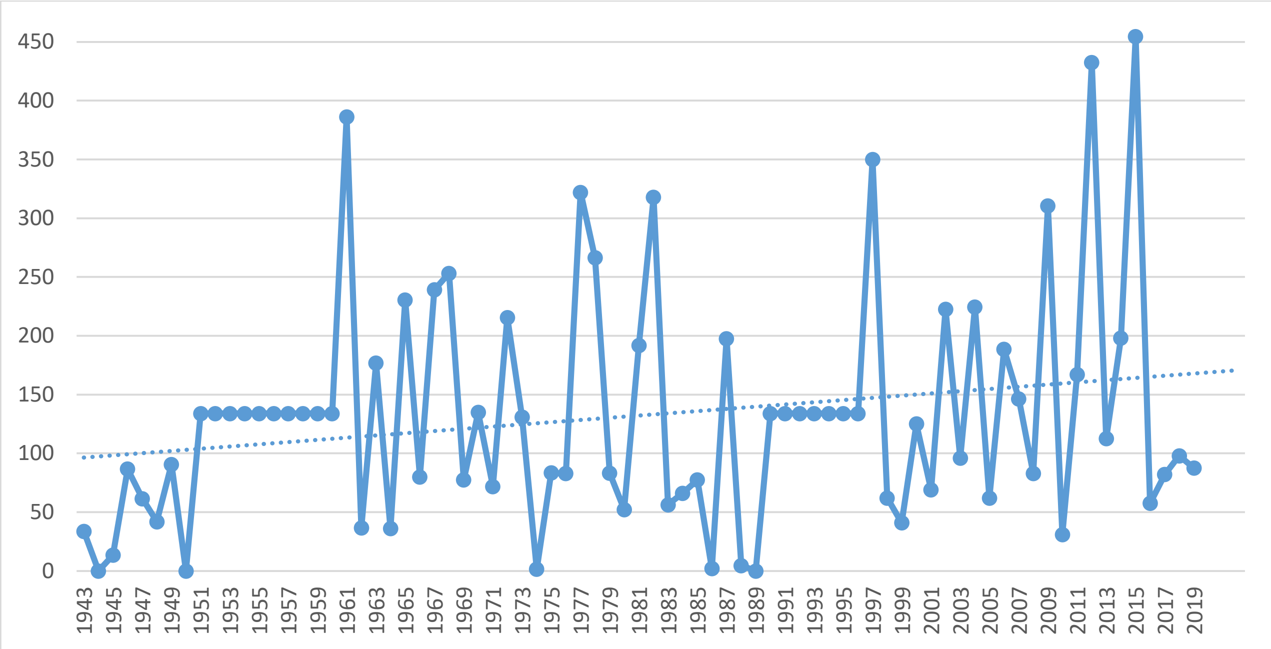


Figure 3.4-10 SOND Rainfall totals in March to May Season Beletwayne from 1940 to 2020 (data from rainfall station, missing data from 1951-60 and 1990-96 was filled in using the long term mean)

Figure 3.4-11 – 18 show spatial variability in the observed trend during the *Gu* and *Deyr* season at the project sites in Somaliland, Puntland, Galmudug and Hirshabelle. Results show that rainfall trend differ spatially, like in Somaliland, where the general trend is positive during the *Deyr* season, there are areas experiencing a negative trend. The rate of change in rainfall also differs in magnitude.

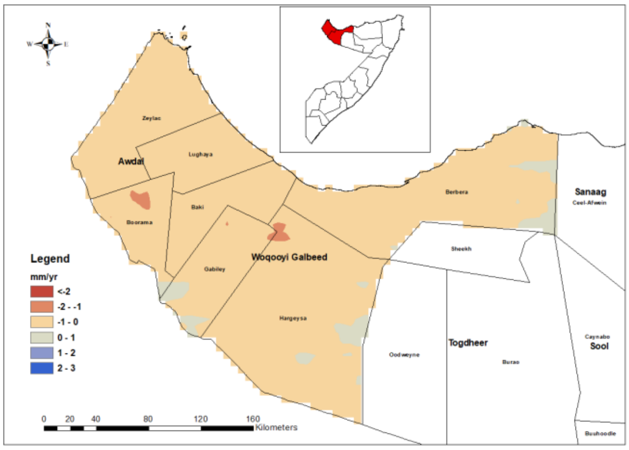


Figure 3.4-11 MAMJ Trend per year in March to June Season at the Somaliland site

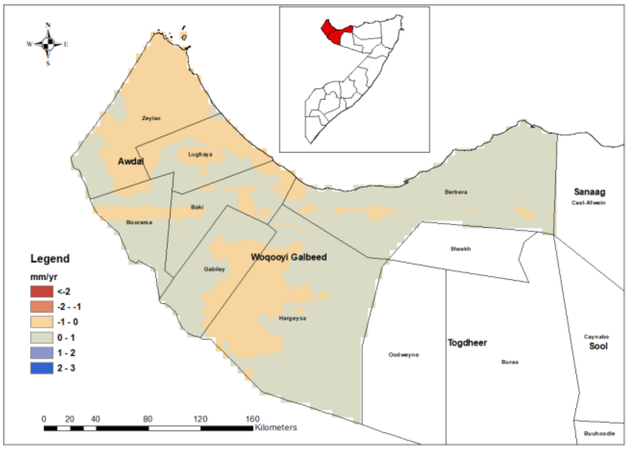


Figure 3.4-12 SOND Trend per year in Sept to Dec Season at the Somaliland site

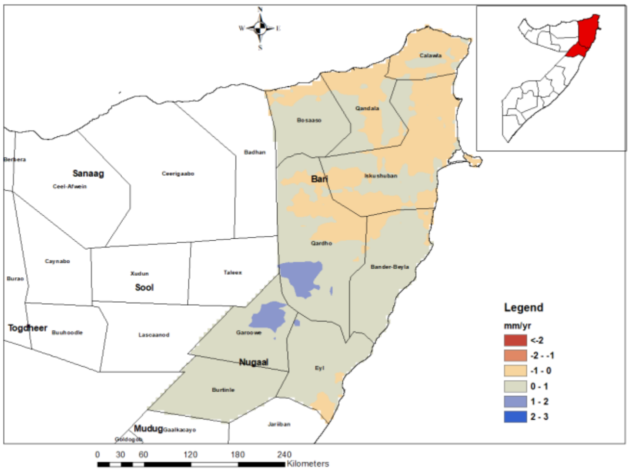


Figure 3.4-13 MAMJ Trend per year in March to June Season at the Puntland site

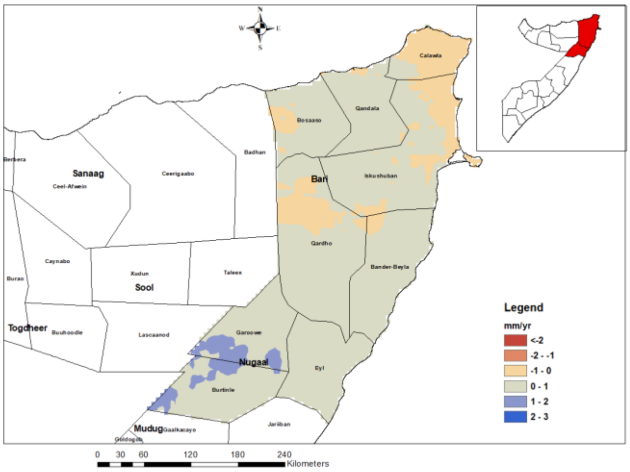


Figure 3.4-14 SOND Trend per year in Sept to Dec Season at the Puntland site

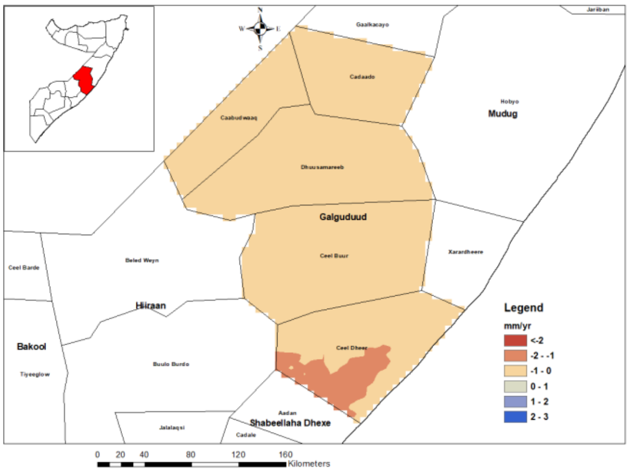


Figure 3.4-15 MAMJ Trend per year in March to June Season at the Galmudug site

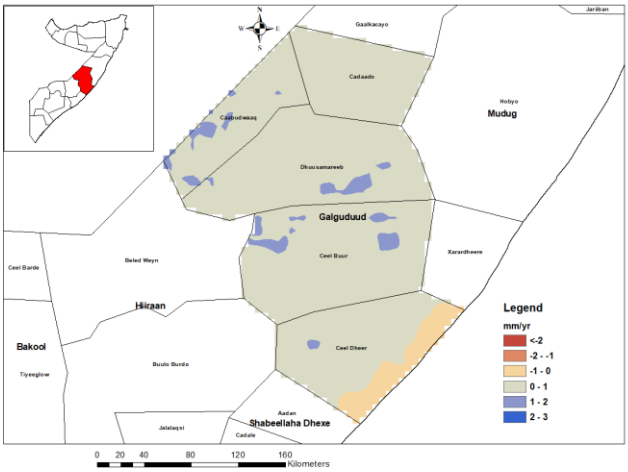


Figure 3.4-16 SOND Trend per year in Sept to Dec Season at the Galmudug site

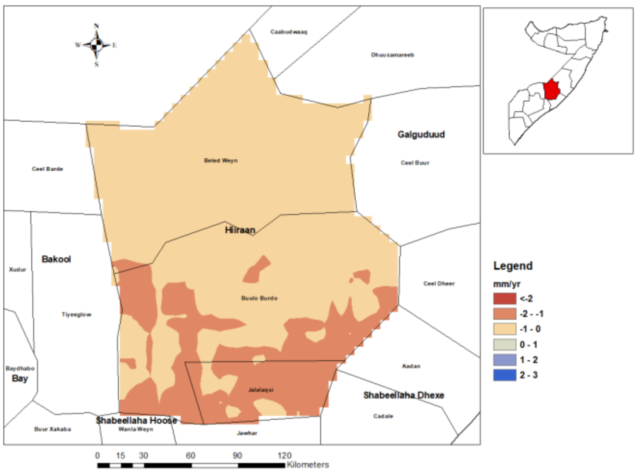


Figure 3.4-17 MAMJ Trend per year in March to June Season at the Hirshabelle site

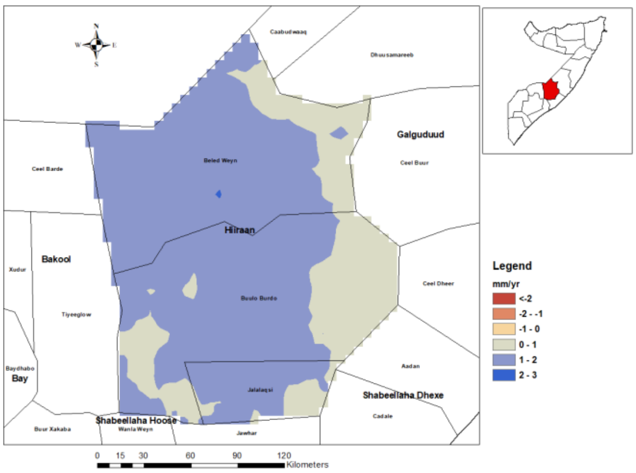


Figure 3.4-18 SOND Trend per year in Sept to Dec Season at the Hirshabelle site

Pastoral movement from season to season in Somalia is usually based on pasture and water availability (UNDP, 2011; Little, 2004). It can therefore be concluded that movement of pastoralists into areas experiencing a decreasing trend in rainfall is bound to change to areas experiencing increasing rainfall. Some parts of Somalia have dug boreholes to reduce movement in search of water and reduce dependence on rainfall, however, the sedentary lifestyle has resulted in issues of land degradation due to overgrazing (USAID, 2014; Gomes, 2006; Thurow et al.1989).

3.5 Mean Rainfall intensity

Rainfall intensity represents the amount of rainfall received per specific unit time. The parameter may reflect surface runoff, rain water erosion potentials, etc. Mean rainfall intensity presented in this section were derived from the amount of rainfall in mm per day. **Figure 3.5-1 to 3.5-8** show significant differences in the spatial patterns of rainfall intensity particularly in the *Gu* and *Deyr* season. Variability in rainfall is observed as the mean intensity of rainfall differs spatially. Somaliland shows the greatest variability particularly in the *Gu* season with parts of Boorama and Gabiley receiving the most intense rainfall while Zeylack and Lughaya receiving the lowest rainfall intensity as seen in **Figure 3.5-1**. Results are similar to the patterns on the total rainfall in the region displayed in **Section 3.2**. The next section provides some highlight on the variance characteristics of rainfall intensity.

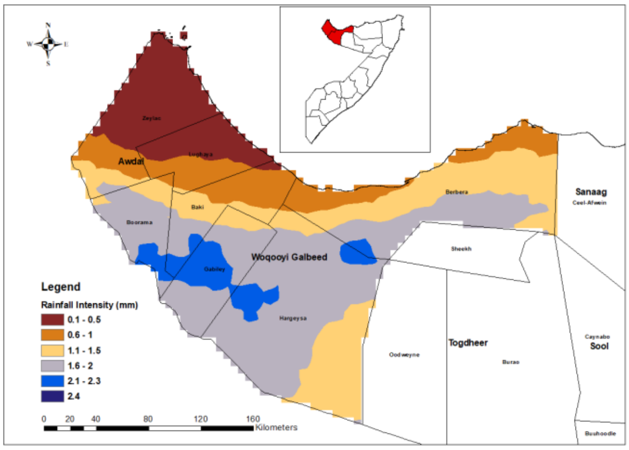


Figure 3.5-1 Seasonal Rainfall Intensity for Gu (MAMJ) at the Somaliland site (1981-2010)

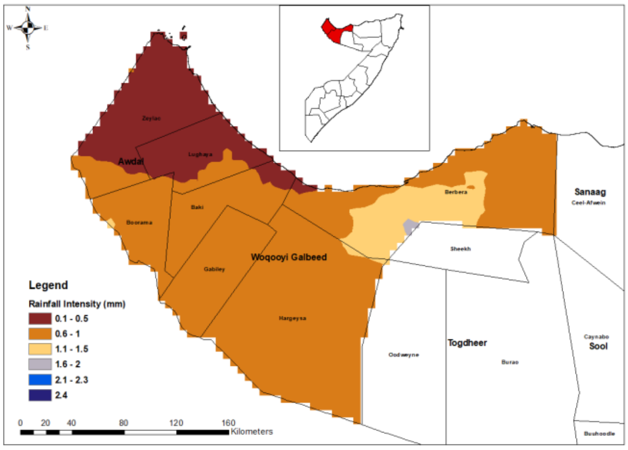


Figure 3.5-2 Seasonal Rainfall Intensity for Deyr (SOND) at the Somaliland site (1981-2010)

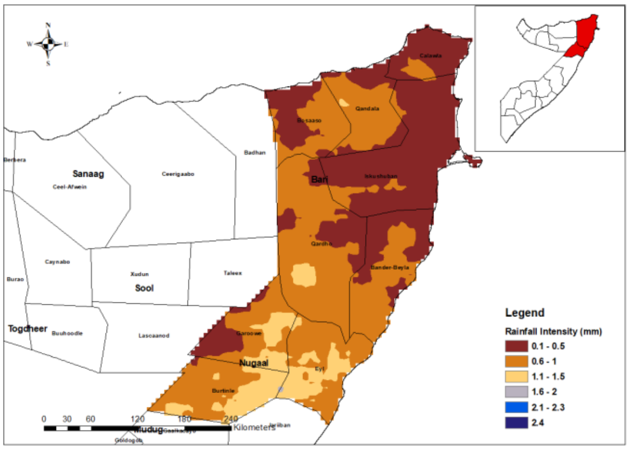


Figure 3.5-3 Seasonal Rainfall Intensity for Gu (MAMJ) at the Puntland site (1981-2010)

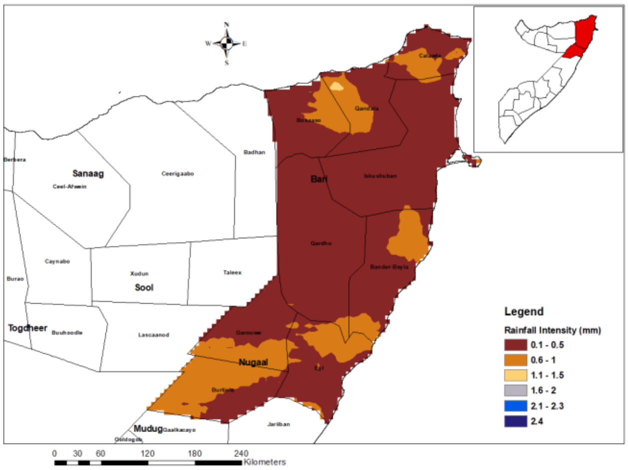


Figure 3.5-4 Seasonal Rainfall Intensity for Deyr (SOND) at the Puntland site (1981-2010)

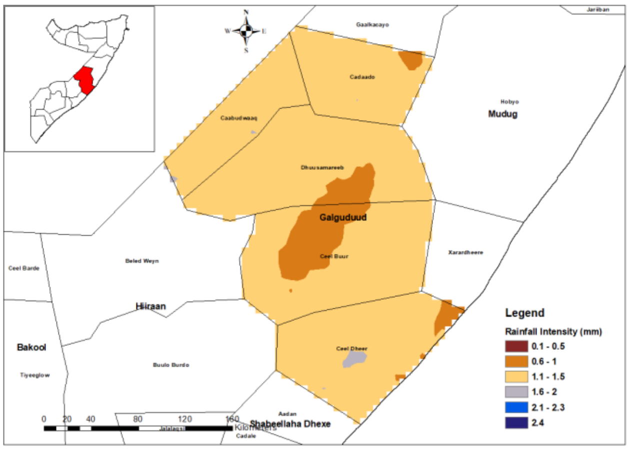


Figure 3.5-5 Seasonal Rainfall Intensity for Gu (MAMJ) at the Galmudug site (1981-2010)

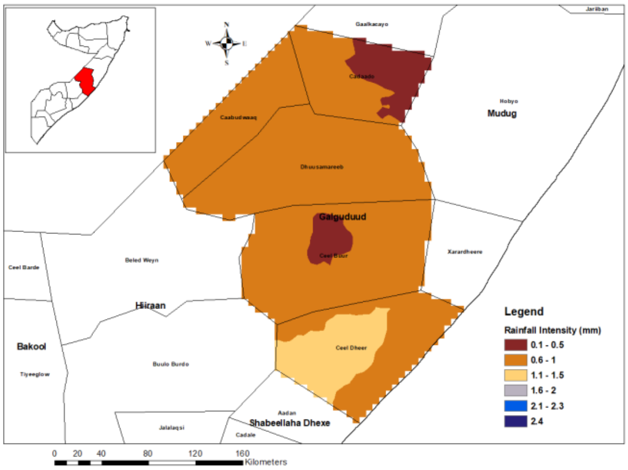


Figure 3.5-6 Seasonal Rainfall Intensity for Deyr (SOND) at the Galmudug site (1981-2010)

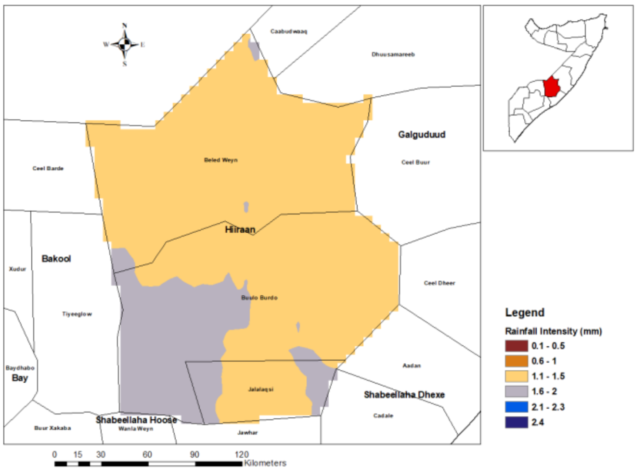


Figure 3.5-7 Seasonal Rainfall Intensity for Gu (MAMJ) at the Hirshabelle site (1981-2010)

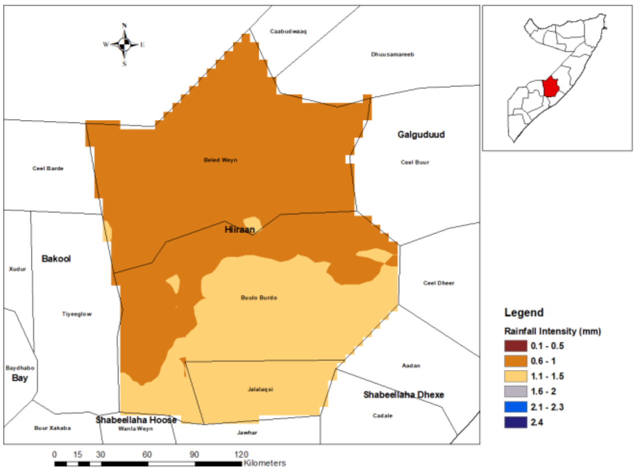


Figure 3.5-8 Seasonal Rainfall Intensity for Deyr (SOND) at the Hirshabelle site (1981-2010)

3.5.1. Observed Variance in Rainfall intensity

This section presents the degree of variability of rainfall intensity within the sites using coefficient of rainfall variability index. **Figures 3.5-9 to 3.5-16** show that the rainfall intensity is generally less variable during *Gu* season than during *Deyr* season. Such knowledge is very critical for climate risk management planning purposes for the district.

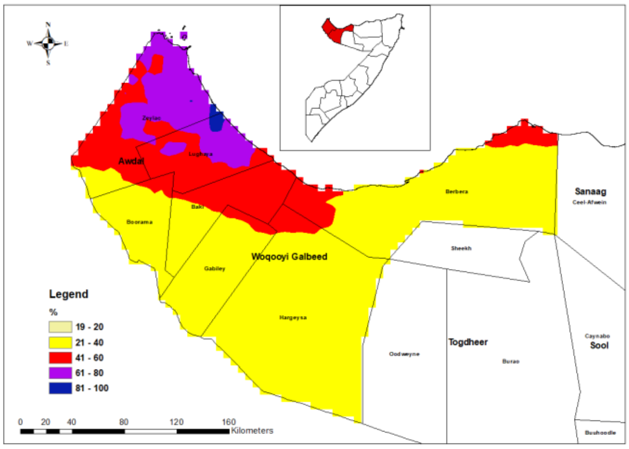


Figure 3.5-9 Gu (MAMJ) Rainfall Intensity: Coefficient of Variance (1981-2010) at the Somaliland site

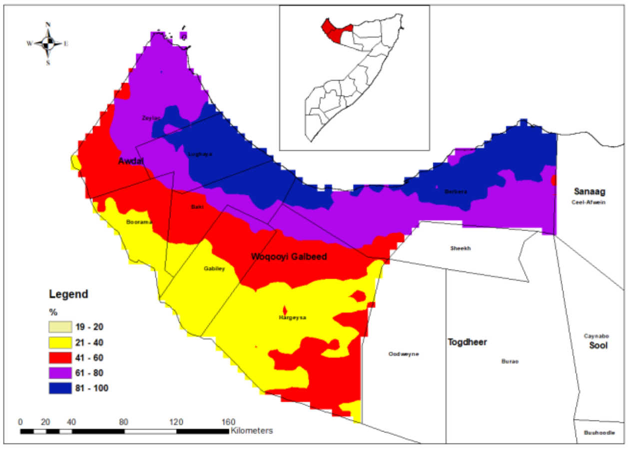


Figure 3.5-10 Deyr (SOND) Rainfall Intensity: Coefficient of Variance (1981-2010) at the Somaliland site

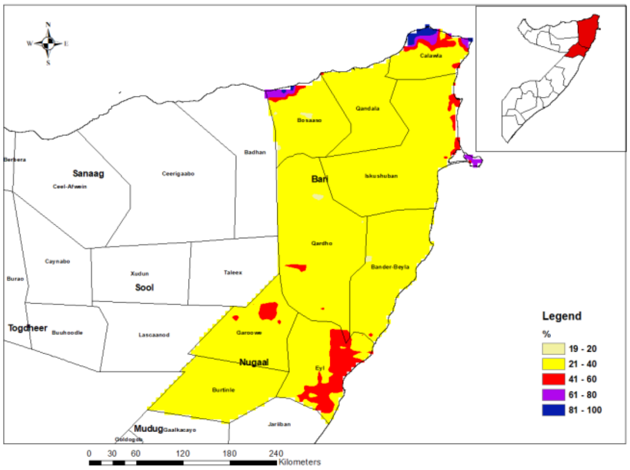


Figure 3.5-11 Gu (MAMJ) Rainfall Intensity: Coefficient of Variance (1981-2010) at the Puntland site

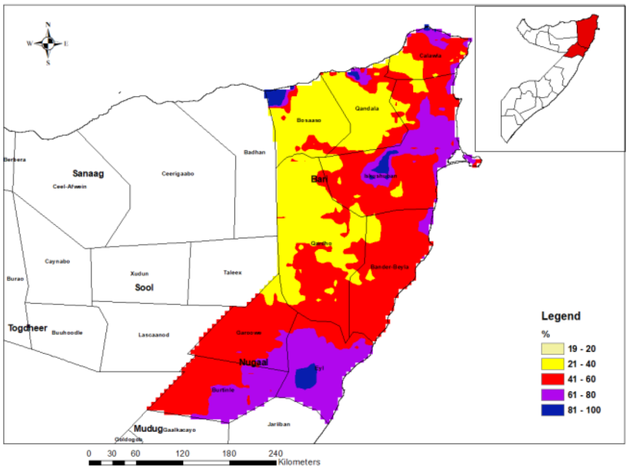
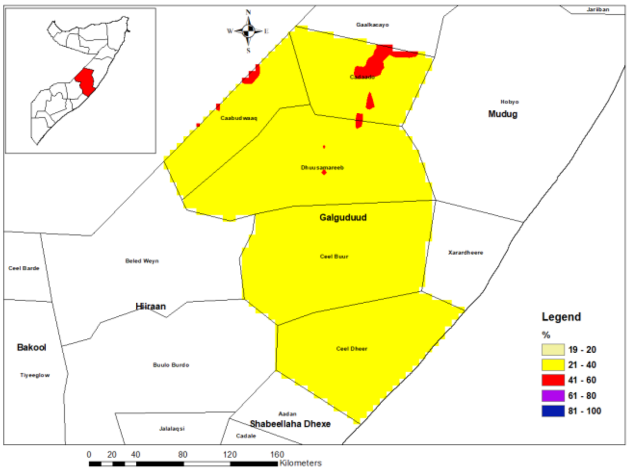


Figure 3.5-12 Deyr (SOND) Rainfall Intensity: Coefficient of Variance (1981-2010) at the Puntland site



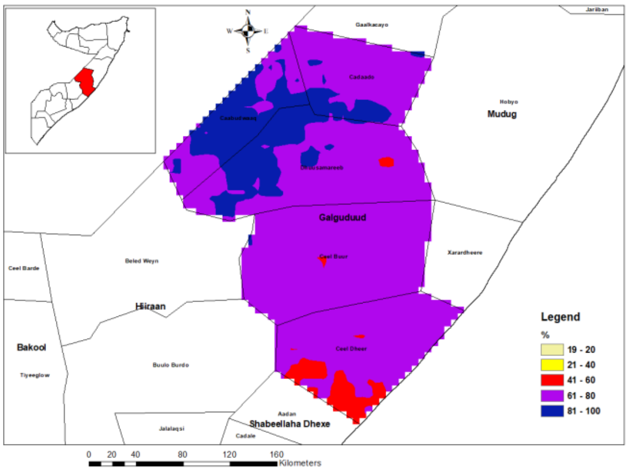


Figure 3.5-13 Gu (MAMJ) Rainfall Intensity: Coefficient of Variance (1981-2010) at the Galmudug site

Figure 3.5-14 Deyr (SOND) Rainfall Intensity: Coefficient of Variance (1981-2010) at the Galmudug site

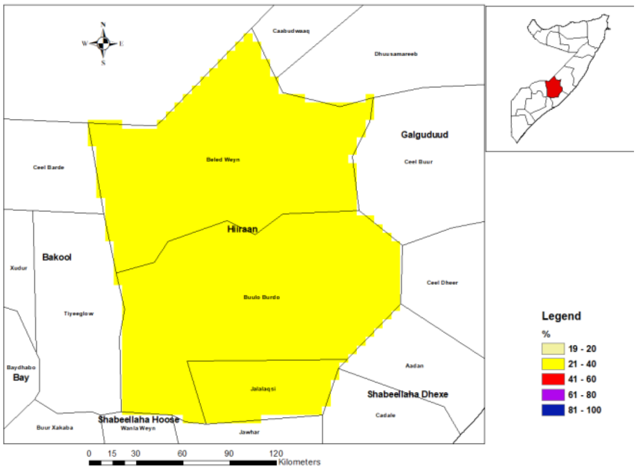


Figure 3.5-15 Gu (MAMJ) Rainfall Intensity: Coefficient of Variance (1981-2010) at the Hirshabelle site

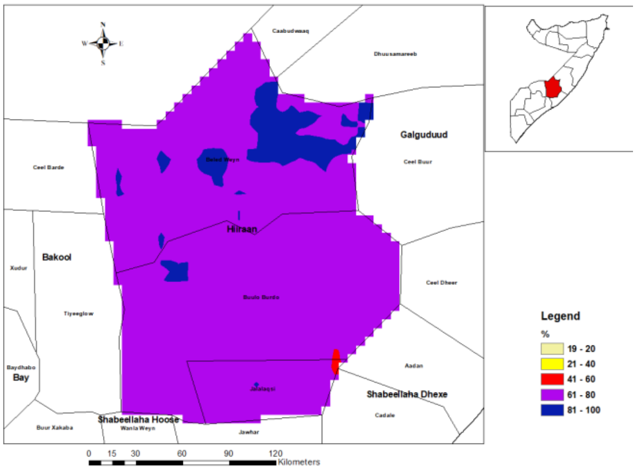


Figure 3.5-16 Deyr (SOND) Rainfall Intensity: Coefficient of Variance (1981-2010) at the Hirshabelle site

3.5.2. Probability of Exceeding Specific Rainfall Thresholds

Many activities that use water have critical thresh hold rainfall needs outside which some degree of stress thresholds for the specific water use. This section presents the probability of receiving rainfall intensity exceeding 5mm per day in Somalia (**Figure 5.5-17 & 3.5-18**). The figures show that the probabilities were generally low in the entire country in both *Gu* and *Deyr* seasons.

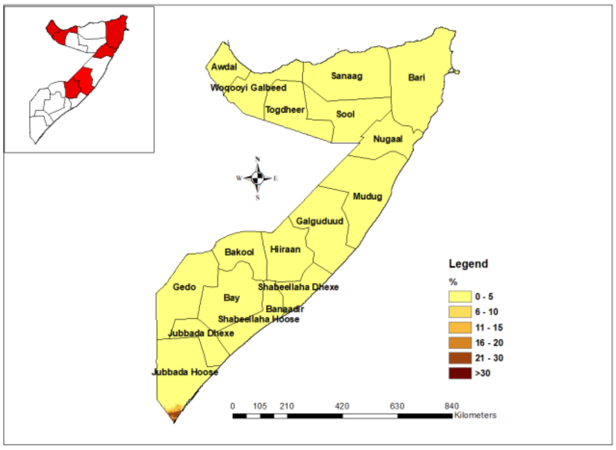


Figure 3.5-17 Probability of Rainfall intensity exceeding 5 mm a day Gu (MAMJ) Seasons (1981-2010) in Somalia

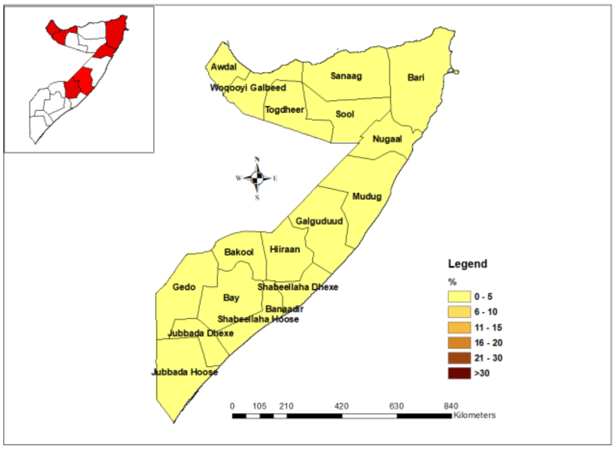


Figure 3.5-18 Probability of Rainfall intensity exceeding 5 mm a day Deyr (SOND) (1981-2010) in Somalia

3.6 Mean Wet Days

A threshold for a wet day was set as a day receiving 1mm or more rainfall per day, while any day receiving less than 1mm per day is set as a dry day. The characteristics of wet/ dry days are very important for many farming activities including application of fertilizer, spraying, movement of heavy farm machines, construction, etc. This section presents the characteristics of wet days at the county for MAMJ and SOND Months. The results as seen in **Figures 3.6-1 to 6.6-8** shows that the number of wet days in during the Gu season are between 1 - 20 days while in the Deyr season the number of wet days are generally less than 10 days. The number of wet days shows more variability in JJAS than in FMAM. The coefficient of variation of the computed wet days are presented in the next section.

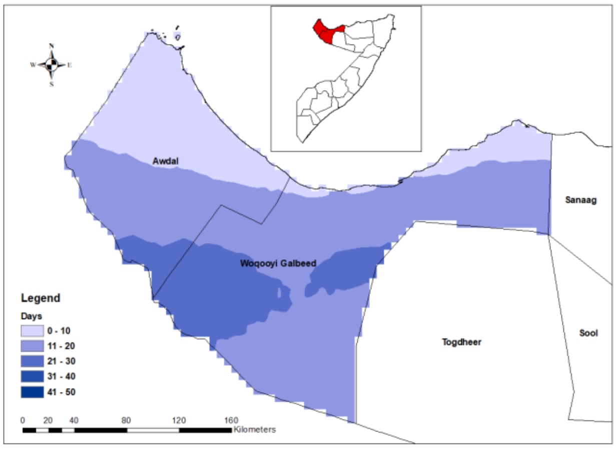


Figure 3.6-1 Average Number of Wet days in the Gu (MAMJ) Season (1981-2010) at the Somaliland site

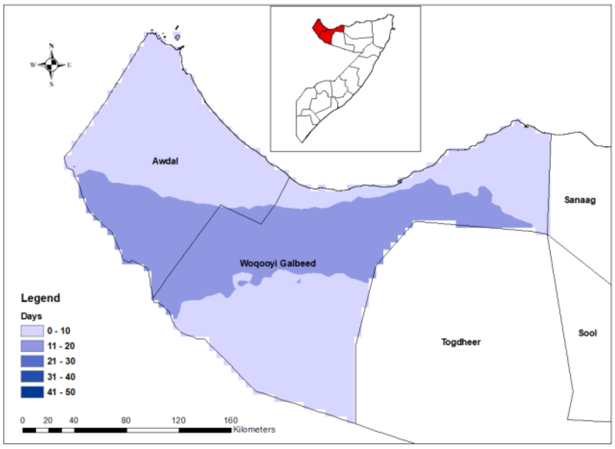
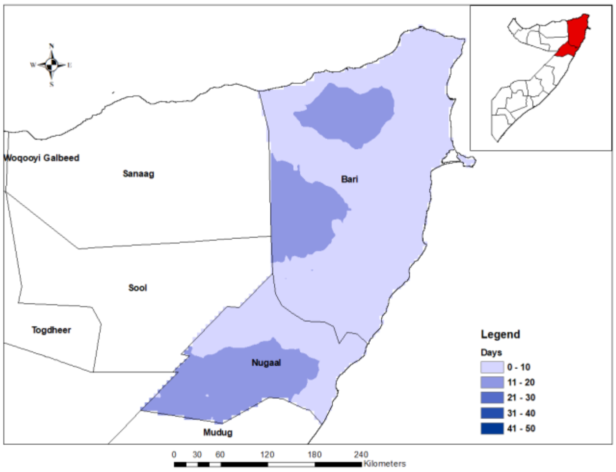


Figure 3.6-2 Average Number of Wet days in the Deyr(SOND) Season (1981-2010) at the Somaliland site



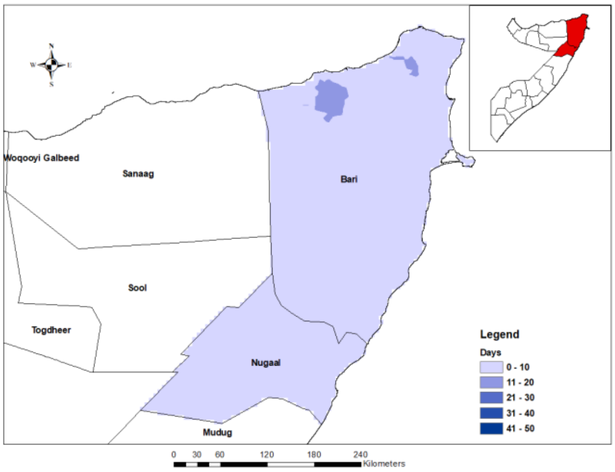
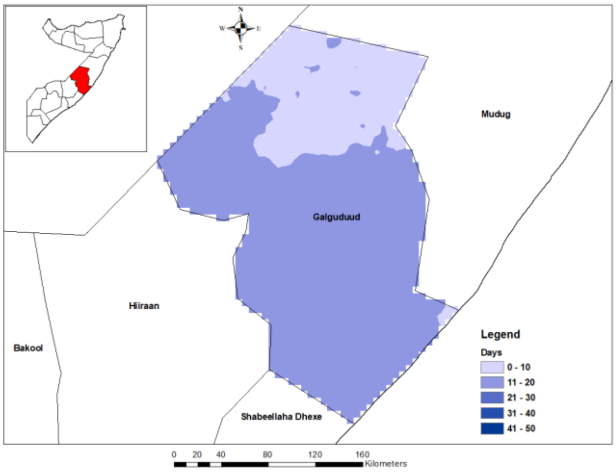


Figure 3.6-3 Average Number of Wet days in the Gu (MAMJ) Season (1981-2010) at the Puntland site

Figure 3.6-4 Average Number of Wet days in the Deyr(SOND) Season (1981-2010) at the Puntland site



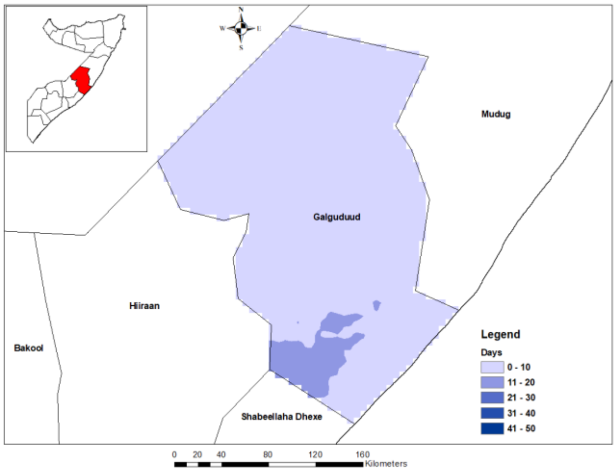
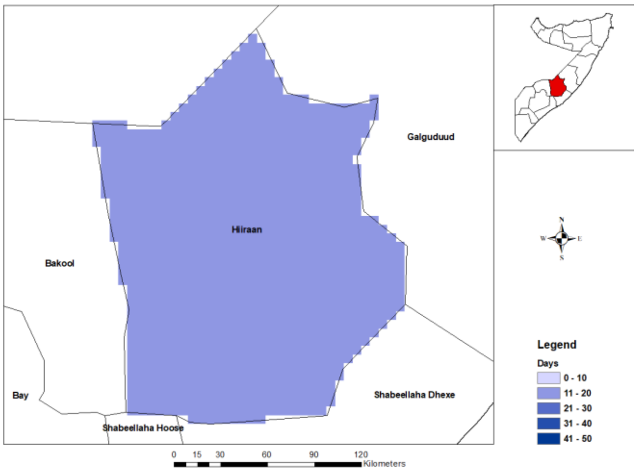


Figure 3.6-5 Average Number of Wet days in the Gu (MAMJ) Season (1981-2010) at the Galmudug site

Figure 3.6-6 Average Number of Wet days in the Deyr(SOND) Season (1981-2010) at the Galmudug site



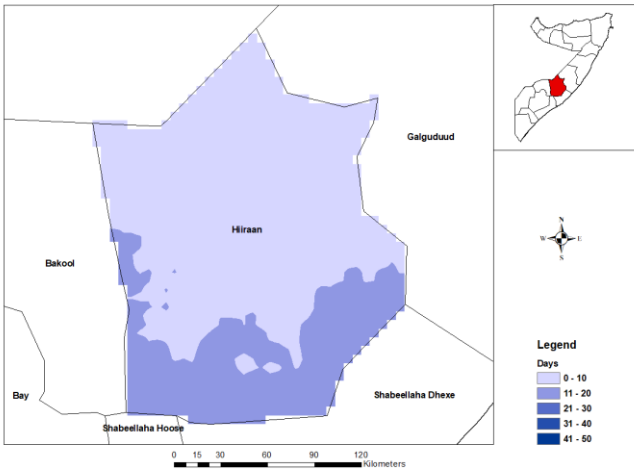


Figure 3.6-7 Average Number of Wet days in the Gu (MAMJ) Season (1981-2010) at the Hirshabelle site

Figure 3.6-8 Average Number of Wet days in the Deyr(SOND) Season (1981-2010) at the Hirshabelle site

3.6.1 Observed Variance in Wet Days

The coefficients of variation of the computed wet days are shown in **Figures 3.6-9 to 3.6-16** for *Gu* and *Deyr* seasons. The figures show that variability in the number of wet days differs significantly spatially in both the *Gu* and *Geyr* season. As with the rainfall intensity (**section 3.5.1**) the observed variance in wet days is generally higher in all sites during the *Deyr* season than it is during the *Gu* season. Some parts of Awdal however recorded a higher coefficient of variance in the *Gu* season than *Deyr* season.

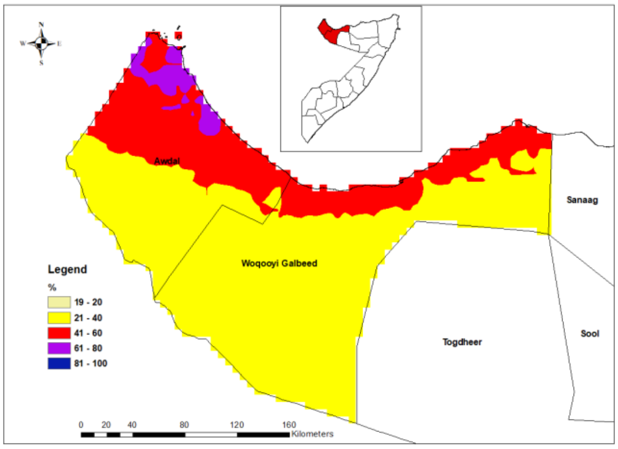


Figure 3.6-9 Wet Days: Coefficient of Variance in the Gu (MAMJ) Season (1981-2010) at the Somaliland site

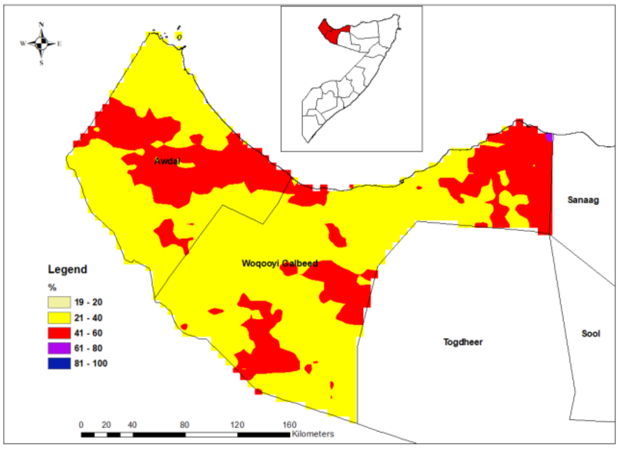


Figure 3.6-10 Wet Days: Coefficient of Variance in the Deyr (SOND) Season (1981-2010) at the Somaliland site

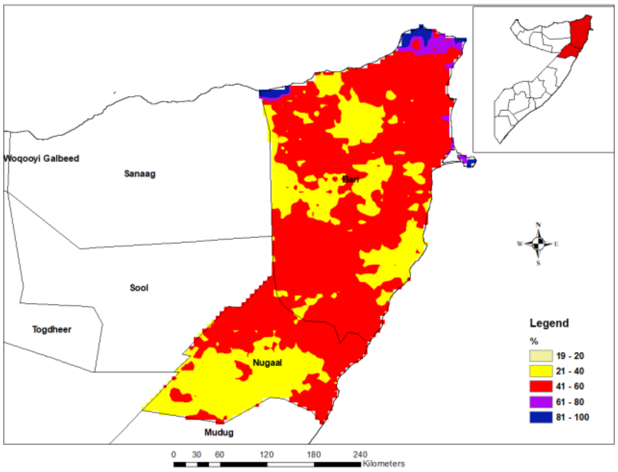


Figure 3.6-11 Wet Days: Coefficient of Variance in the Gu (MAMJ) Season (1981-2010) at the Puntland site

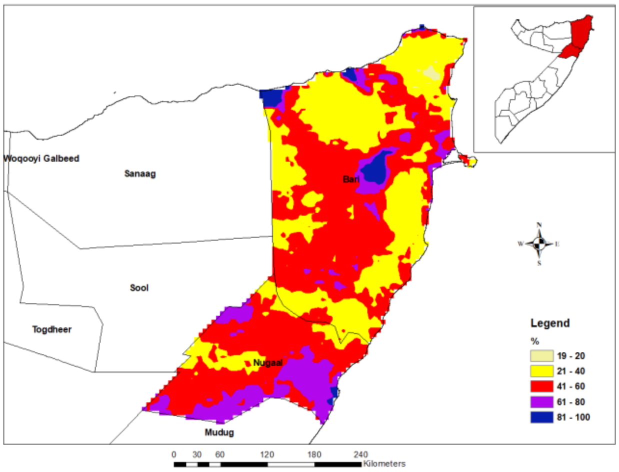


Figure 3.6-12 Wet Days: Coefficient of Variance in the Deyr (SOND) Season (1981-2010) at the Puntland site

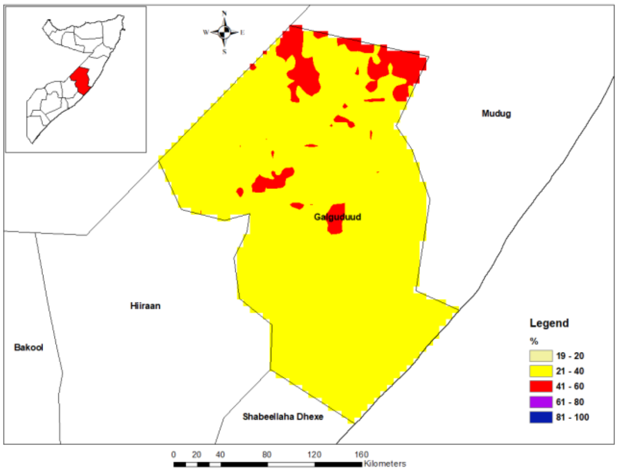


Figure 3.6-13 Wet Days: Coefficient of Variance in the Gu (MAMJ) Season (1981-2010) at the Galmudug site

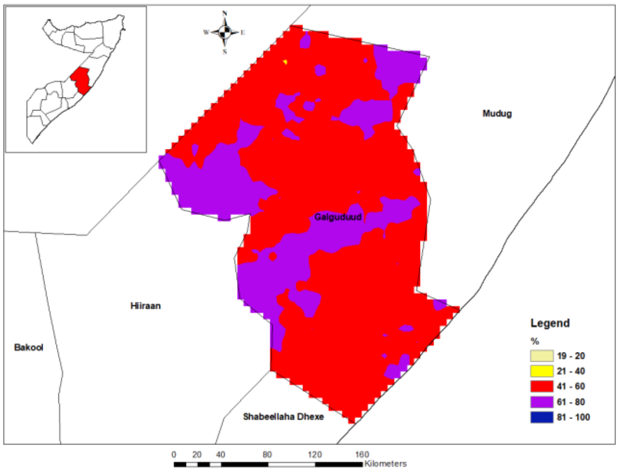


Figure 3.6-14 Wet Days: Coefficient of Variance in the Deyr (SOND) Season (1981-2010) at the Galmudug site

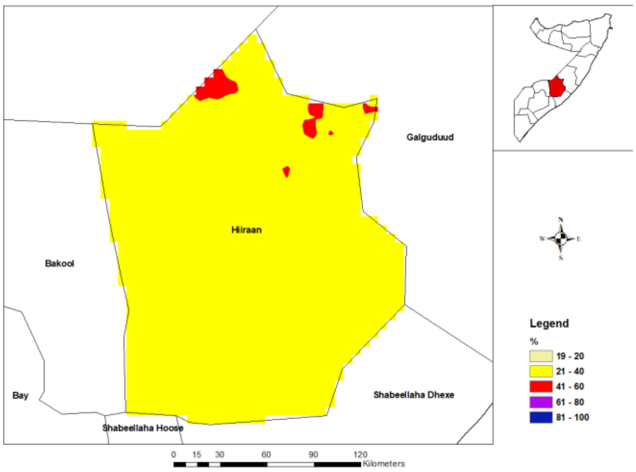


Figure 3.6-15 Wet Days: Coefficient of Variance in the Gu (MAMJ) Season (1981-2010) at the Hirshabelle site

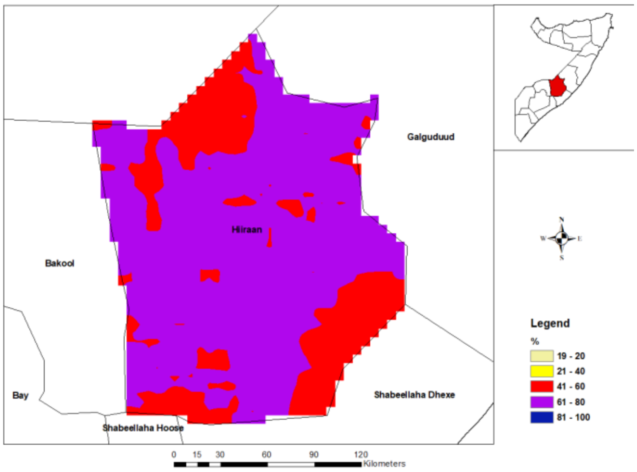


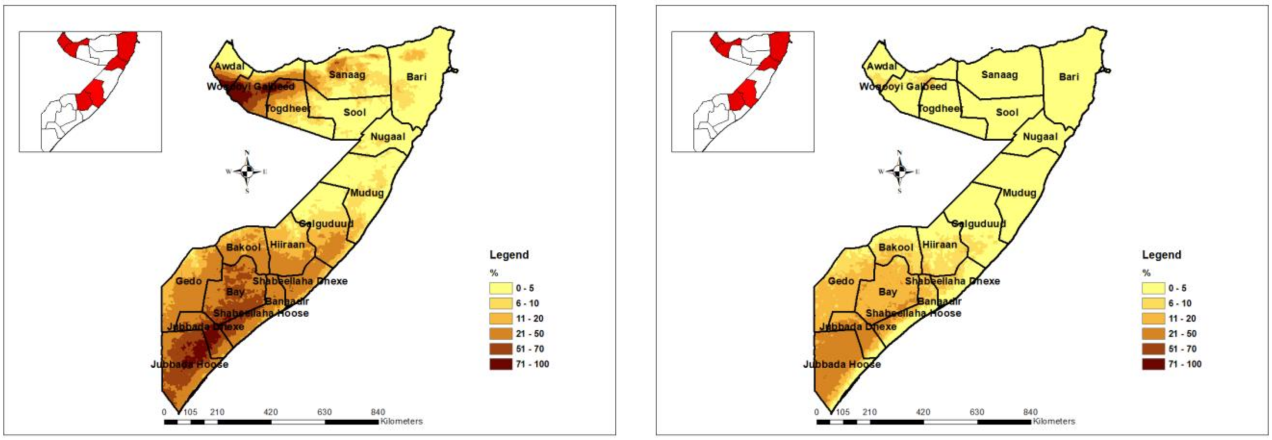
Figure 3.6-16 Wet Days: Coefficient of Variance in the Deyr (SOND) Season (1981-2010) at the Hirshabelle site

3.6.2 Probability of Number Wet Days

This section presents baseline statistics for the Probability of the number of Wet Days at the project sites. The figures show that the probability of the number of wet days exceeding 20 is over 50% in parts of Awdal and Woqooyi Galbeed in Somaliland with the probability being as higher than 70% in some parts in Awdal during the *Gu* Season. The probability of the number of wet days exceeding 20 days in all the sites during the *Deyr* season is generally low. The probability of the number of wet days exceeding 30 days in both the MAMJ and SOND seasons in the entire country is very low (**Figure 3.6-17**).

March – June (MAMJ) Season | *September- December (SOND) Season*

Probability of the number of wet days in the season exceeding 20



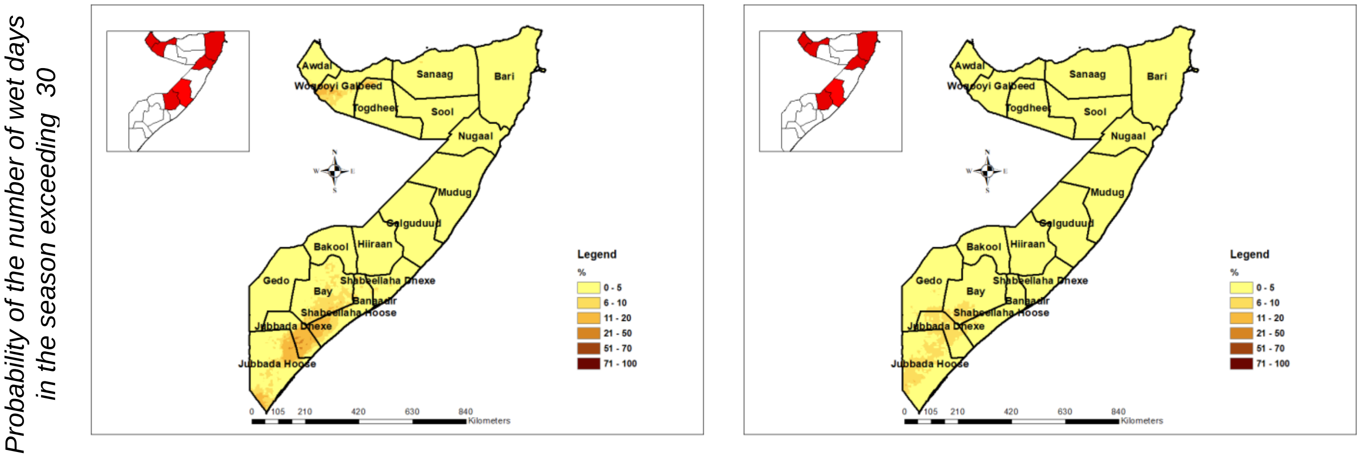


Figure 3.6-17 Probability of the number of wet days in the MAMJ and SOND season exceeding 20 & 30 days (1981-2018) in Somalia

3.7 Mean Wet Spells

A wet spell of *n* days, for example 3 days, is taken to represent a case where at least 1mm daily rainfall threshold was received for *n* (3) continuous wet days. The figures below shows that there is no part of Somalia that generally receives even one wet spell in MAMJ season than in SOND season in the reported period (**Figures 3.7-1 & 3.7-2)**.

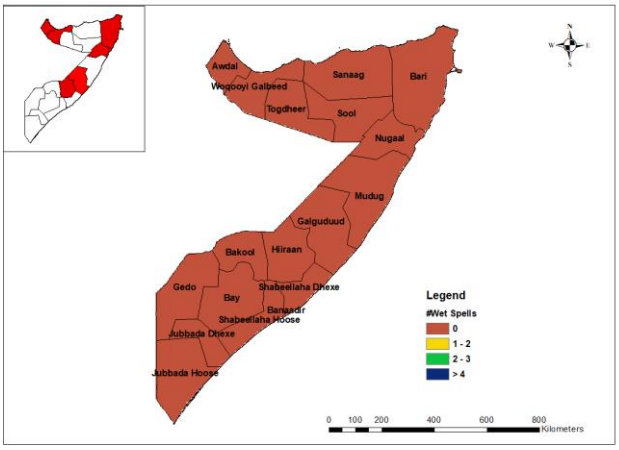


Figure 3.7-1 Number of wet spells in MAMJ in Somalia

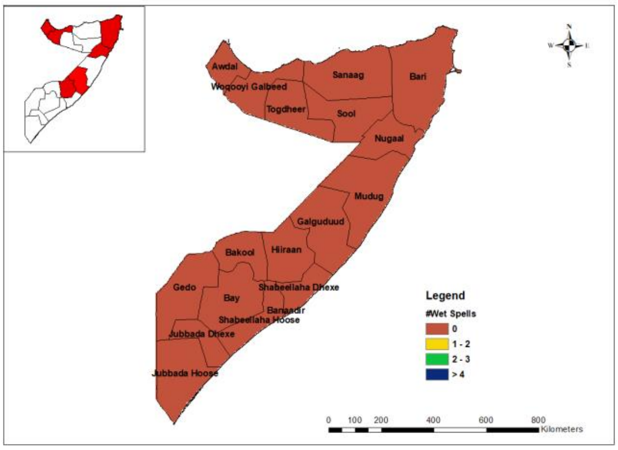


Figure 3.7-2: Number of wet spells in SOND in Somalia

The next section provides some probabilities for occurrences of some specific wet spells.

3.7.1 Probability: Wet Spells

The previous section presented baseline statistics for wets days. It noted that there are no occurrences of wet spells in the *Gu* or *Deyr* season. This section presents examples of the probabilities for occurrences of some specific wet spells, using the 3 continuous wet days to define a wet spells. While the occurrence of a wet spell in Somalia is zero there is over 50% probability of a wet spells occurring in Awdal and Woqooyi Galbeed in Somaliland and in parts of Puntland during the *Gu* season. In the Deyr season, some parts in Awdal and Woqooyi Galbeed have over 50% probability of receiving at least one wet spell. The probability of wet spells exceeding 3 spells in the either season in Somalia is generally low as shown in **Figure 3.7-3.**

However, in parts of Gabiley in Woqooyi Galbeed region Somaliland the probability of exceeding 3 wet spells is over 50%.

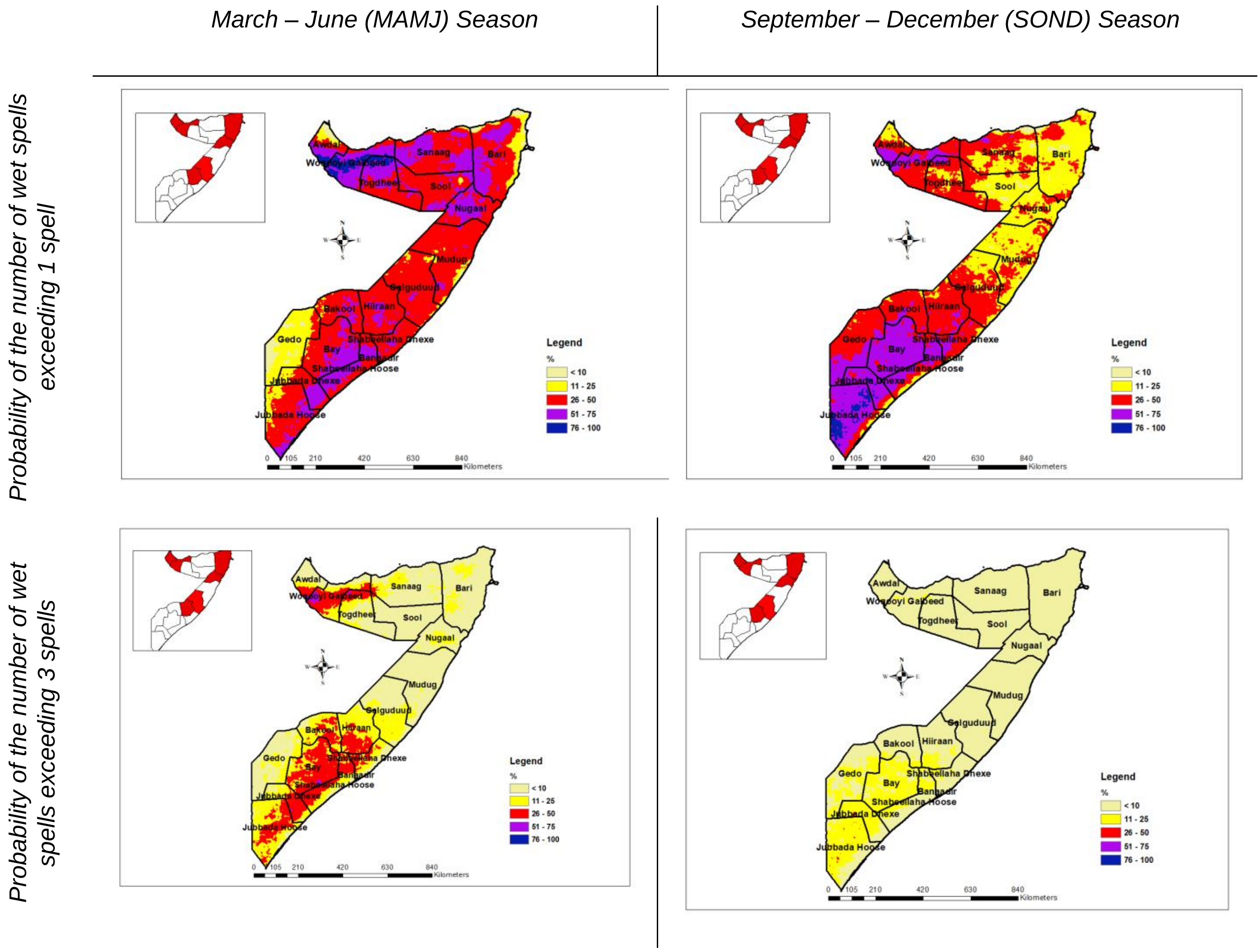


Figure 3.7-3 Probability of the number of wet spells in MAMJ & SOND Season exceeding 3 Spells

3.8 Mean Dry Days

The number and distribution of the dry days can be used to highlight drought potentials of a given location as highlighted in the following sections. **Figures 3.8-1 to 3.8-8** present mean number of dry days observed at the RLACC sites in in Somaliland, Puntland, Galmudug and Hirshabelle. The figures indicate that the number of dry days in all the regions generally ranges between 70 and 100 days in MAMJ season and 100-120 in SOND season.

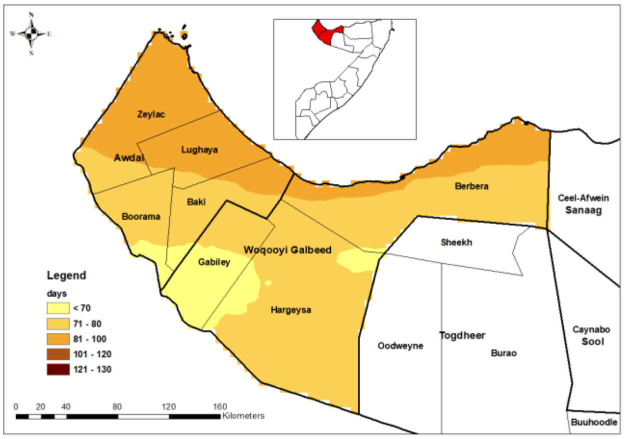


Figure 3.8-1 Average Number of dry days in the Gu (MAMJ) Season (1981-2010) at the Somaliland site

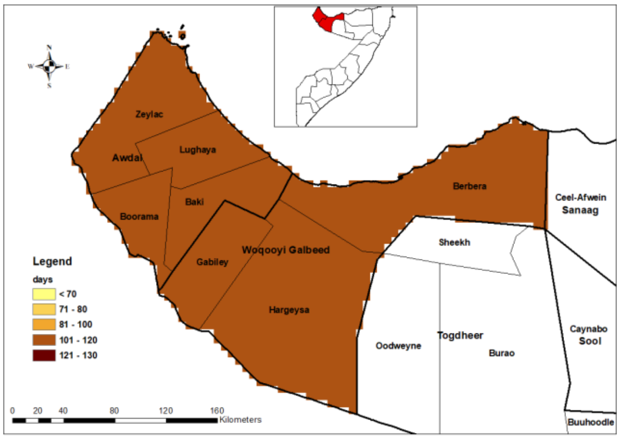


Figure 3.8-2 Average Number of dry days in the Deyr(SOND) Season (1981-2010) at the Somaliland site

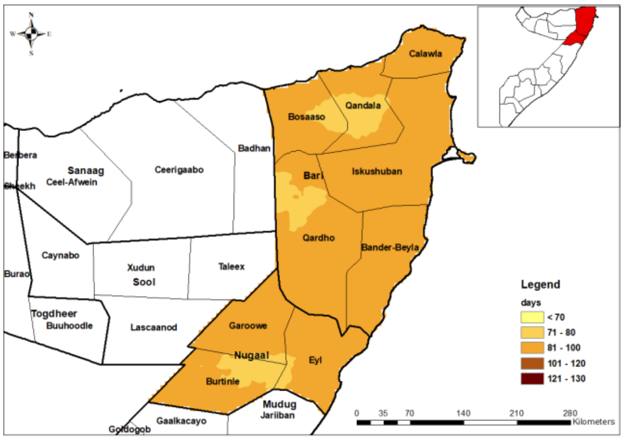


Figure 3.8-3 Average Number of dry days in the Gu (MAMJ) Season (1981-2010) at the Puntland site

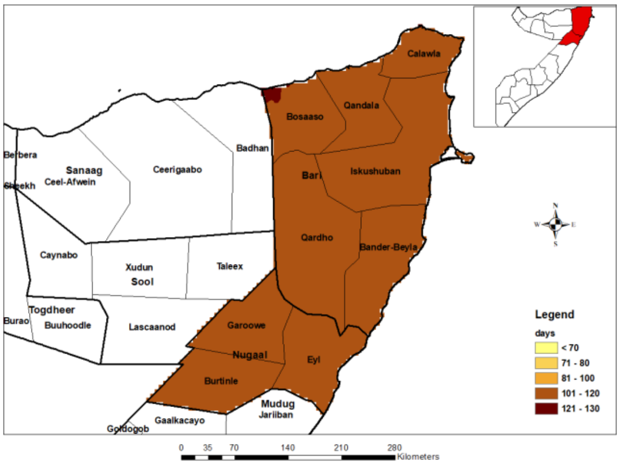


Figure 3.8-4 Average Number of dry days in the Deyr(SOND) Season (1981-2010) at the Puntland site

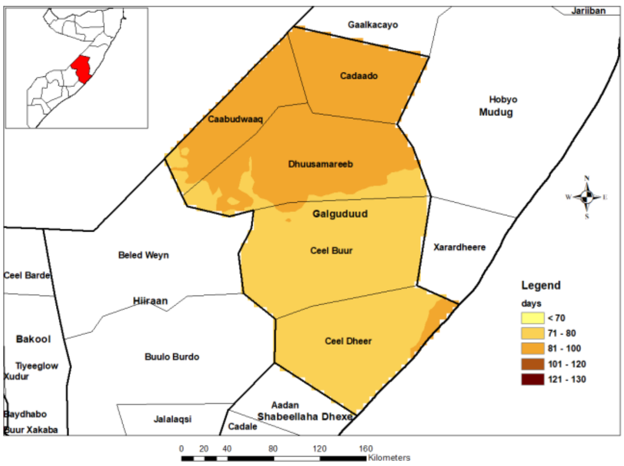


Figure 3.8-5 Average Number of dry days in the Gu (MAMJ) Season (1981-2010) at the Galmudug site

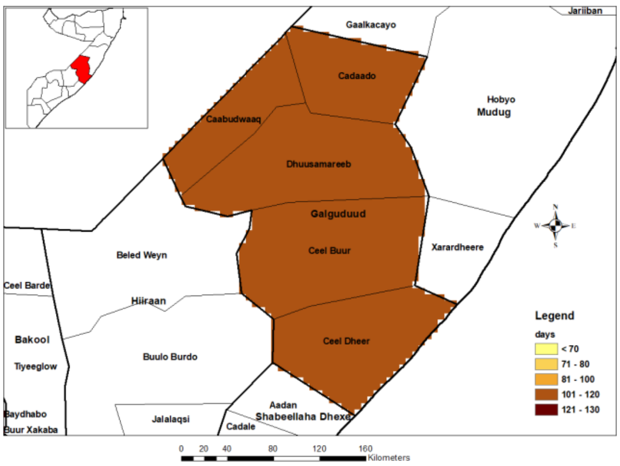


Figure 3.8-6 Average Number of dry days in the Deyr(SOND) Season (1981-2010) at the Galmudug site

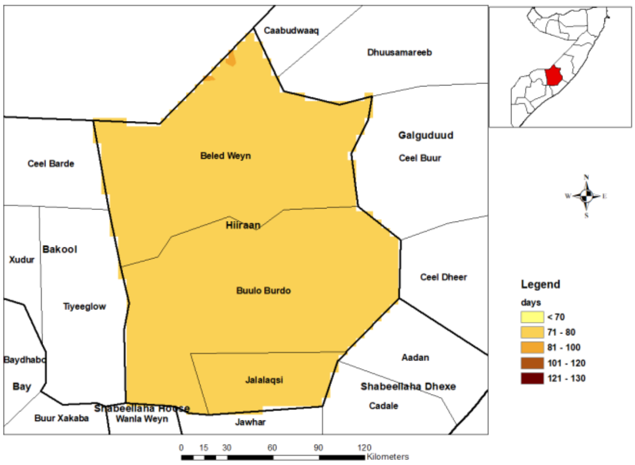


Figure 3.8-7 Average Number of dry days in the Gu (MAMJ) Season (1981-2010) at the Hirshabelle site

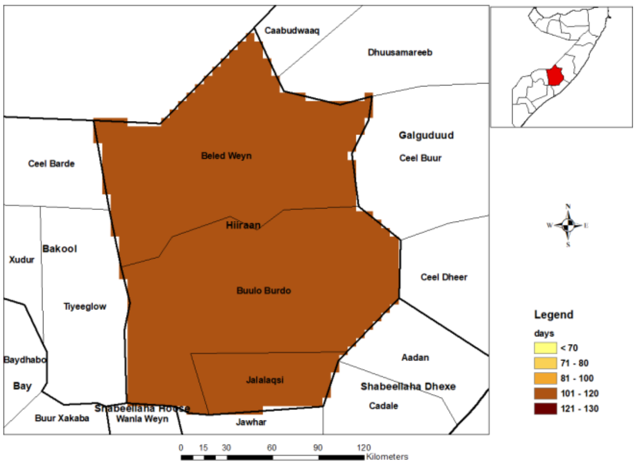


Figure 3.8-8 Average Number of dry days in the Deyr(SOND) Season (1981-2010) at the Hirshabelle site

Section 3.8-3 shows spatial patterns of the observed variance of the dry days while their corresponding probability of occurrence is given in Section 3.8-4.

3.8.1 Coefficient of variation: Dry Days

The spatial patterns of the variance of the dry days in for the RLACC sites in Somaliland, Puntland, Galmudug and Hirshabelle is given in **Figures** 3**.9-1& 3.8-2.** The figures indicate that the variance in the number of dry days is generally in the *Gu* and the *Deyr* season showing the persistence in dry days in the region.

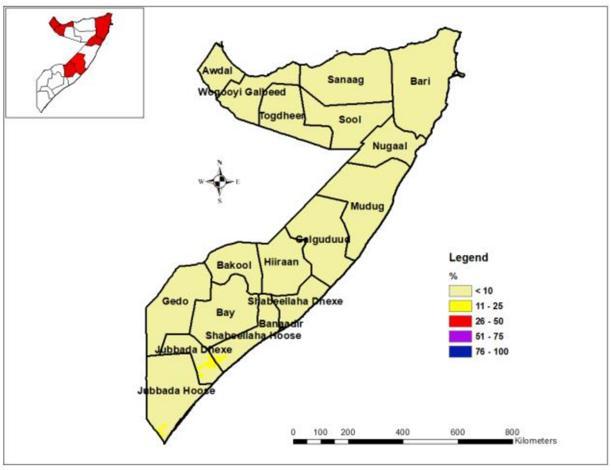


Figure 3.8-9 Dry Days: Coefficient of Variance during the MAMJ (1981-2018)

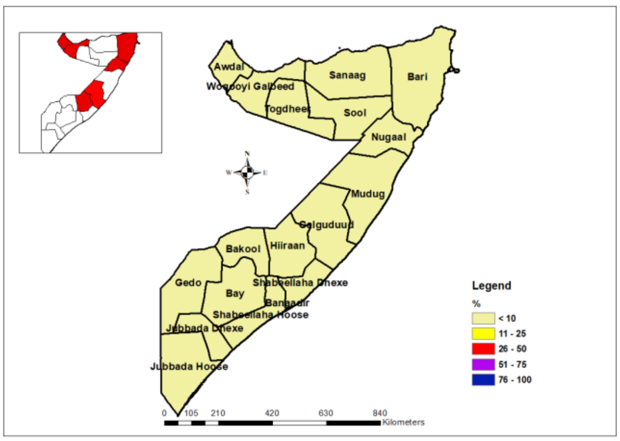


Figure 3.8-10 Dry Days: Coefficient of Variance during the SOND (1981-2018)

3.9 Mean Dry Spells

Like in the case of wet spells, a dry spell of *n* (e.g. 7) days represent a case of *n* (7) days without receiving any wet day (at least 1 mm rainfall). Results show that the number of dry spells in both *Gu* and *Deyr* rainfall seasons. **Figures 3.9-1 to 3.9-8**. There is more variability observed during *Deyr* than in *Gu* season, with the *Gu* season generally having 6-8 dry spells with some parts of Awdal in Somaliland and in Bari region Puntland that experience shorter spells. Shorter spells were evident in *Deyr* season. The variance of these dry spells are presented in the next section.

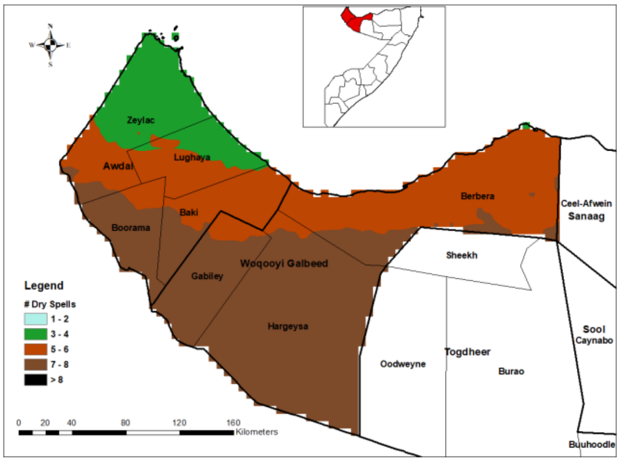


Figure 3.9-1 Average Number of Wet Spell in the Gu (MAMJ) Season (1981-2010) at the Somaliland site

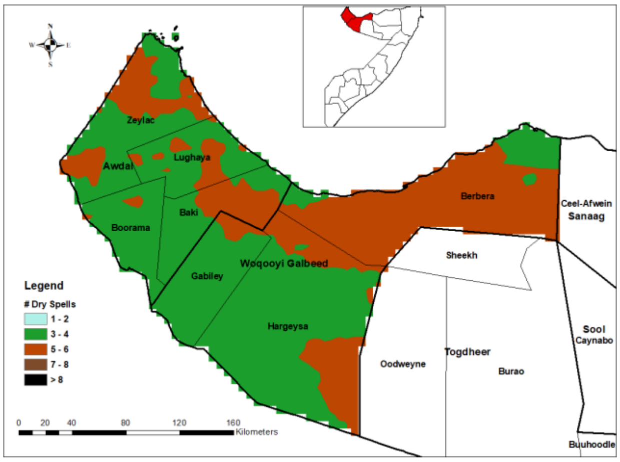


Figure 3.9-2 Average Number of Wet Spell in the Deyr(SOND) Season (1981-2010) at the Somaliland site

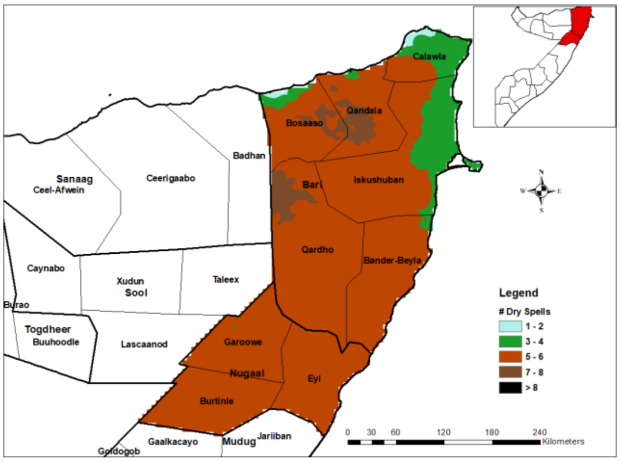


Figure 3.9-3 Average Number of Wet Spell in the Gu (MAMJ) Season (1981-2010) at the Puntland site

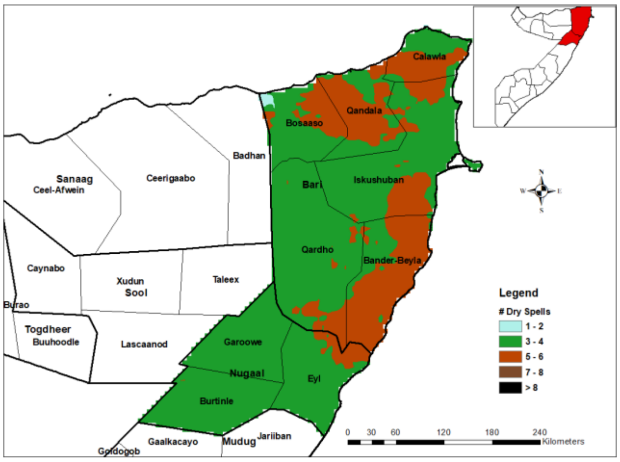
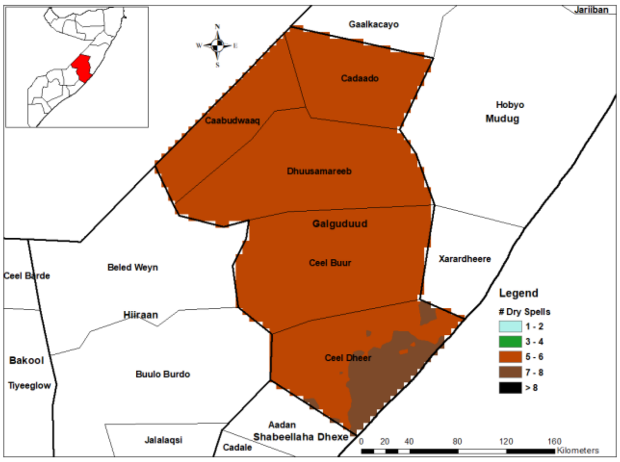


Figure 3.9-4 Average Number of Wet Spell in the Deyr(SOND) Season (1981-2010) at the Puntland site



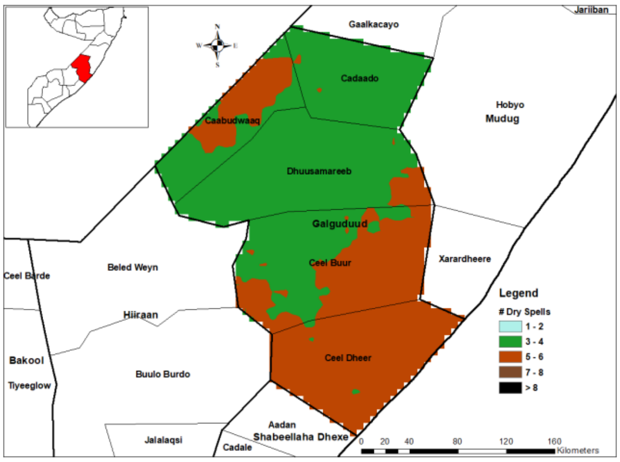
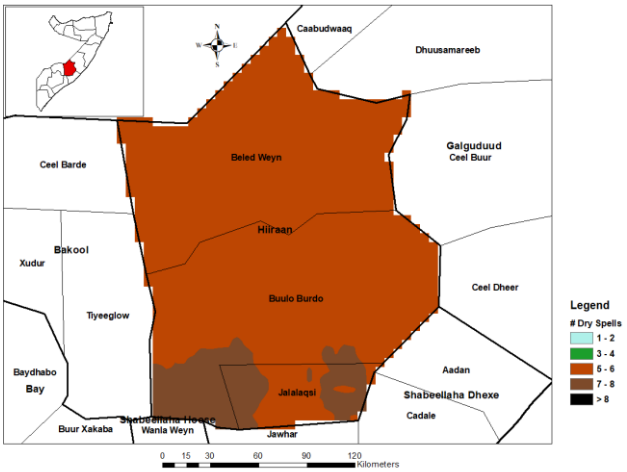


Figure 3.9-5 Average Number of Wet Spell in the Gu (MAMJ) Season (1981-2010) at the Galmudug site

Figure 3.9-6 Average Number of Wet Spell in the Deyr(SOND) Season (1981-2010) at the Galmudug site



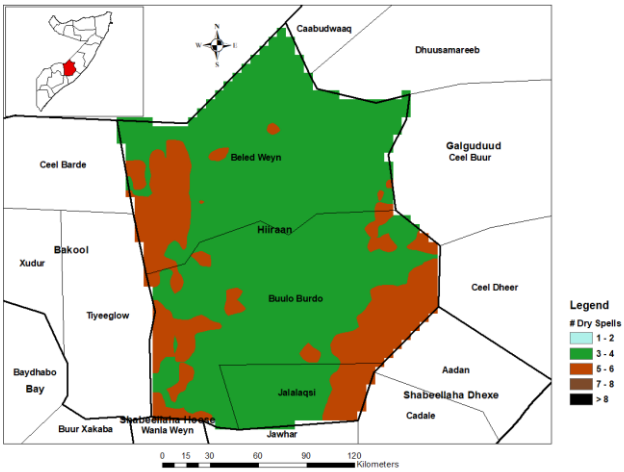
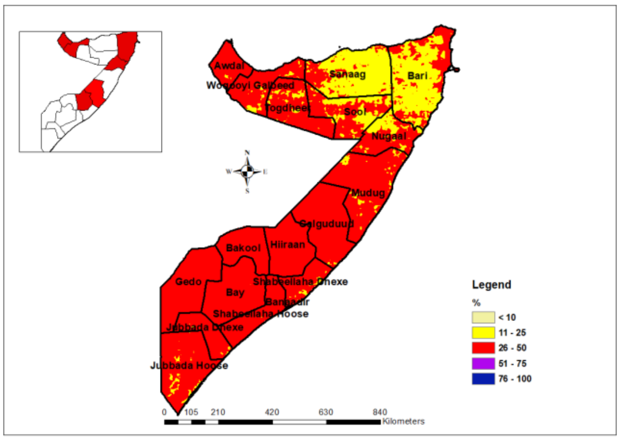


Figure 3.9-7 Average Number of Wet Spell in the Gu (MAMJ) Season (1981-2010) at the Hirshabelle site

Figure 3.9-8 Average Number of Wet Spell in the Deyr(SOND) Season (1981-2010) at the Hirshabelle site

3.9.1 Coefficient of variation: Dry Spells

The coefficient of variation in both *Gu* and *Deyr* is generally less than 50% as seen in **Figures 3.9-9 & 3.9-10.** This shows that the variability from the long term mean in the number of dry spells is generally low, signifying the degree of persistence of the dry spells. The probability of these dry spells are presented in the next section.



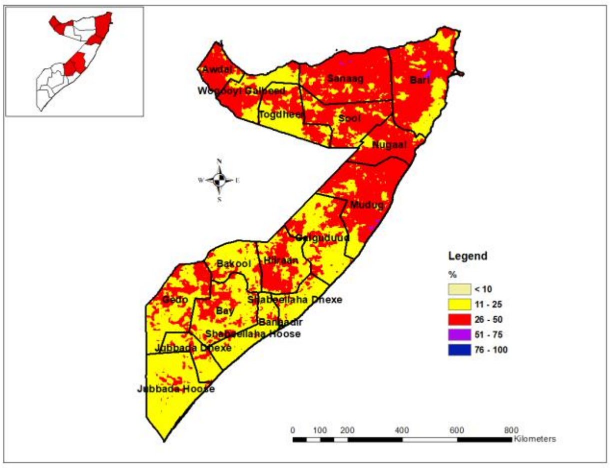


Figure 3.9-9 Dry Spell: Coefficient of Variance during the MAMJ (1981-2018)

Figure 3.9-10 Dry Spell: Coefficient of Variance during the SOND (1981-2018)

3.9.2 Probability: Dry Spells

The probability of the dry spells exceeding 3 in both *Gu* and *Deyr* seasons is generally high as shown in **Figure 3.9-13.** The probability of exceeding 5 dry spells in in varies from region to in magnitude at the sites in Somaliland, Puntland, Galmudug and Hirshabelle but generally exceeds 50% in both rainfall seasons. The probability of dry spells exceeding 7 dry spells is low in both seasons at all RLACC sites with the exception of parts Somaliland where the probability is high.

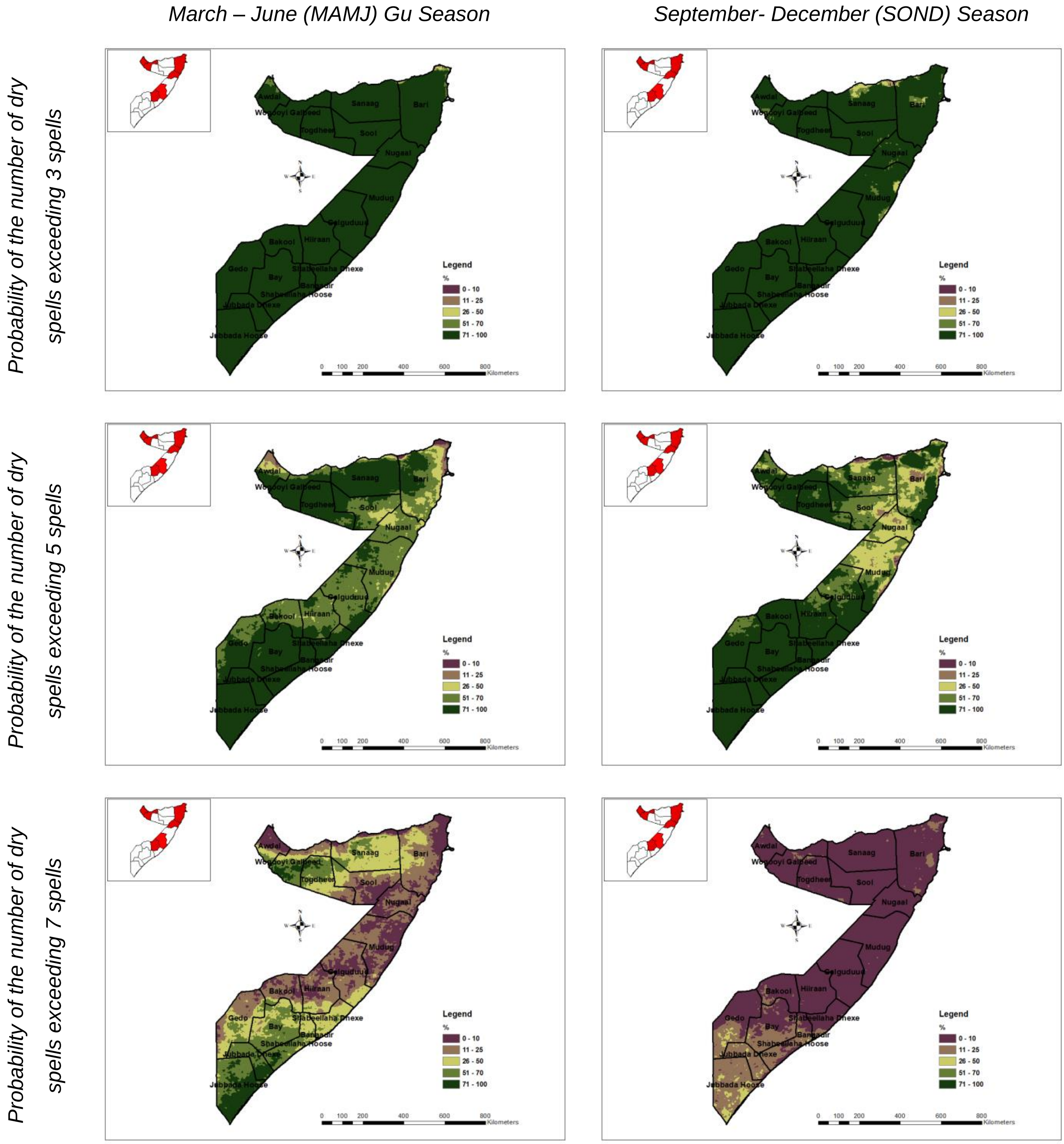


Figure 3.9-11 Probability of the number of dry spells in the MAMJ & SOND season exceeding 3, 5 and 7 dry spells

3.10 Climatological Baselines for Onset, Cessation dates and Length of Growing Period

The onset marks the beginning of the rains while cessation marks the end. The length of time between the onset and cessation dates gives the length of the growing season assuming that the water requirement for specific crop is met throughout the period. The climatological baselines for Onset, Cessation dates and Length of Growing Period are discussed in the following sections.

3.10.1 Onset

The onset was calculated with a threshold 1mm of rainfall per day, having a rainfall total of 5 mm in five days with at least two rainy days with a dry spell not exceeding seven days. **Figure 3.10-1 – 3.10-8** shows the mean onset of the of the *Gu* and *Deyr* Season. The onset in the *Gu* season generally falls in the second decade of April at the sites in Somaliland, Galmudug and Hirshabelle, and the third decade of April in Puntland. During the Deyr season, the onset in Hirshabelle and parts of Galmudug generally experience an onset in the second decade of October while Puntland and parts of Galmudug receive rainfall in the third decade of October. Results shows spatial variability in Somaliland on the onset date, with some parts having an onset as early as the first decade of September while other parts in the last decade of October.

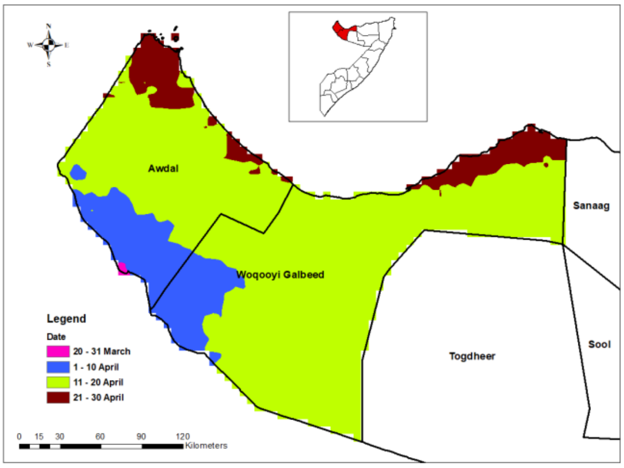


Figure 3.10-1 Historical onset in the Gu Season (1981-2019) at sites in Somaliland

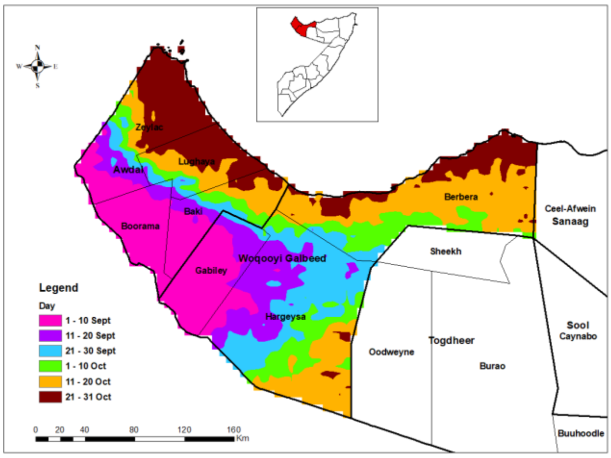


Figure 3.10-2 Historical onset in the Deyr Season (1981-2018) at the Somaliland

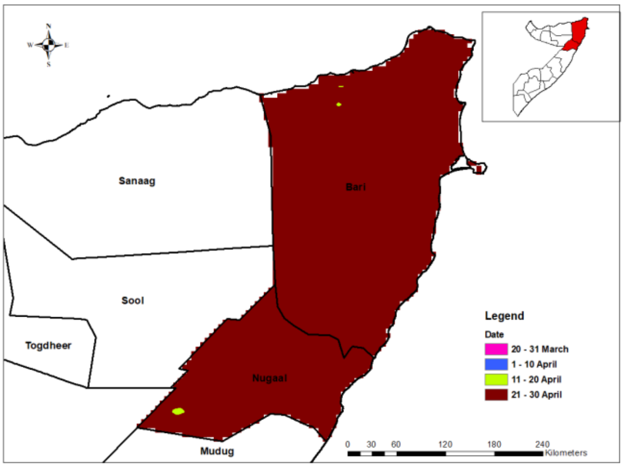


Figure 3.10-3 Historical onset in the Gu Season (1981-2019) at sites in Puntland

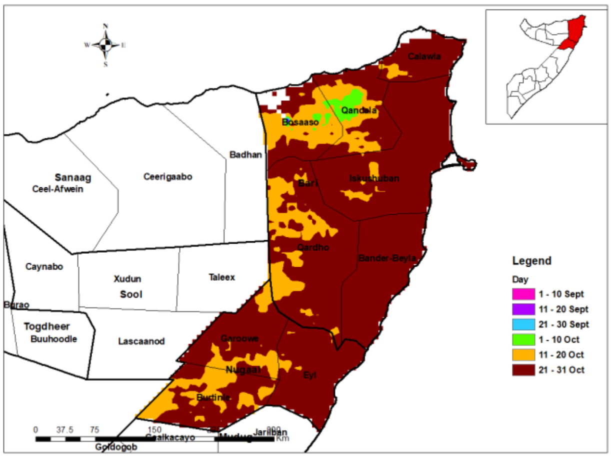


Figure 3.10-4 Historical onset in the Deyr Season (1981-2018) at the Puntland

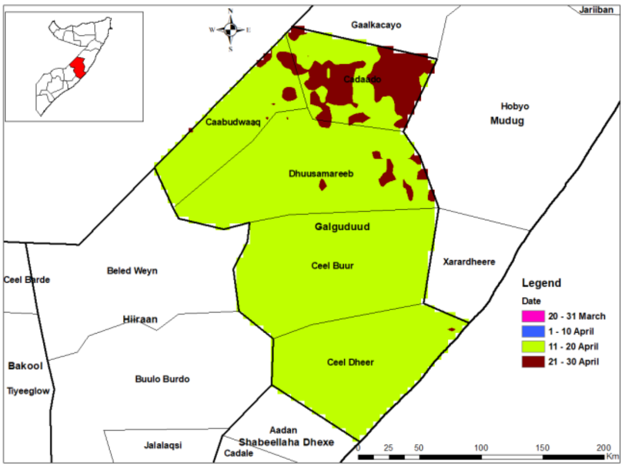


Figure 3.10-5 Historical onset in the Gu Season (1981-2019) at sites in Galmudug

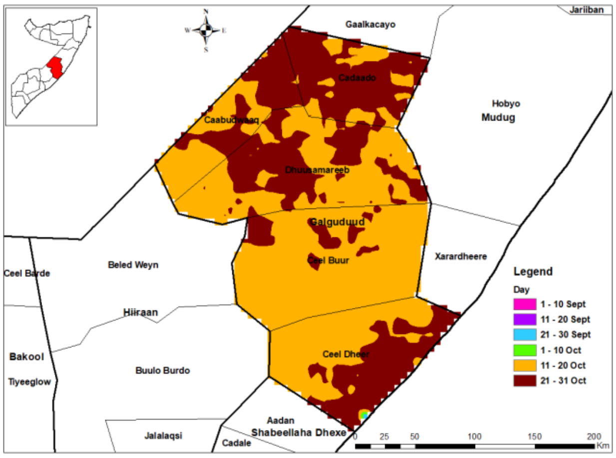


Figure 3.10-6 Historical onset in the Deyr Season (1981-2018) at the Galmudug

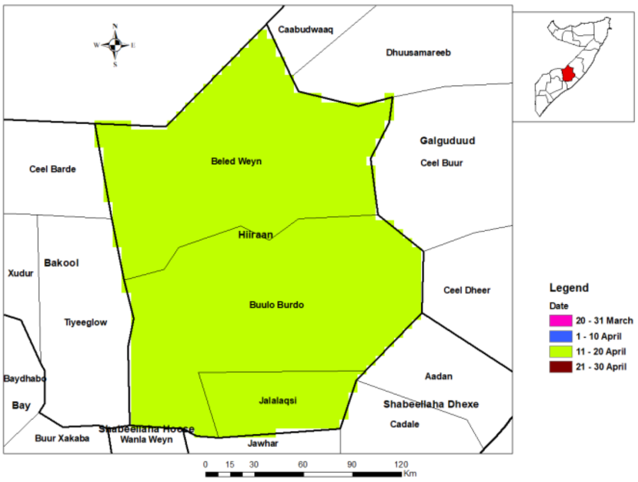


Figure 3.10-7 Historical onset in the Gu Season (1981-2019) at sites in Hirshabelle

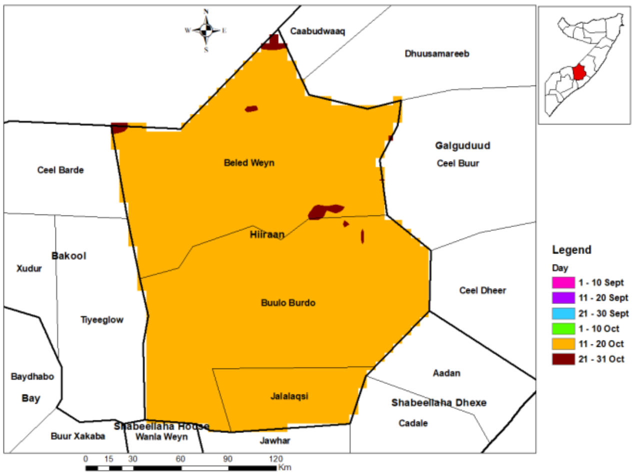


Figure 3.10-8 Historical onset in the Deyr Season (1981-2018) at the Hirshabelle

Very unique patterns were evident in some years associated with strong positive and negative ENSO and IOD events when early and late onset dates are observed (**Figure 3.10-9 & 3.10-10)**.

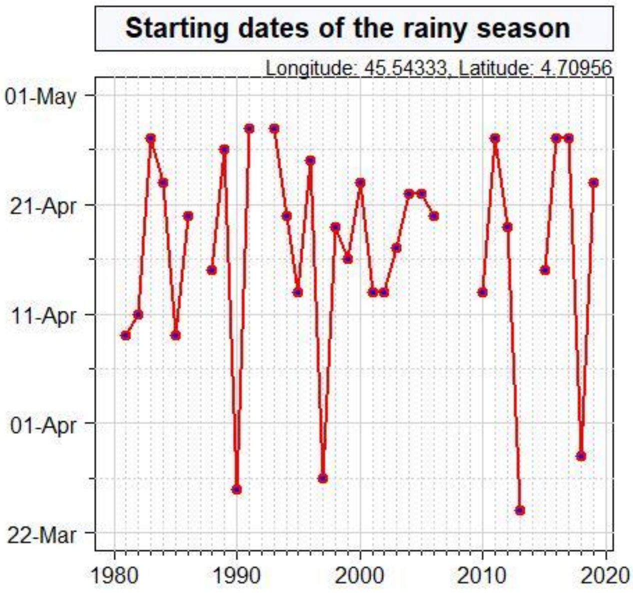


Figure 3.10-9 Time Series of Onset for a point in Hirshabelle during the MAMJ season (1981-2018)

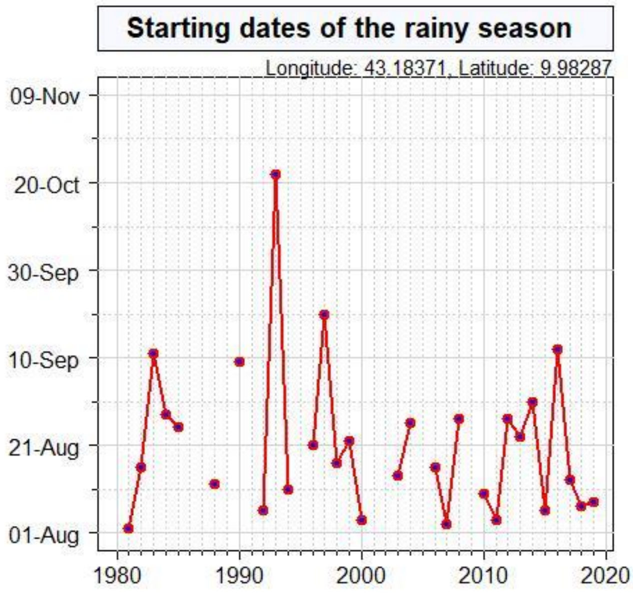


Figure 3.10-10 Time Series of Onset for a point in Somaliland during the SOND season (1981-2018)

3.10.2 Cessation

Cessation of the season was calculated with the threshold where the accumulated 10-day rainfall total is less than 0.5 of the potential evapotranspiration. The results show that the mean cessation of the MAMJ rainfall season districts generally occurs in the first dekad of May though cessation occurs in the second decade of May in some parts of Somaliland, Puntland and Galmudug. Generally the mean cessation date for SOND occurs on the first decade of November (**Figure 3.10-11 to 3.10-18**).

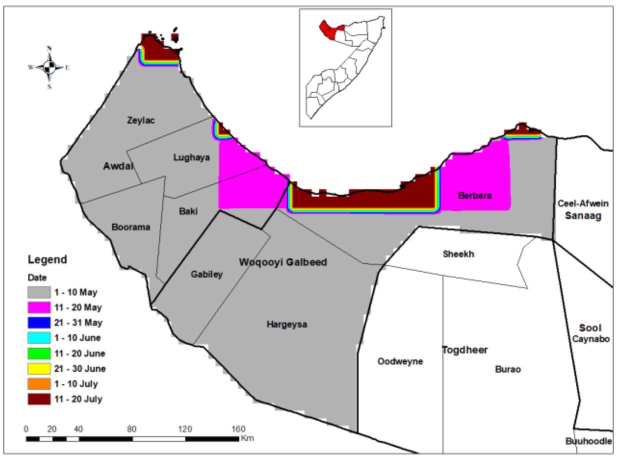


Figure 3.10-11 Historical cessation in the Gu Season (1981-2018) at the Somaliland site

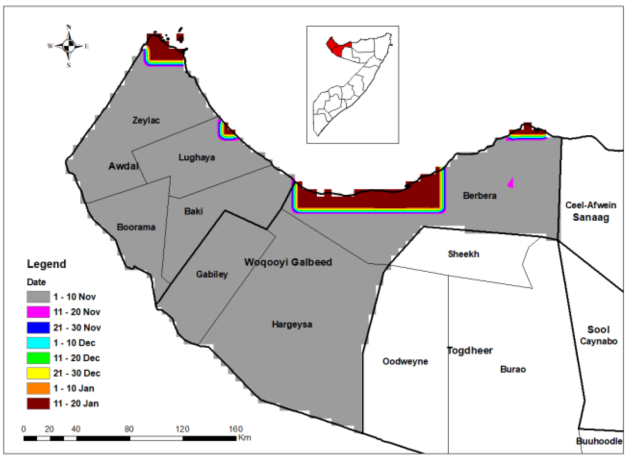


Figure 3.10-12 Historical cessation in the Deyr Season (1981-2018) at the Somaliland site

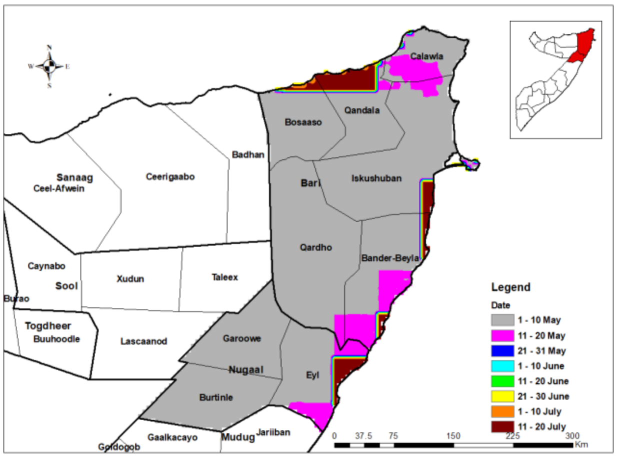


Figure 3.10-13 Historical cessation in the Gu Season (1981-2018) at the Puntland site

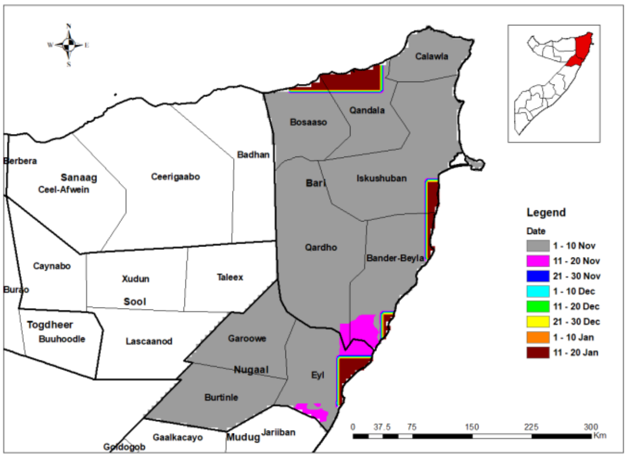


Figure 3.10-14 Historical cessation in the Deyr Season (1981-2018) at the Puntland site

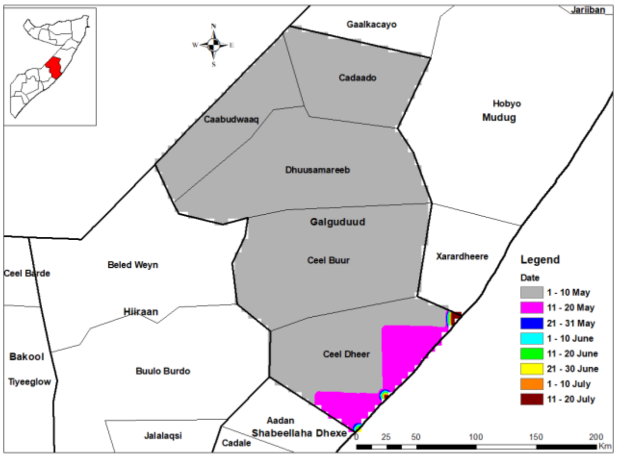


Figure 3.10-15 Historical cessation in the Gu Season (1981-2018) at the Galmudug site

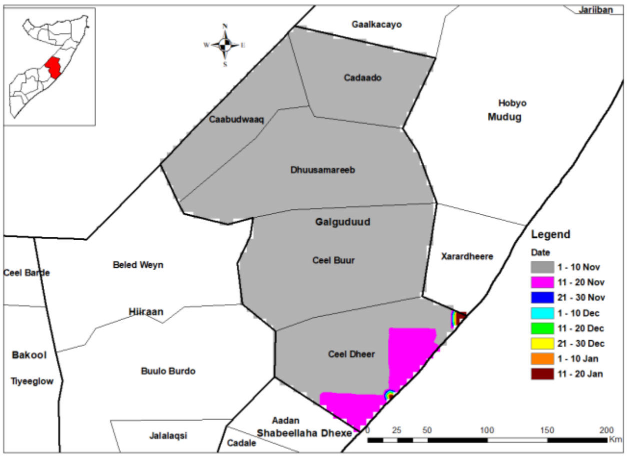


Figure 3.10-16 Historical cessation in the Deyr Season (1981-2018) at the Galmudug site

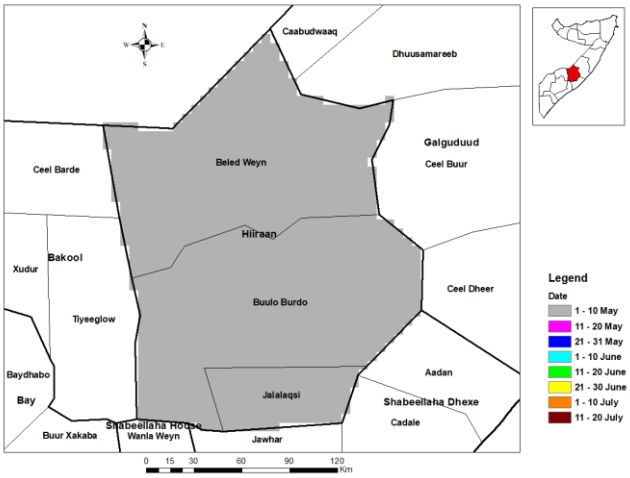


Figure 3.10-17 Historical cessation in the Gu Season (1981-2018) at the Hirshabelle site

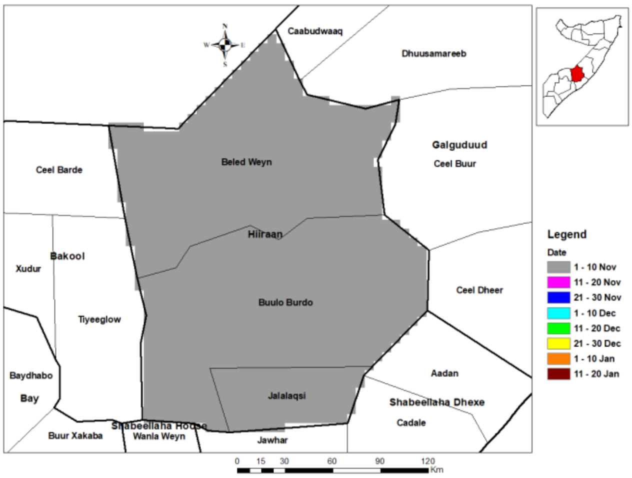


Figure 3.10-18 Historical cessation in the Deyr Season (1981-2018) at the Hirshabelle site

Apart from the above climatological statistics for the rainfall onset and cessation dates, very unique patterns were evident in some years associated with strong positive and negative ENSO and IOD events when early and late cessation dates are observed (**Figure 3.10-19 to 3.10-20)**.

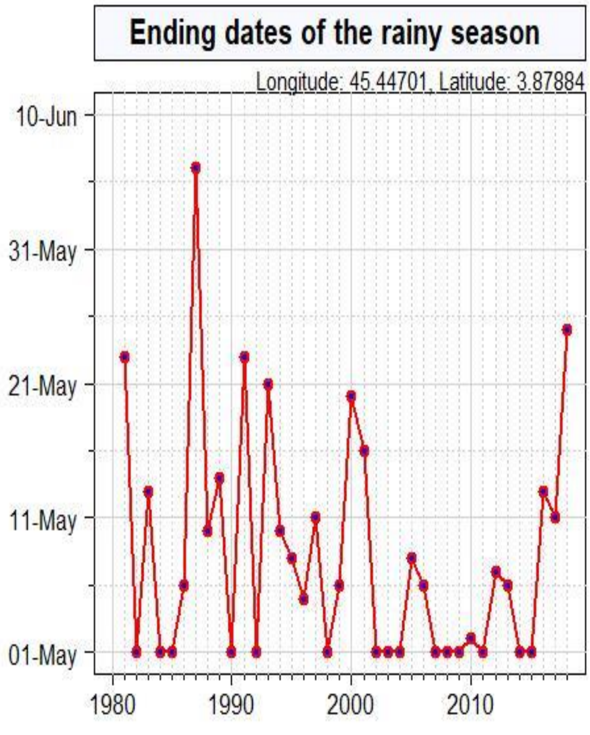


Figure 3.10-19 Time Series of cessation for a point in Hirshabelle during the MAMJ season (1981-2018)

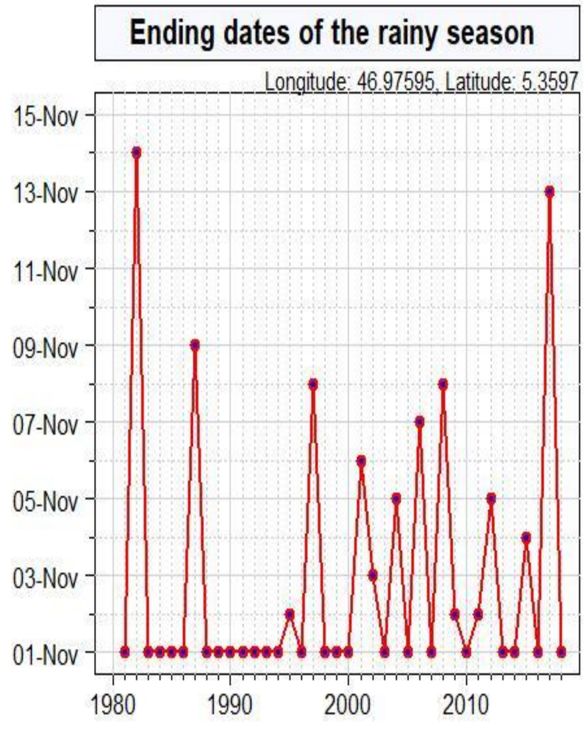


Figure 3.10-20 Time Series of cessation for a point in Galmudug during the SOND season (1981-2018)

3.10.3 Length of Season

The mean length of the MAMJ rainfall season generally is about 11 to 30 days in Somaliland, Galmudug and Hirshabelle, in Puntland, a significant part of the area has a season length of less than 10 days. The length of the SOND season in similar to the MAMJ in Galmudug and Hirshabelle generally having 11 to 30 days. In Somaliland however, the SOND season is seemingly longer and very variable with some areas receiving 51 to 70 days. The SOND season in Puntland generally less than 20 days **Figure 3.10-21 to 3.10-28**.

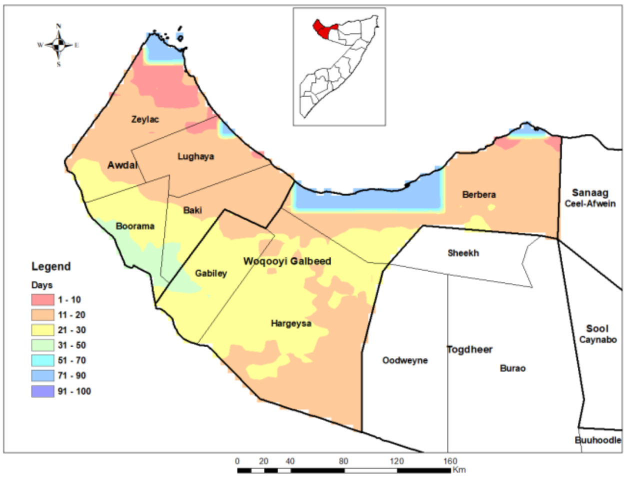


Figure 3.10-21 Historical Length of Season in the Gu Season (1981-2018) in Somaliland

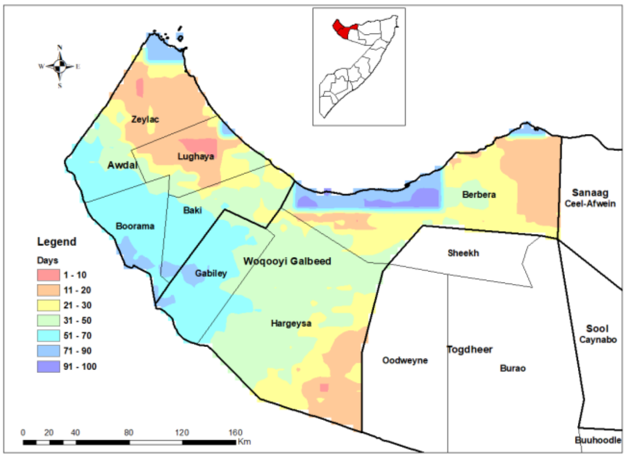


Figure 3.10-22 Historical Length of Season in the Deyr Season (1981-2018) in Somaliland

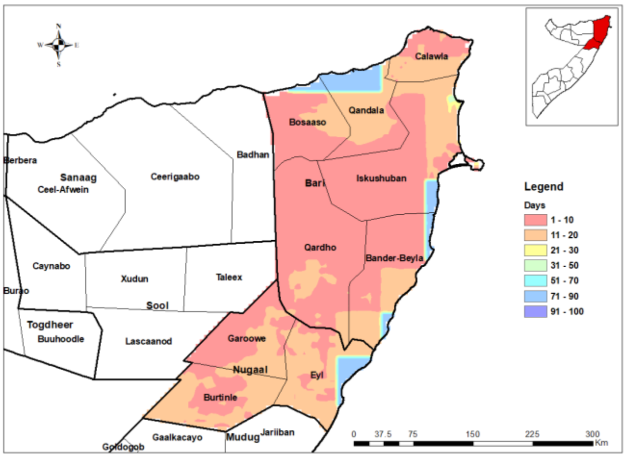


Figure 3.10-23 Historical Length of Season in the Gu Season (1981-2018) in Puntland

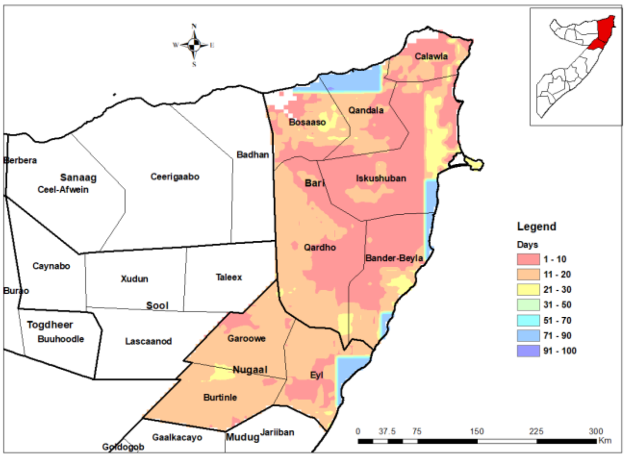


Figure 3.10-24 Historical Length of Season in the Deyr Season (1981-2018) in Puntland

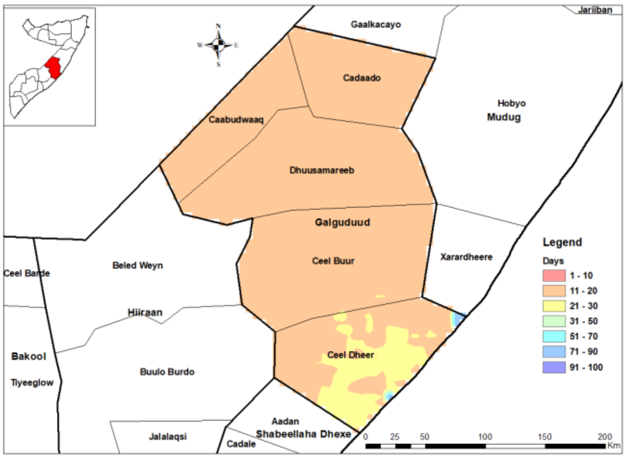


Figure 3.10-25 Historical Length of Season in the Gu Season (1981-2018) in Galmudug

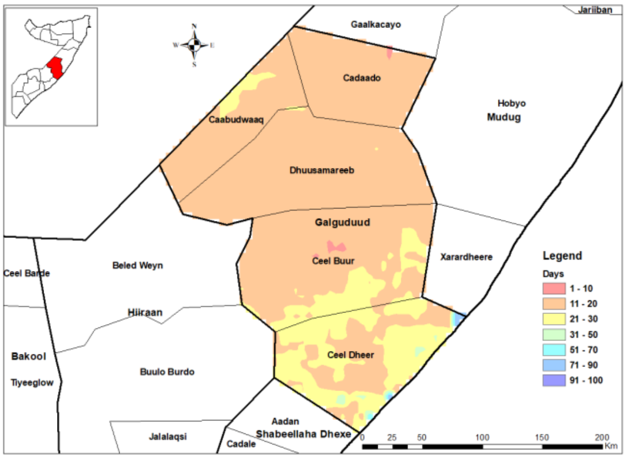


Figure 3.10-26 Historical Length of Season in the Deyr Season (1981-2018) in Galmudug

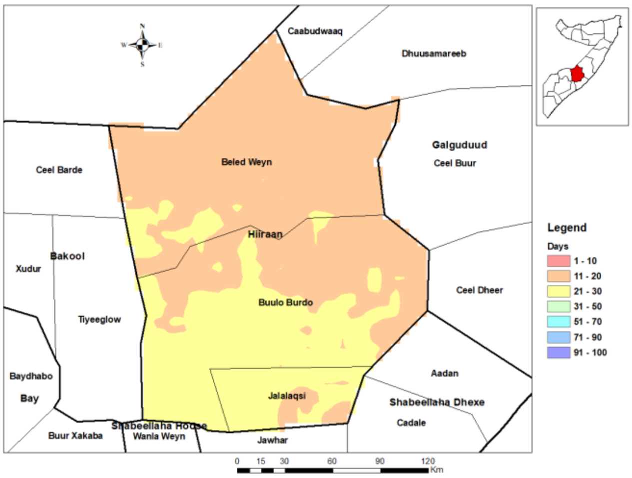


Figure 3.10-27 Historical Length of Season in the Gu Season (1981-2018) in Hirshabelle

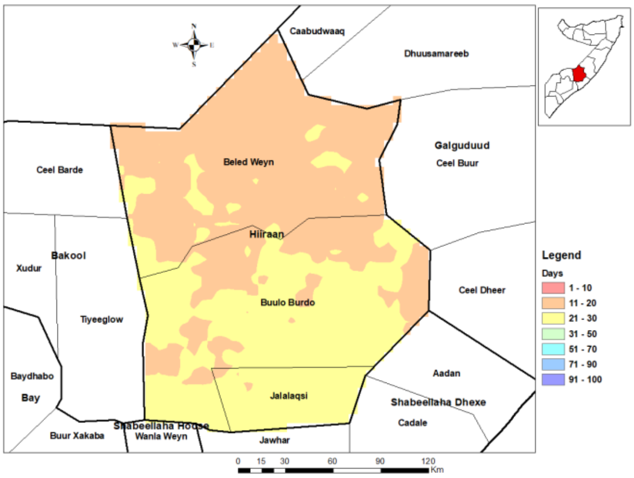


Figure 3.10-28 Historical Length of Season in the Deyr Season (1981-2018) in Hirshabelle

Since length of the seasons is determined by the rainfall onset and cessation dates, very unique patterns were also evident in some years with strong positive and negative ENSO and IOD events, when shorter or longer than normal growing season length are observed. In some of these cases the short growing season lead to water shortage, food deficits, hunger and some deaths.

3.11 Temperature

A part from rainfall parameters, the other climate parameter that is of great significance in the ASALs areas is Temperature. Temperature stress has physiological impacts on all ecosystems among many other effects. Warmer temperatures are reported to be reducing plant and vegetation productivity in semi-arid environments. Temperature increase can affect people directly through increase in heat-related illness, whereas indirect health impacts can also result from changes to natural and social systems. The following sections present the observed temperature characteristics at the RLACC sites in Somaliland, Puntland, Galmudug and Hirshabelle.

3.11.1 Annual Mean Temperature

The annual mean temperature was obtained from average monthly temperature for the twelve months within the period 1981-2010. Mean climatology for annual mean, maximum and minimum temperatures are shown in **Figure 3.11-1** to **4.11-3**.The mean temperatures varies from location to location with relatively lower temperatures observed around Woqooyi Galbeed and parts of Awdal in Somaliland where the lowest mean temperatures were about 21⁰C - 22⁰C. The highest temperatures in the areas of interest are observed in both Galmugug and Hirshabelle at a mean annual temperature ranging between 27⁰C -28 ⁰C as shown in **Figure 3.11-1**.

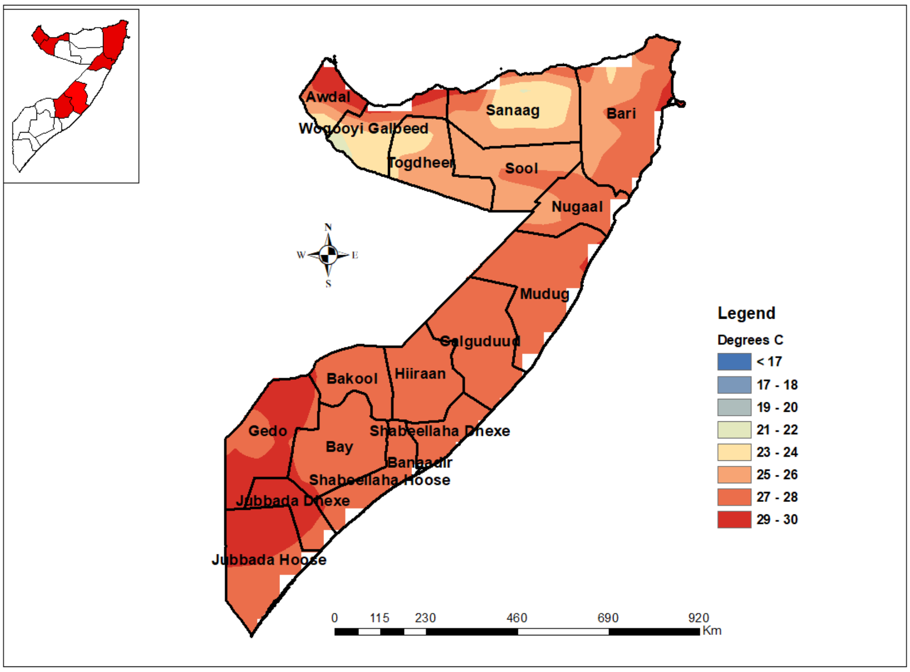


Figure 3.11-1 Mean annual surface temperature climatology (1981–2010) for Somalia region

The pattern observed in the annual temperature is also seen in the Minimum and Maximum Temperature shown in **Figure 3.11-2** and **Figure 3.11-3** respectively.

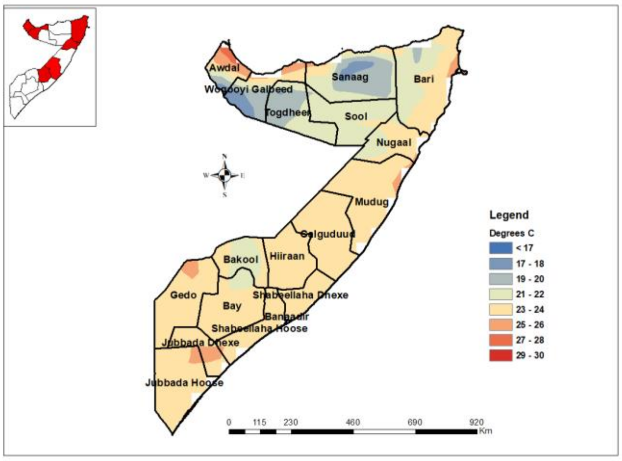


Figure 3.11-2 Mean annual minimum surface temperature climatology (1981–2010) for the Somalia region

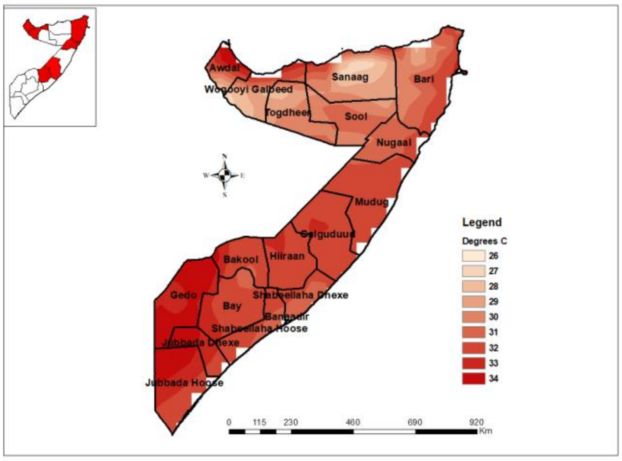


Figure 3.11-3 Mean annual maximum surface temperature climatology (1981–2010) for the Somalia region

3.11.2 Mean Monthly Temperature

The mean monthly temperature differs in each site as shown in **Figure 3.11- 4 to 3.11- 7** with the areas of interest in Somaliland generally experiencing much cooler temperatures than Galmudug and Hirshabelle in particular. January and December are the coolest month in Somaliland and Puntland with a mean temperature of 20ºC to 21ºC while in Galmudug and Hirshabelle, the coolest temperatures are experienced in July where the mean maximum temperature is the lowest in the year.

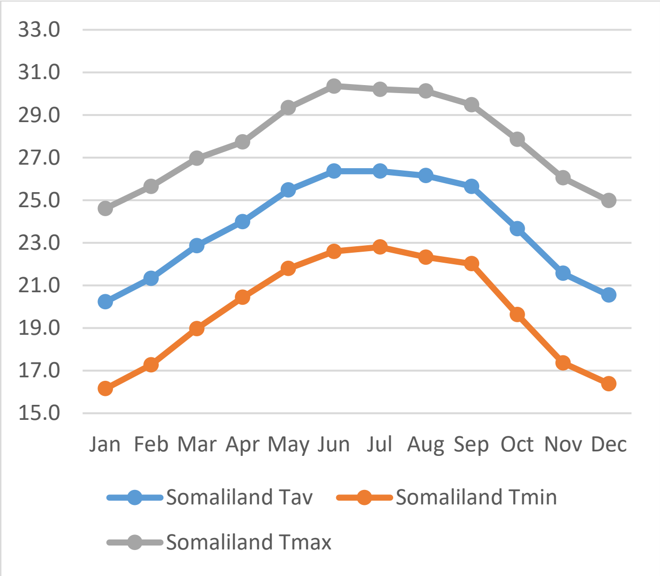


Figure 3.11-4 Minimum, Maximum and Average Monthly Temperature over Project Site in Somaliland (1981-2010)

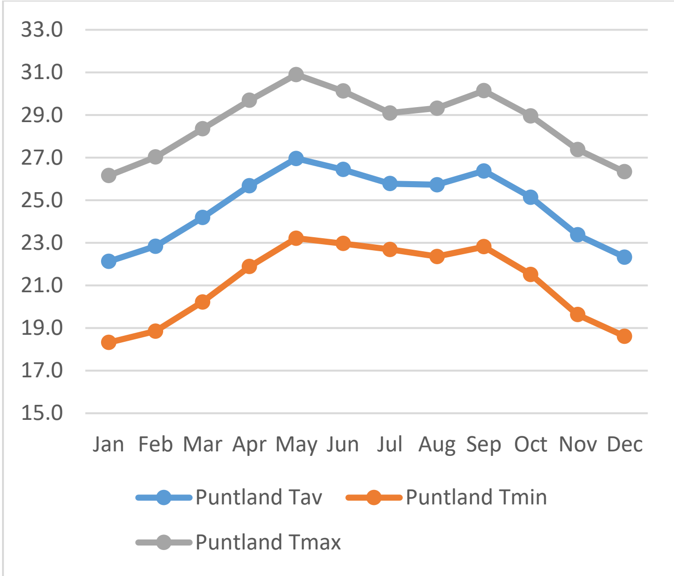


Figure 3.11-5 Minimum, Maximum and Average Monthly Temperature over Project Site in Puntland (1981-2010)

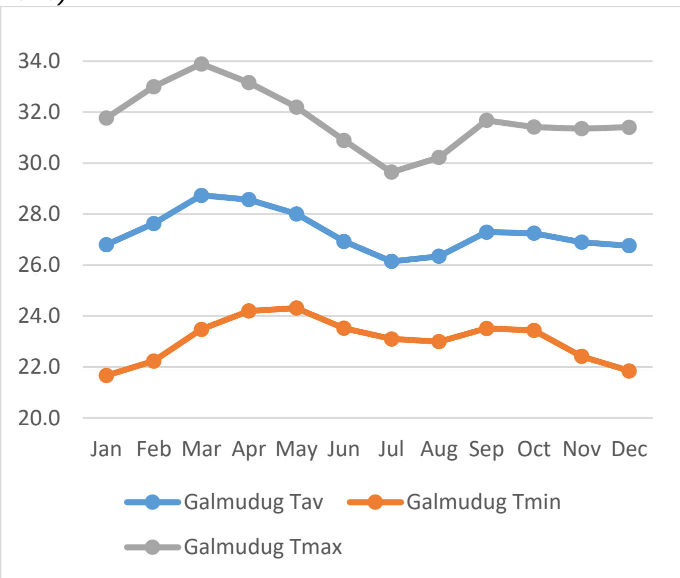


Figure 3.11-6 Minimum, Maximum and Average Monthly Temperature over Project Site in Glamudug(1981-2010)

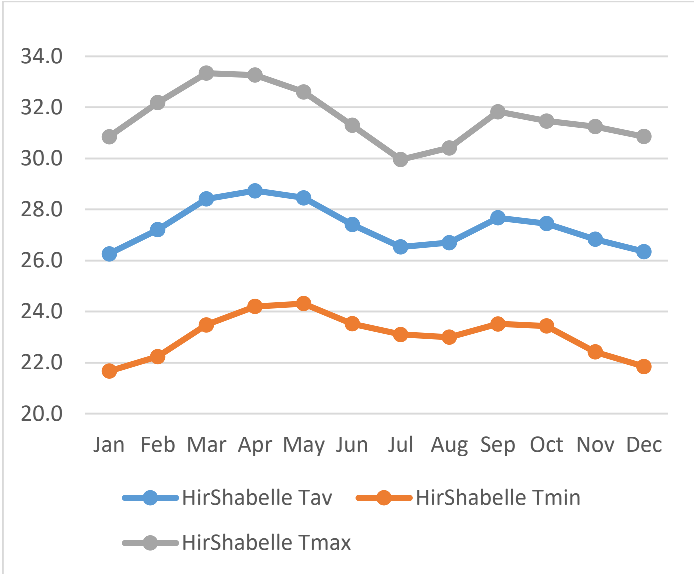
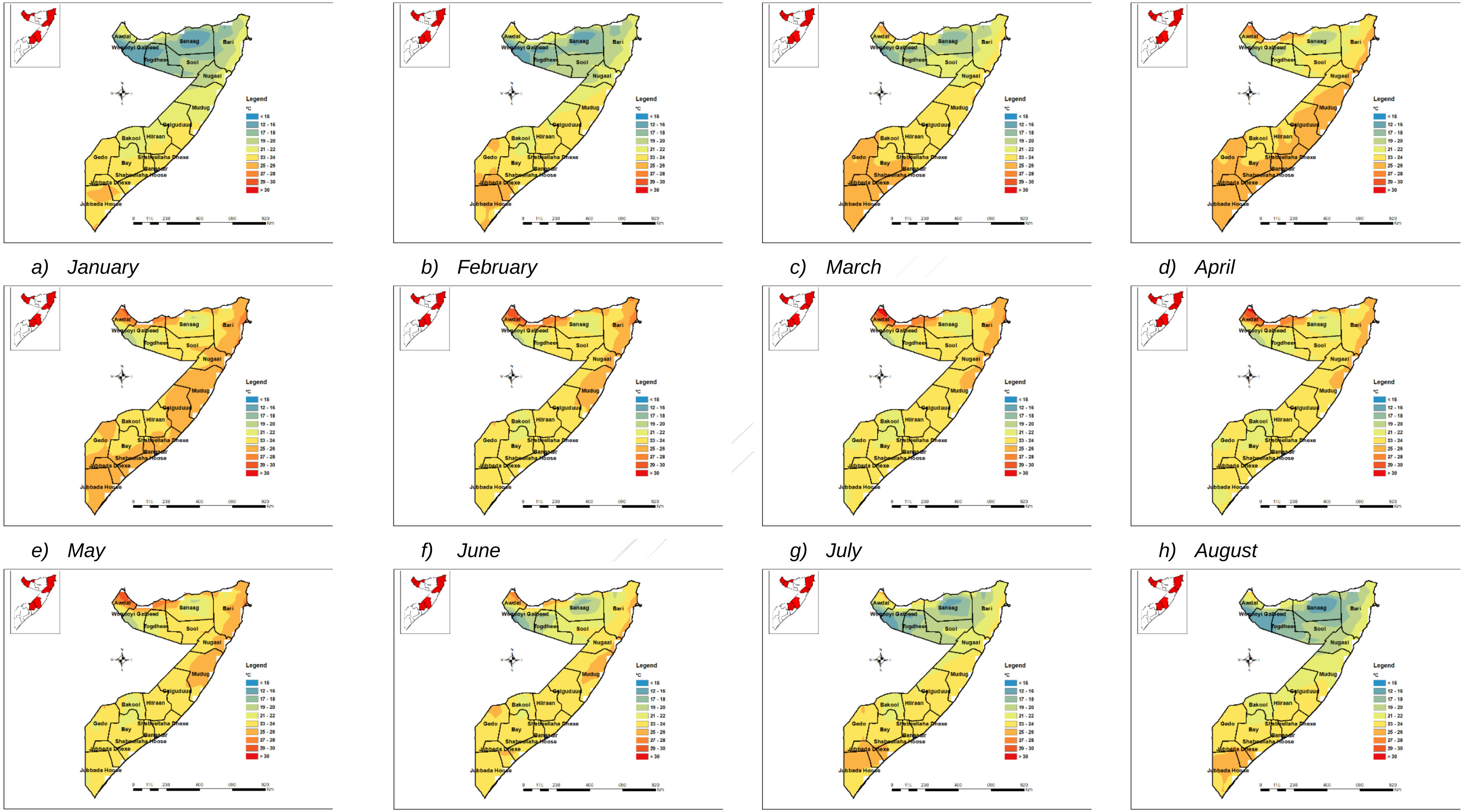


Figure 3.11-7 Minimum, Maximum and Average Monthly Temperature over Project Site in Glamudug(1981-2010)

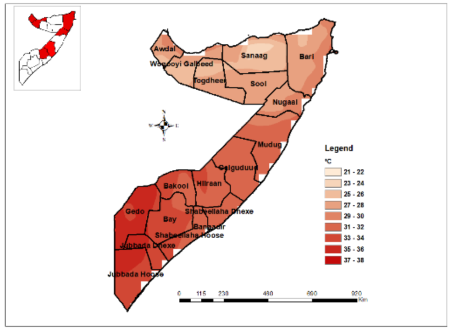
The spatial temperature characteristics are generally homogeneous in each region as shown in **Figure 3.11-8 to 3.11-9** though some variability is observed in Somaliland.



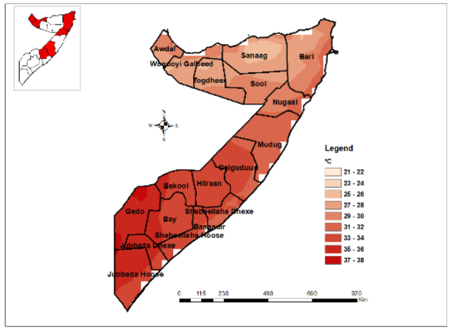
a) January
b) February
c) March
d) April
e) May
f) June
g) July
h) August
i) September
j) October
k) November
l) December

Figure 3.11-8 Average Monthly Minimum Temperature over the Somalia Region (1981-2010)

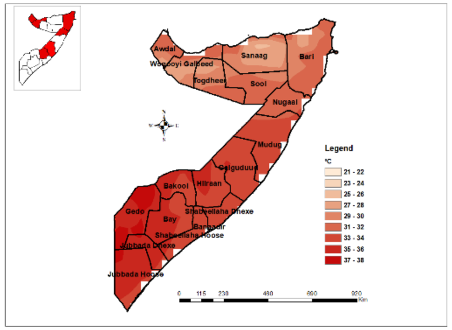
Figure 3.11-9 Average Monthly Maximum Temperature over the Somalia Region (1981-2010)



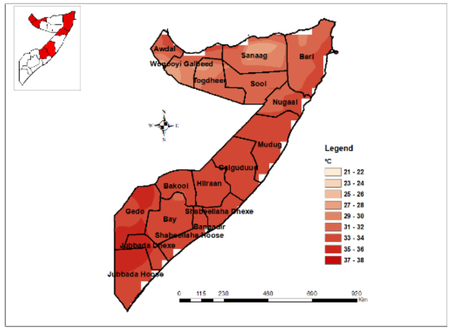
a) January



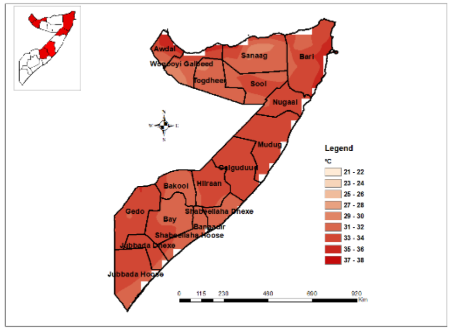
b) February



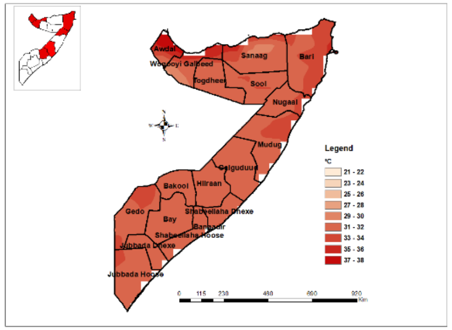
c) March



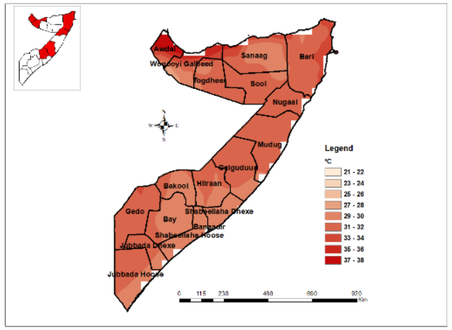
d) April



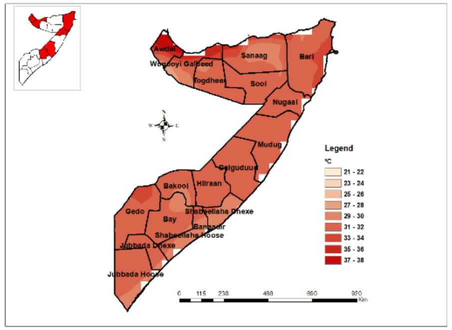
e) May



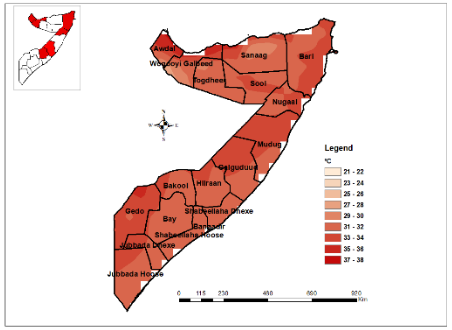
f) June



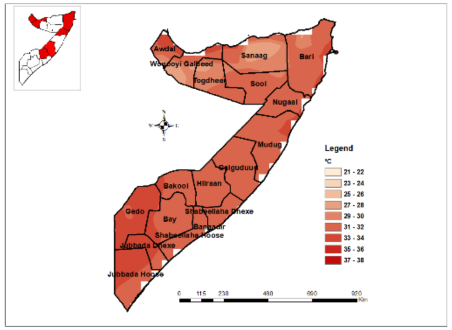
g) July



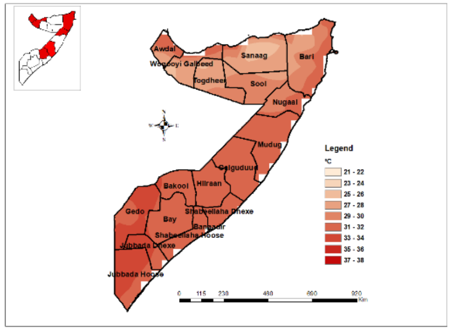
h) August



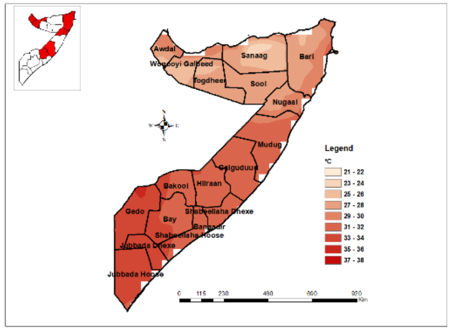
i) September



j) October



k) November



l) December

3.11.3 Seasonal Temperature Climatology

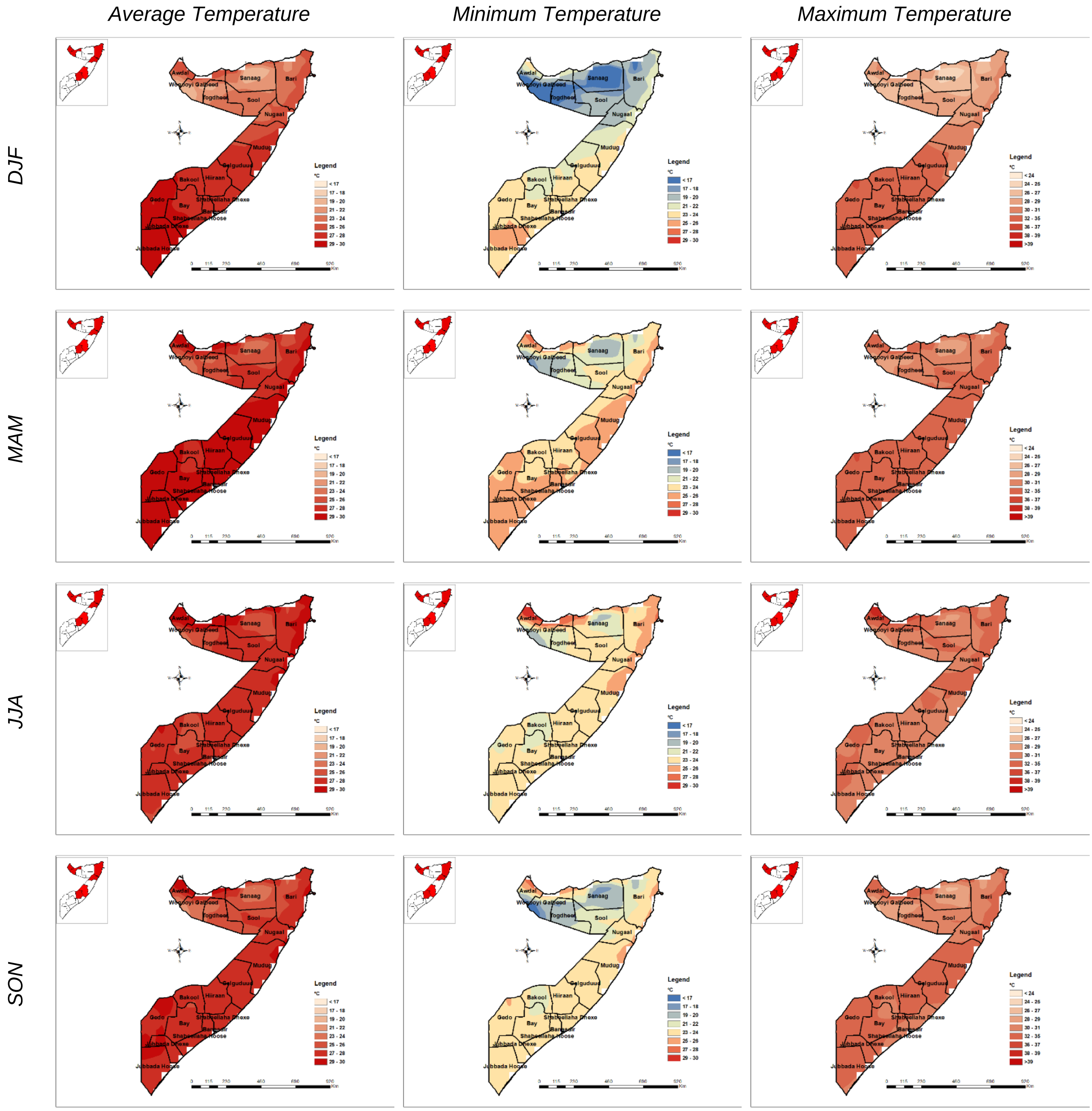
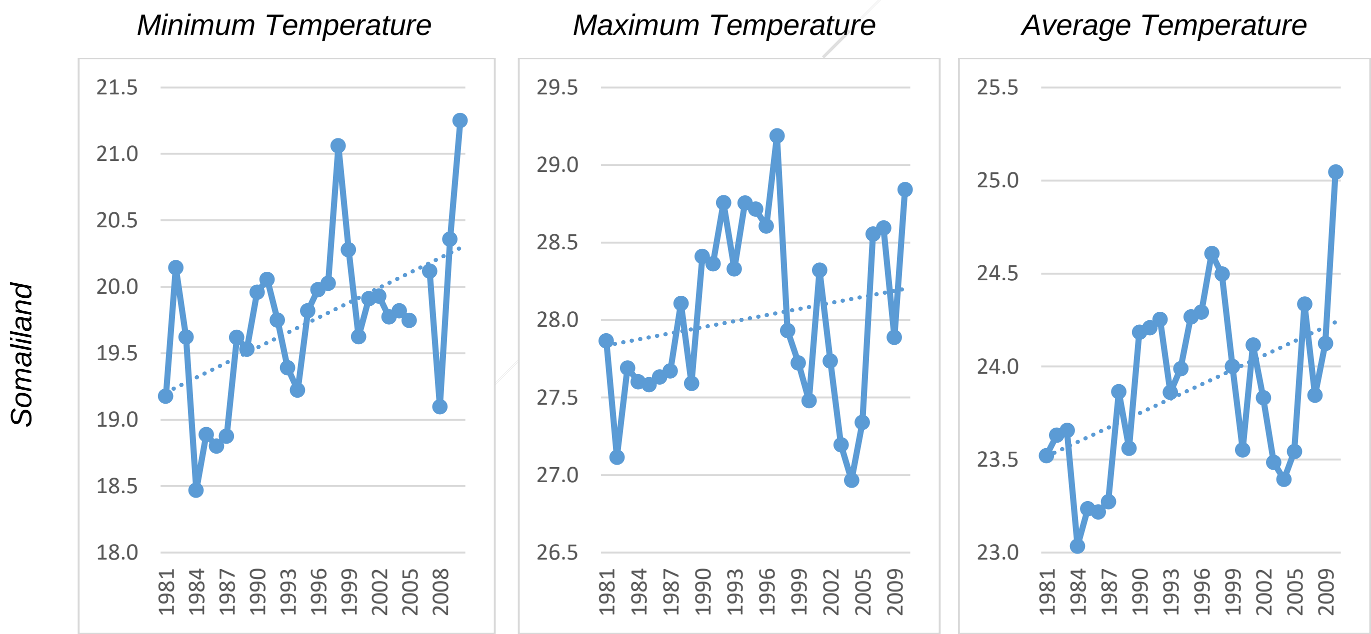


Figure 3.11-10 Average Seasonal Temperature over Somalia (1981-2010)

The temperature characteristics that were common with the monthly records are still evident from the respective seasonal temperature climatology. **Figure 3.11-10** shows that December – February (DJF) season are generally relatively cooler in Somaliland and Puntland while June –July (JJA) season is relatively cooler in Hirshabelle and Galmudug.

3.11.4 Temperature Trends

Temperature time series are shown in **Figure 3.11-11**. An overall increasing trend in average temperature is observed in Somaliland and Puntland, while a general decreasing trend is observed Galmudug and Hirshabelle. The observed trends were significant at 95% confidence. Although the observed increasing trends in the mean, minimum and maximum temperatures observed in Somaliland are consistent with global warming trends that are being observed worldwide, the short duration of data used could not enable us associate the observed warming trends to climate change and global warming signals (Ogallo, Ouma, & Omondi, 2017; IPCC, 2014). Mean surface temperature globally is reported to have increased by 1ºC (ICPAC, 2018; IPCC, 2014). The observed decrease in minimum and maximum temperature trends seen in Puntland, Galmudug and Hirshabelle is similar to observed trends in other coastal regions (Falvey & Garreaud, 2009; Gebrechorkos, Hülsmann, & Bernhofer, 2019)



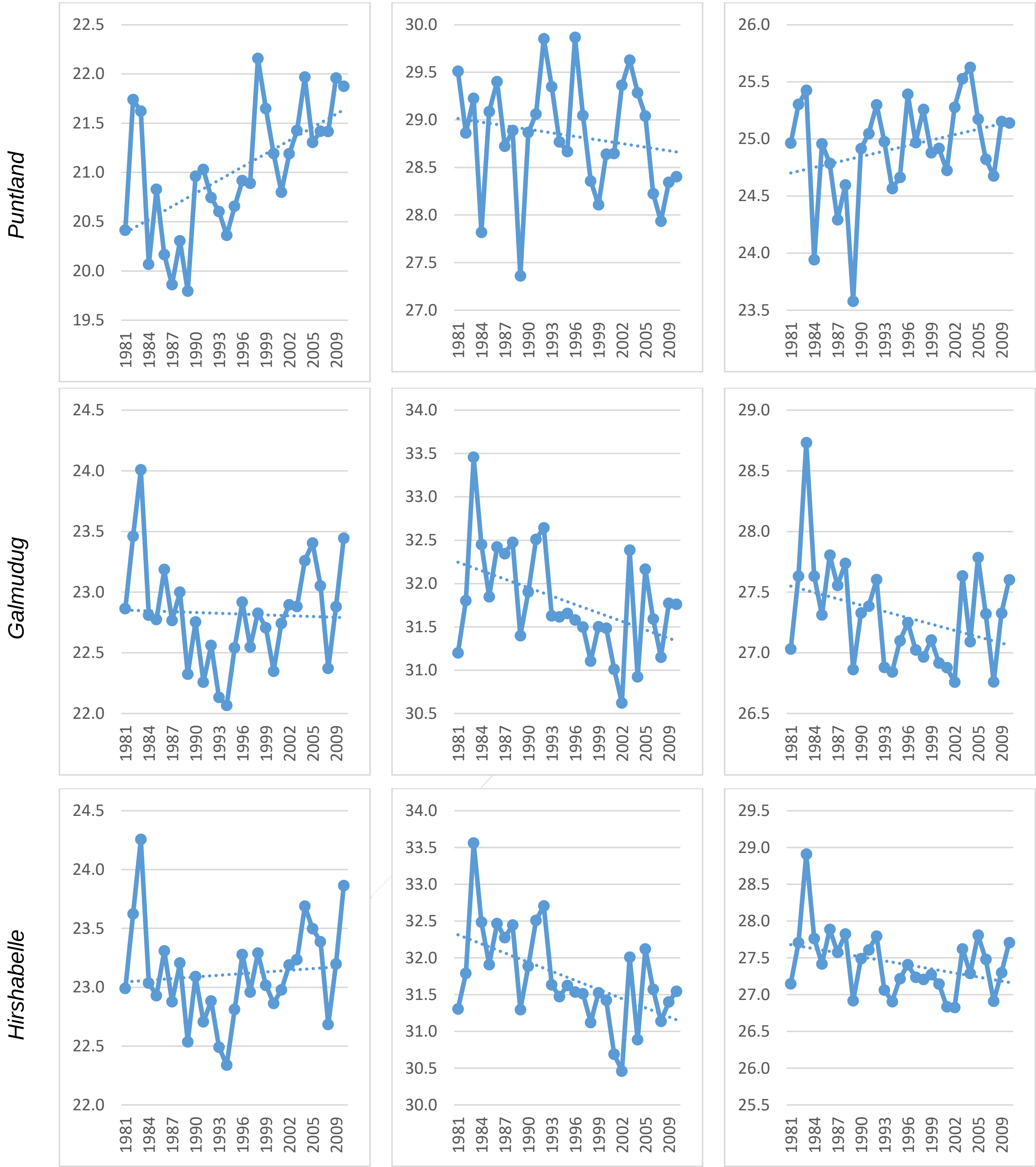
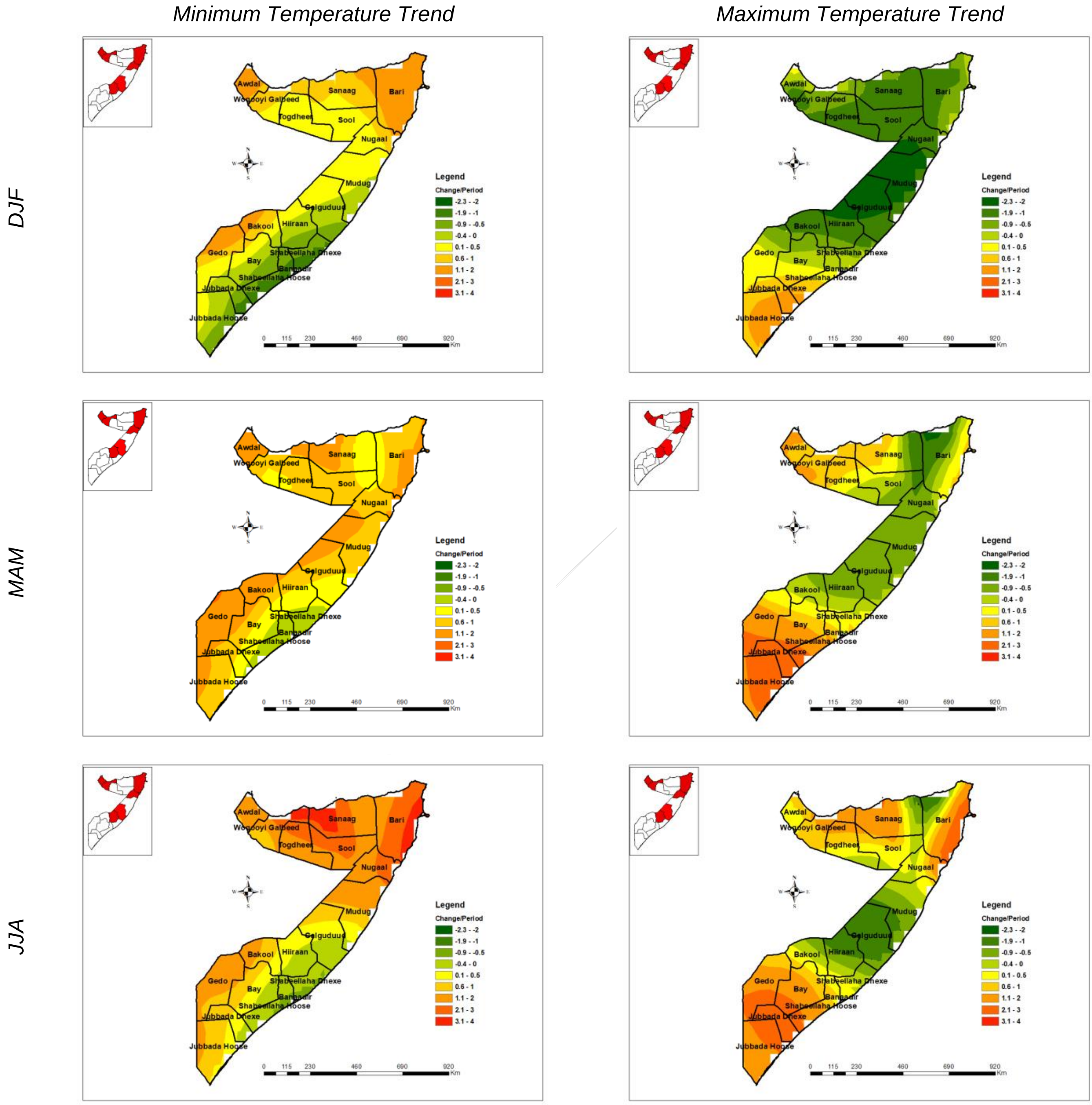


Figure 3.11-11 Time series for minimum, maximum and average temperature for RLACC sites (1981-2010)

Spatial and temporal patterns of the maximum and minimum temperature trends for over Somalia is shown in **Figures 3.11-12**. Although some variations were observed in space and time characteristics of temperature, the space-time variability were relatively consistent when compared to rainfall. The minimum temperature is generally increasing in both Somaliland and Puntland though temporal and spatial variability in the rate of increase is observed. Galmudug and Hirshabelle on the other hand show spatial variability in trend with some areas receiving a decreasing trend in temperature while other areas an increase in temperature **Figures 3.11-10**. Temporal and spatial variability is observed in the maximum temperature trend, with no clear patterns being delineated overall, as the trends differ from location to location and from season to season in Puntland and Somaliland. Galmudug and Hirshabelle are generally experiencing decrease in temperature though the rate of decrease varies from season to season.



SON

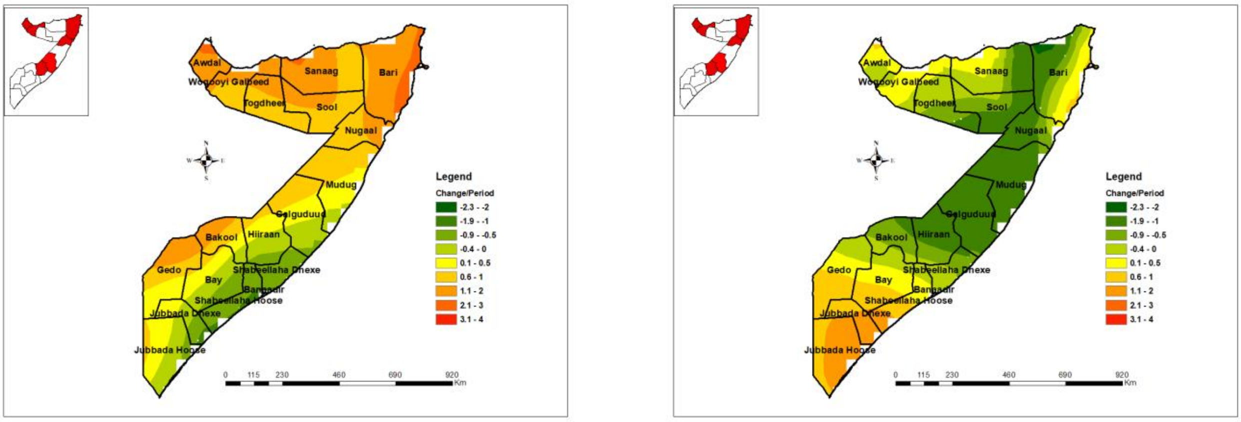


Figure 3.11-12 Mean Seasonal Temperature Trend over Somalia (1981-2010)

4. CONCLUSIONS

As stated, the Rural Livelihood's Adaptation to Climate Change in the Horn of Africa – Phase II (RLACC II) is a multinational program targeting Puntland (Bari and Nugaal regions), Somaliland (Awdal region) and Galmudug and Hirshabelle. The main objective of the project is to improve the resilience of pastoral and agro-pastoral communities to climate change in the HoA through: (i)introducing of adaptation strategies to reduce the negative impacts of climate change and strengthen the capacity of pastoral/agro-pastoral households to cope with climatic hazards, (ii) enhancing the capacity of communities to not only absorb shocks, but to also effectively adapt their livelihoods to harsher climatic conditions, (iii) helping pastoral and agro-pastoral households manage drought risks, (iv) supporting community-led initiatives to protect, conserve and restore natural resources in a sustainable and climate-resilient manner, (v) strengthening the participation of pastoral communities in planning and implementing activities pertaining to their development. The objectives are in line with the IGAD Drought Disaster Resilience Sustainability Initiative (IDDRSI) programme, the National Adaptation Plans of Action (NAPAs) and Development Strategies/Visions. Baseline climate data analysis in the Somalia were undertaken by organizing a workshop at ICPAC headquarters between February 10 and 14.

This report provides a summary of the observed baseline rainfall characteristics including rainfall intensity and associated variance; probability of exceedance of specific rainfall thresholds and associated variance; mean characteristics of wet/dry days and associated variance; probability of occurrence of specific wet/dry spells; Onset, cessation and length of growing seasons. Mean, maximum and minimum temperature baseline statistics were also presented. The report shows significant variations in rainfall characteristics in Puntland (Bari and Nugaal regions), Somaliland (Awdal region and Woqooyi Galbeed region) and Galmudug and Hirshabelle. The trend patterns were not consistent across the different regions as cases of positive and negative trends were evident. There were however clear evidences of increase in frequency and recurrences of the above and below rainfall events at all locations.

A general increase in mean, maximum and minimum temperatures were observed in Somaliland (Awdal region and Woqooyi Galbeed region). The observed increasing trends however, is consistent with global warming trends that are being observed worldwide, the short duration of data used could not enable us associate the observed warming trends to climate change and global warming signals. A general decrease in mean, maximum and minimum temperatures were observed in Galmudug and Hirshabelle. In Puntland (Bari and Nugaal regions), a general increase was observed in the mean temperature however a general increasing trend was observed in the minimum temperature while a decreasing trend observed in the maximum temperature.

The climate baselines from this report will serve as information material for all components of the project as well as the partners and stakeholders. It will also help to achieve project Outcomes 1.1 Climate change-related adaptation measures are integrated into development plans of targeted local communities; and Outcome 2.1: Adaptation practices are developed and implemented to respond to specific climate-change induced stress in the livestock sector in ASALs ecosystems. The workshop outcomes include among others:-

i. Capacity building of NMHs RInstat and CLIMSOFT for storage of station data and analysis of historical climate;
ii. Availability of climatological baseline based on analysis of historical climate of project sites including monthly climatology, rainfall intensity, historical onsets, rainfall and temperature trends among others;
iii. Availability of location specific climate products and services on which the climate hazard and other risk management maps can be created;

The report therefore has therefore provided firm foundation on which all components of the RLACC project are being implemented in Somalia.

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