SOMALIA

AFRICAN DEVELOPMENT BANK

NATIONAL CLIMATE CHANGE PROFILE

PRODUCED IN COLLABORATION WITH:
African Climate & Development Initiative, University of Cape Town;
Climate Systems Analysis Group, University of Cape Town;
Energy Research Centre, University of Cape Town; Cirrus Group.

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SOMALIA

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ACKNOWLEDGEMENT

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1. BACKGROUND

1.1 Geographic and socio-economic context

Somalia (officially the Federal Republic of Somalia, shown below in Figure 1-1) is an East African country situated at the Horn of Africa, bordered by the Indian Ocean to the east, Ethiopia to the west, Djibouti to the northwest, the Gulf of Aden to the north, and Kenya to the southwest. Somalia's landscape, the majority of which is classified as semi-arid or arid desert, is bordered by a coastline of ~3,300 km (the longest in continental Africa). As a result of protracted social and economic stability, Somalia's development has been severely undermined in the period since the outbreak of civil war in 1991. However, the establishment of coalition government structures and then the Federal Government in 2012 has supported the country to move towards the establishment of permanent democratic institutions, resumption of public services, and stabilisation of the economy. Despite recent progress, Somalia may still be considered among Africa's most vulnerable and fragile states, with considerable socio-economic and developmental challenges. As a result of the collapse of institutions and mechanisms for systematic record-keeping, there are major gaps in the quality and availability of basic demographic and economic information from Somalia. The world bank estimates Somalia's total GDP to be ~USD 6.2 billion per year and the GDP per capita as ~USD 434 per year. The urban population (~40% of the total population) is increasing at a rate over 4% per annum, and ~74% of urban residents live in 'slum' dwellings. Over 1/3rd of the country, approximately 5.9 million people, live within 100 km of the coast and are therefore vulnerable to coastal flooding. The fragility of Somalia's economy is partly a result of the vulnerability to climate-related hazards such as drought, floods and high temperatures. Somalia has the 6th largest number of people affected by drought in Africa and the 5th largest number of people affected by floods, where these climate-related events affected ~16,935,000 and ~3,300,000, respectively, during the period 1996-2016. Key socio-economic and demographic indicators are further presented and summarised in Table 1-1, below.

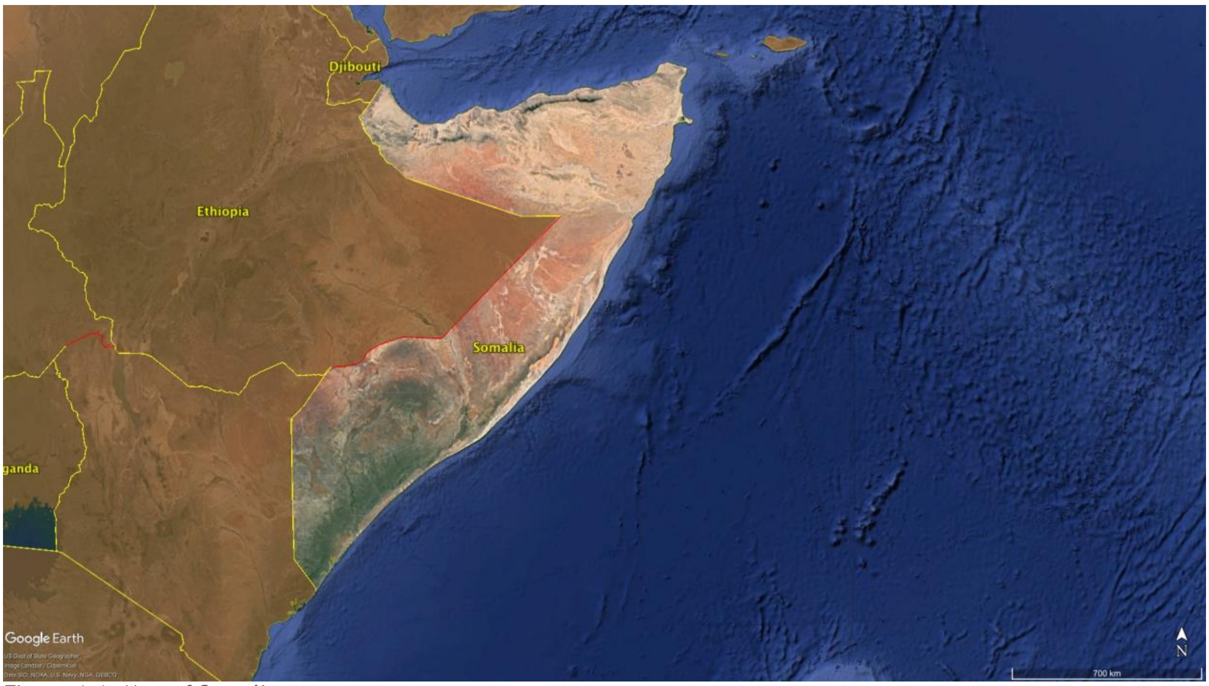


Figure 1-1: Map of Somalia

SOMALIA

Table 1-1: Socio-Economic Context of Somalia (reference year ranges from 2014 - 2017)

VARIABLE		SCORE/TOTAL	UNIT	RANK (OUT OF 54)
Geography, Socio-Economy and Demographics				
Population[1]		11,391,962	people	32
Population growth rate[1]		2.8	% population. yr^{-1}	16
Population density[1]		18	People/km^2	43
Land area[1]		625,932	km^2	18
% Urban population[1]		40.2	% population	25
% Urbanisation rate[2]		4.1	% population. yr^{-1}	17
Economy: total GDP[2]		6.2	USD billions. yr^{-1}	36
Economy: GDP/capita[2]		434	USD per capita/yr.	45
Access to electricity[3]		19.1	% population	42
Population below the poverty line[3]		38.0	% below USD 1.90 per day	24
Gender Inequality Index[4]		52.8		28
GINI co-efficient[3]		40.3		34
HDI[5]		0.49		30
Access to electricity[6]		61.0	% population	17
Summary indicators of climate change vulnerability				
Number of people affected by drought[4]		16,935,624	people	6
Number of people affected by flood events[4]		3,334,178	people	5
Population living within 100 km of coast[5]		5,914,330	people	13
Population living in informal settlements[3]		73.6	% urban population	13
Incidence of malaria[6]		86	cases per 1000 population at risk	34
ND-Gain Vulnerability Index[7]	Total	N/A		N/A
	Readiness	N/A		N/A
	Vulnerability	0.68		3

2. CLIMATE AND WEATHER

Somalia has an arid climate to the north and semi-arid climate to the south. Temperatures are hot, and rainfall occurs primarily during the long rains (March – May) associated with the southwest monsoons, and the short rains (October – November) associated with the northeast monsoons.

Somalia's water region extends to the northwest into Ethiopia and southwest into Kenya. Climate variation within that region is sufficient to distinguish three sub-regions primarily due to the magnitude of rainfall. The Somalia region is illustrated in **Figures 2-1** and **2-2**, below, and summary descriptions can be found in **Table 2-1** below.

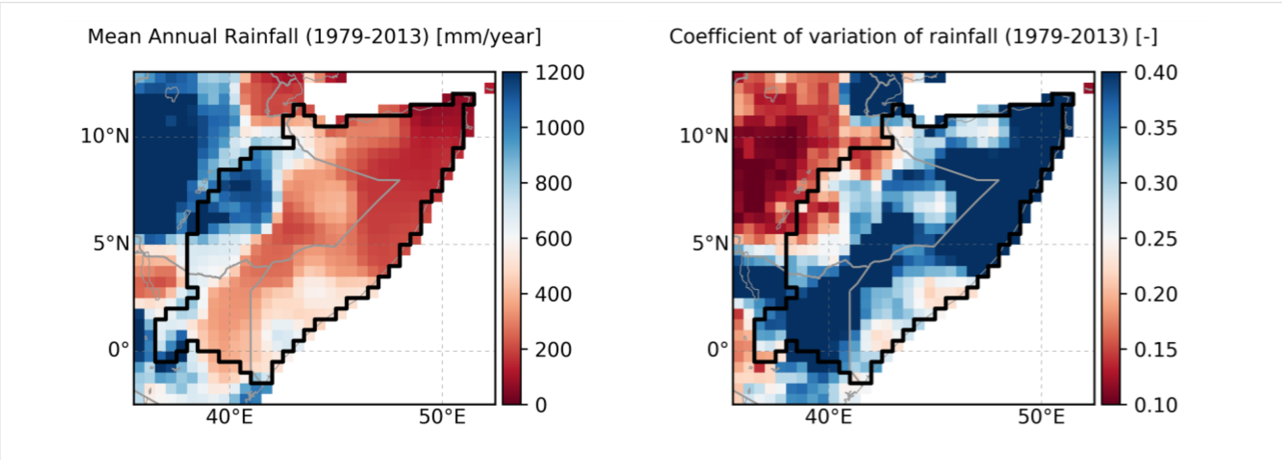
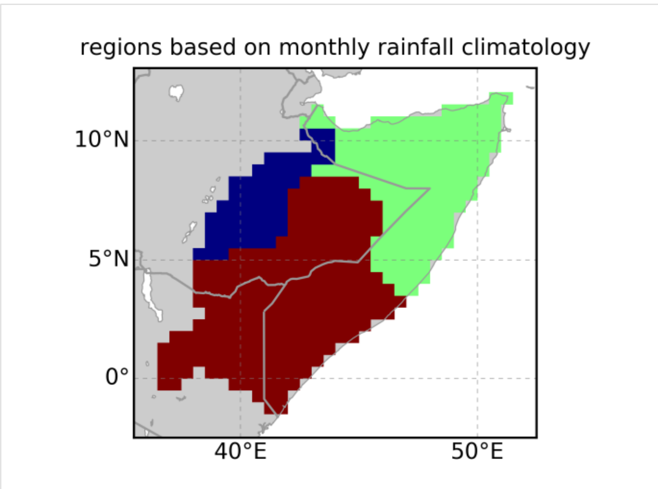


Figure 2-1: Main characteristics (magnitude and variability) of rainfall in Somalia and its region



Coloured regions on the map (above) correspond to the colours used in rainfall and temperature graphs (below)

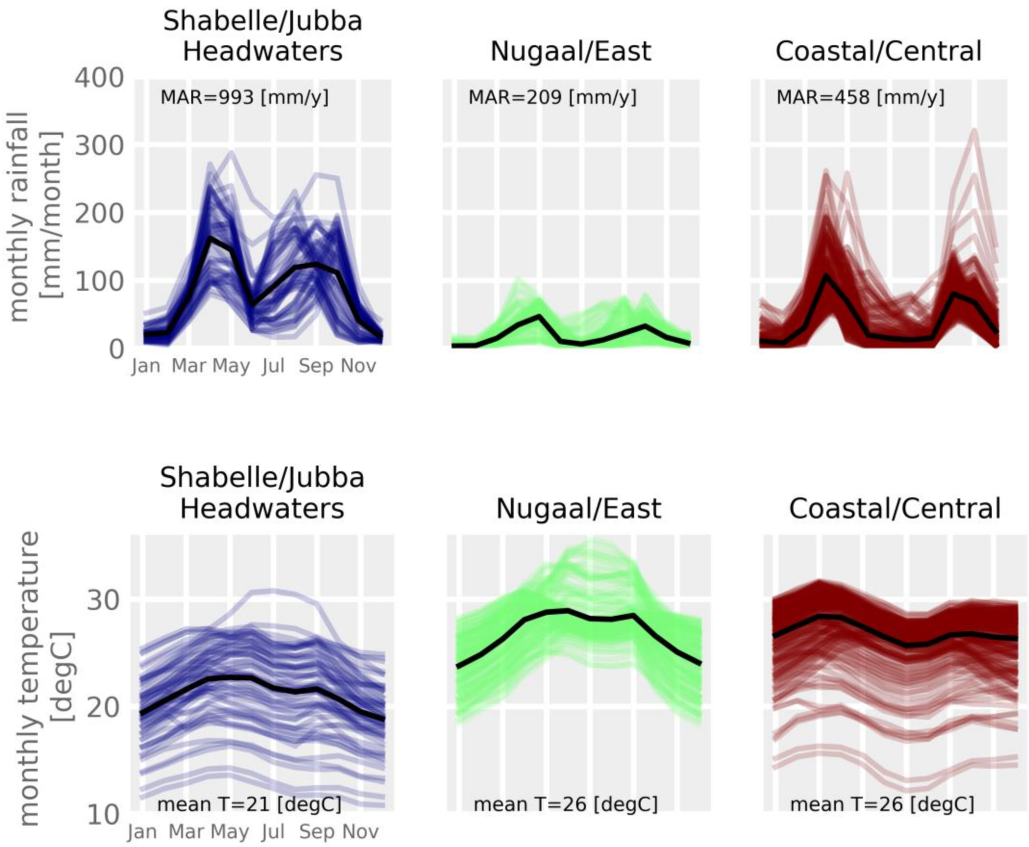


Figure 2-2: Rainfall regions of Somalia based on similarity of standardised rainfall climatology, and their rainfall and temperature climatologies

Table 2-1: Main characteristics of rainfall of Somalia region

SHABELLE / JUBBA HEADWATERS	Daily mean temperature of 21° C and mean annual rainfall reaching 1000 mm/year, with the magnitude of rainfall increasing with increased elevation within this region. Relatively low interannual variability is evident over most, but not all of the region. Rainfall occurs from March to October peaking during April and May (~160 mm/month) with a secondary peak from August to October (120 mm/month). A dry season occurs from November to February. The seasonal cycle of temperature averages 8° C with warmest temperature during boreal summer and coolest temperatures in winter. Strong spatial differences, due primarily to altitude, are found in temperature over this region.
NUGAAL / EAST	Daily mean temperature of 26° C and mean annual rainfall reaching only 210 mm/year, with values decreasing towards the northeast. The rainfall is very unpredictable which is seen in the large interannual variability. The seasonal cycle of temperature averages 7° C with warmest temperature during boreal summer and coolest temperatures in winter.
COASTAL / CENTRAL	Daily mean temperature of 26° C and mean annual rainfall reaching 460 mm/year, with highest values, and lower interannual variability, along the coast and over the higher elevation areas within Ethiopia and Kenya and lowest values over the central plains. The seasonal cycle of temperature averages 5° C with warmest temperature during boreal summer and coolest temperatures in winter. Strong spatial differences, due primarily to altitude, are found in temperature over this region.

2.1 Observed historical climate variations and climate trends

The majority of Somalia experiences **relatively high rainfall variability** on an inter-annual basis. On **decadal time scales** Somalia also experiences **clear variability** with some decades being relatively drier or wetter than others. This variability can be seen in the supporting evidence plots provided in the supplementary Appendix **(Figures A-1 to A-4).**

Long term trends across all three regions show **slight increasing temperatures** over the period 1979 – 2015. Long term increasing trends in total annual rainfall, the frequency of rainfall events and extreme rainfall events are relatively strong and statistically significant for the Nigaal / East region. No clear trend in total rainfall or extreme rainfall events, and only a non-statistically significant increase in rain day frequency are evident in the Coastal/Central region. The Shabelle/Jubba Headwaters region shows mixed results with a non-statistically significant decreasing trend in total annual rainfall and statistically significant increase in rain day frequency but decrease in extreme rain day frequency. Long term trends and variability in the Somalia region are summarized in **Table 2-2** below and illustrated further in the supplementary Appendix **(Figures A-1 to A-4).**

Table 2-2: Summary of trends in rainfall and temperature attributes in Somalia (1979 - 2015)

REGION	MEAN T [DEG C/DECADE]	TOTAL RAINFALL [MM/DECADE]	EXTREME RAINY DAYS [DAYS/DECADE]	RAINY DAYS [DAYS/DECADE]
Shabelle/Jubba Headwaters	+0.15	-36.1	-2.7	+5.1
Nigaal/East	+0.06	+22.8	+2.5	+4.5
Coastal/Central	+0.15	not evident	not evident	+2.7

2.2 Projected (future) climate change trends, including temperature, precipitation and seasonality

Projected changes in main attributes of climate for the Somalia region are summarized in Table 2-3, below, and described in Sections 2.2.1 and 2.2.1. Additional analysis and visualisation of projections be found in **Figures A-5 to A-8** in the supplementary Appendix.

2.2.1 Projected changes in precipitation from present to 2100

Rainfall projections across the Somalia region show a pattern of **potential increased rainfall** emerging from about the 2040s for the Shabelle/Jubba Headwaters and even earlier for the Coastal/Central and Nugaal/East regions. Relative magnitudes of potential increased rainfall for the Shabella/Jubba Headwaters region reach about 300mm/year or even 600 mm/year wetter by 2100 which equates to 30% or 60% of the baseline normal. The increase for the Coastal/Central and Nugaal/East regions is roughly 40% and 50% respectively above the baseline normal. **The increase in rainfall** seems to be strongly associated with an **increase in rainfall events and extreme intensity rainfall** (days above the 95th percentile). It must be noted that these results are derived from GCM projections which may not accurately represent changes in extreme rainfall dynamics. They are, however, consistent with the increased convective rainfall intensity (e.g. thunderstorm-related rainfall) expected in a warmer climate.

2.2.2 Projected changes in temperature from present to 2100

Air temperature is projected to be between 1 and 2.5°C warmer in the Somalia region by the 2050s. By 2100 the range of projected temperatures is greater with the coastal regions showing projected increases of 2.5°C to 5°C.

Table 2-3: Summary of projected climate changes across regions of Somalia for key climate variables by 2050

REGION	AVERAGE TEMPERATURE [°C]	TOTAL ANNUAL RAINFALL [MM/YEAR]	NUMBER OF HEAVY RAINFALL [DAYS/YEAR]	RAINY DAYS [DAYS/YEAR]
Shabelle/Jubba Headwaters	**Increasing** +1°C to +2.5°C by 2050s but changes evident in next decades	**Normal to increasing**, ranging from no change to an increase of up to 50% by 2100. Change could become evident after 2050s	**Normal to increasing**, could become evident in the 2030s	**Normal to increasing**, could become evident in the 2050s
Coastal / Central	**Increasing** +1°C to +2°C by 2050s but changes evident in next decades	**Normal to increasing**, ranging from no change to an increase of up to 100% by 2100. Change could become evident after 2030s	**Normal to increasing**, could become evident in the 2050s	**Normal to increasing**, could become evident in the 2030s
Nugaal / East	**Increasing** +1.5°C to +2.5°C by 2050s but changes evident in next decades	**Normal to increasing**, ranging from no change to an increase of up to 50% by 2100. Change could become evident after 2030s	**Normal to increasing**, could become evident in the 2050s	**Normal to increasing**, could become evident in the 2030s

2.3 Expected climate vulnerabilities

NOTE: Determining vulnerability of different sectors to climate variations or change is extremely challenging as there are many factors involved in vulnerability and different approaches can yield different results. The vulnerabilities presented here are based on UNFCCC reporting documents such as national communications or national adaptation plans of action where available, and other literature where UNFCCC documents are not available.

Dominated by areas classified as semi-arid or desert Somalia can be considered a water scarce country and increasing temperature trends is likely to increase the pressure on water resources despite indications that rainfall trends may be normal to increasing into the future. With historically frequent and severe droughts and devastating floods causing large-scale starvation and death of both people and livestock the possible increase in extreme rainfall events into the future is a major concern. Increasing temperature and more extreme rainfall is of further concern for both the economy and for food security, given the dominating role of agriculture, a highly climate sensitive sector which engages 70% of the Somali workforce. Given Somalia's extensive coastline, where about one third of the country's population is located, a large portion of the human settlements and associated developments are vulnerable to sea-level rise and associated stresses.

Table 2-4: Broad scale sectoral vulnerabilities and potential climate change impacts in Somalia

SECTOR	IMPACTS
Agriculture	- **Loss of livestock and reduced productivity (fertility and reproduction), owing to drought** - Increased incidence of pests, diseases and insect invasions, owing to contamination of water reservoirs, high temperatures or extreme rainfall - **Loss of pasture land as erosion spreads and sand dunes emerge, owing to drought** - Reduced productivity of agricultural lands owing to extreme rainfall, and loose topsoil being swept away with strong winds - Crop loss and reduced yields, particularly for fruits, owing to strong winds or extreme rainfall - Increased salinity in rivers and shallow wells - **Reduced availability of irrigation water owing to drought** - Increased exposure of plants to water stress, owing to high temperatures - Increased water demand owing to high temperatures - Increased demand for agricultural input and insufficient supply - Loss of stored food owing to extreme rainfall - **Rising local food prices owing to drought** - Increased potential for conflict between farmers and pastoralists
Fisheries	- **Reduced plankton production owing to drought** - Increased salinity in coastal groundwater due to salt-water intrusion owing to drought - Coral reef destruction owing to high sea-surface temperatures - Water contamination as waste water flow into the sea, owing to extreme rainfall - Destruction of mangroves owing to extreme rainfall
Water resources	- **Reduced availability of and increased demand on water resources, both from shallow wells and groundwater, owing to drought and high temperatures** - Decreased water quality, owing to droughts leading to more concentrated water pollution and extreme rainfall leading to increased water contamination - **Increased sedimentation owing to strong winds or extreme rainfall** - **Increased water prices owing to drought** - **Increased potential for conflict over limited water resources owing to drought** - **Decreased water infiltration owing to drought, steep terrain, shallow and thin soils and sparse vegetation** - Infrastructure damage, flooding and contamination owing to extreme rainfall and lack of infrastructure for capture and storage of floodwater - Salinization of coastal aquifers, owing to sea level rise and changing ocean dynamics
Built infrastructure and human settlements	- Disruption to local services, including telecommunications, electricity and transportation, owing to strong winds or extreme rainfall - Damage to or destruction of infrastructure, including houses, canals, roads and markets, owing to extreme rainfall - Increased pollution and spread plastic waste owing to strong winds - Sewage overflows in urban areas owing to extreme rainfall - **Spread of sand dunes in coastal areas owing to drought**

SECTOR	IMPACTS
Human health	- Increased prevalence of vector-borne diseases such as malaria, owing to increased temperatures - Increased prevalence of water-borne diseases, such as cholera and diarrhoea, owing to extreme rainfall and poor sanitation - Increased prevalence of skin disease owing to increased temperatures - Increased prevalence psychological illness due to stress owing to drought - Increased incidence of tuberculosis, pneumonia, asthma and other lung and nasal diseases owing to drought or extreme rainfall - Increased number of people at risk of heat-related medical conditions, such as heat stroke, sunburn, dehydration, heat exhaustion and sunstroke owing to drought and high temperatures - Increased loss of life owing to heavy or sharp objects (especially GI sheets used as roofing) being flung at people due to strong winds - Overburden on existing health facilities owing to additional illness and diseases outbreaks owing to increasing temperatures and more frequent and intense extremes - Destruction of pharmaceuticals owing to exposure to increased temperatures - Destruction of health service facilities owing to extreme rainfall - Increased food insecurity and malnutrition, owing to drought and extreme rainfall

3. CLIMATE CHANGE MITIGATION, GREENHOUSE GAS EMISSIONS AND ENERGY USE

The major carriers of Somalia's energy mix, and the energy demands of major economic sectors, are summarised in Section 3.1, below. The major sources of GHG emissions, described by fuel source and sector, are described in Section 3.2. The latter section also includes summarised statistics on Somalia's agriculture sector, historical land use change and vegetation cover.

3.1 National energy production and consumption

Somalia's energy sector is characterised by particularly poor quality and availability of data, and as a result all figures presented below should be considered as rough estimates and projections. However, the majority of Somalia's population suffers from major deficits in energy production and electricity access. Effectively, biomass-based fuels account for virtually all energy applications aside from a small quantity of oil products which support the transport sector and the limited generation of (on-grid and off-grid) electricity. National energy production from biomass fuels totals ~3.1 MTOE, compared to an estimated ~0.1 MTOE from oil products, beyond which no other major energy sources are identified.

The residential sector accounts for the majority of national energy consumption (over half of national energy consumption at ~1.6 MTOE), after which the next-largest consumer of energy is 'non-specified' users (0.6 MTOE). The only other major energy-consuming sectors that could be identified for Somalia were the industrial and transport sectors (~0.04 MTOE each, or ~1.3% of national total). The total annual GHGs emitted by the abovementioned sectors and fuel carriers are described further in Section 3.2.

Unless stated otherwise, all energy figures are derived from UN Stats (2014) [10]; World Energy Council (2016); [11]; and the World Resources Institute (2013) [12]. Agriculture & forestry-related emissions are also reported from Food and Agriculture Organisation (2014-2017) [14] and Global Forest Watch. (2015-2017) [15].

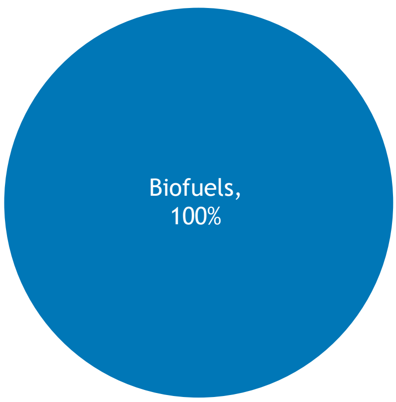


Figure 3-1: Distribution of Somalia's national energy production between major energy carriers (2014-2016)

Table 3-1: National energy and electricity production in Somalia (2014-2016)

NATIONAL ENERGY PRODUCTION[8]		
Source	Total (MTOE)[1]	% of total energy production
Biofuels[8]	3.1	100
Total national energy production	3.1	

[1] *Energy is expressed in 'Megatonnes of Oil Equivalent', where 1 Tonne Oil Equivalent = 11,630 KiloWatt hours (KWh)*

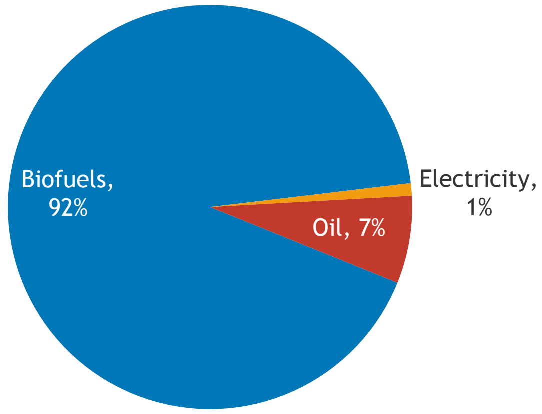


Figure 3-2: Distribution of Somalia's national energy consumption by major energy carriers

Table 3-2: Somalia's national energy consumption by energy source

CONSUMPTION BY ENERGY SOURCE[8]	
Source	**Total (MTOE)**
Oil	0.1
Biofuels	2.2
Electricity	0.0
Total national energy consumption by source	2.3

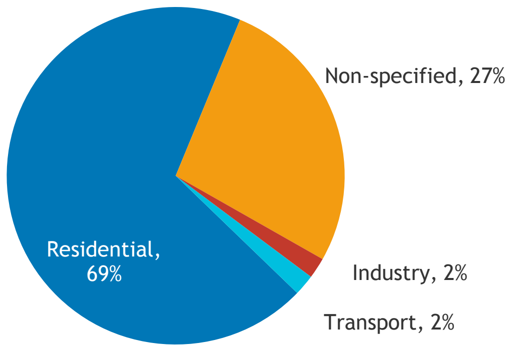


Figure 3-3: Distribution of Somalia's national energy consumption by sector (2014-2016)

Table 3-3: Somalia's national energy consumption by sector (2014-2016)

CONSUMPTION BY SECTOR[8]	
Source	**Total (MTOE)**
Industry	0.04
Transport	0.04
Residential	1.6
Non-specified	0.6
Total national energy consumption by sector	2.3

Table 3-4: Somalia's national total primary energy supply (estimated for 2014-2016)

TOTAL PRIMARY ENERGY SUPPLY[8]	
Source	**Total (MTOE)**
Oil	0.2
Biofuels	2.9
Total primary energy supply	3.1

3.2 National greenhouse gas emissions by source and sector

Section 3.2.1, below, describes GHG emissions from energy consumption – these figures include direct combustion of fuels as a primary energy carrier as well as conversion to other forms of energy (e.g. transport). These figures are based on statistics from the United Nations Statistics Division and have been derived using IPCC methods from the Guidelines for National Greenhouse Gas Inventories. Section 3.2.2 provides additional details on Somalia's Land Use and Land Use Change sector, including detailed summaries of emissions from the agriculture sector and historical land use changes.

3.2.1 GHG emissions from energy consumption, by source and sector

Table 3-5: Somalia's national greenhouse gas emissions from energy consumption (estimated for 2014-2016)

GHG EMISSIONS FROM ENERGY CONSUMPTION BY SOURCE AND SECTOR	
Source / Sector	**Total emissions (MT CO_2e)**
Oil	0.35
Biofuels	8.91
Total fuel source emissions	9.27
Manufacturing, construction and mining	0.14
Transport (road)	0.13
Domestic households	6.56
Other consumers	2.44
Total sector emissions	9.27

**Emissions statistics derived from UNstats energy data, using IPCC conversion methods from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*

3.2.2 GHG emissions from agricultural practices

Table 3-6, below, summarises GHG emissions from Somalia's agriculture and land use sector (derived from Food and Agriculture Organisation statistics). In the case of Somalia, the livestock production sector is the primary contributor to agricultural GHG emissions. In particular, enteric fermentation and manure left on pastures contributes ~90% (~18.4 out of a total of 20.3 MT CO_2e) of total GHG emissions from this sector, the remainder accounted for by other fractions of livestock manure management. No figures are available for GHG emissions from crop cultivation and soil management. With respect to emissions from land use change, the majority of emissions are attributed to forest land (13.2 MT CO_2e), which may be attributable to the conversion of the small remaining extent of dense forested areas by the charcoal trade.

Table 3-6: National annual greenhouse gas emissions from agricultural practices, forestry and other land use in Somalia (estimated for 2014-2017)

VARIABLE		ANNUAL EMISSIONS (MT CO_2E)
Annual GHG emission from agricultural practices [9]	Burning - crop residues	<0.01
	Burning - savanna	0.02
	Crop residues	0.03
	Enteric fermentation	13.0
	Manure management	0.6
	Manure applied to soils	0.1
	Manure left on pasture	6.4
	Rice cultivation	<0.01
	Sub-total (Agricultural practices)	20.3
Annual GHG emission from land use change [9]	Forest land	13.2
	Burning biomass	<0.01
	Sub-total (Land use change)	13.2
Total emissions		33.5

Table 3-7, below, summarises the recent historical changes in land use in Somalia through analysis of land use change. Statistics derived from the Global Forest Watch database were used to summarise the total area of wooded vegetation in various categories of canopy cover density (where 10-30% canopy cover can be considered as savanna, 30-50% cover can be considered woodland and 50-100% cover can be considered dense forest), as well as the historical rates of change in each vegetation category. Somalia is largely characterised by arid semi-desert and desert and as a result total national tree cover is only ~6.1% (~3.87 million hectares). The most common category of wooded vegetation is savanna woodland and grassland (~3.79 million hectares), while there is estimated to be less than 100,000 hectares of remaining wooded vegetation with canopy cover > ~30%. Global Forest Watch reports the total aboveground carbon stock of Somalia's forest and woodland biomass as ~379.6 million tonnes.

Table 3-7: Vegetation cover and land use change in Somalia (estimated for 2015)

VARIABLE		TOTAL (HECTARES)	TOTAL (% OF LAND AREA)	UNIT
Total tree cover [10]	10-30% canopy cover	3,787,952	5.94	% of total land area
	30-50% canopy cover	69,149	0.1	
	50-100% canopy cover	14,255	0.0	
	Total	3,871,356	6.1	
Land use change and agricultural expansion	Historical annual rate of deforestation[11]	10-30% canopy cover	0.0	% of previous year
		30-50% canopy cover	0.2	
		50-100% canopy cover	0.5	
	Area of agricultural land[18]	44,853,004	70.3	% of total land area

4. SUMMARISED NATIONAL PRIORITIES FOR CLIMATE CHANGE ADAPTATION AND MITIGATION

Somalia's main priority actions related to climate change are described in the country's submissions to the UNFCCC through the Intended Nationally Determined Contributions (NDC) document. This document includes detailed descriptions of Somalia's major commitments and priorities related to GHG mitigations (Table 4-2, below) as well as major priorities related to adaptation (Table 4-3, further below).

As described in Section 3, above, the production and consumption of biomass fuels (mainly in the forms of charcoal and firewood) is the largest contributor to Somalia's GHG emissions and is given significant consideration in the country's NDC. Somalia's charcoal trade has implications for climate change mitigation as well as adaptation, as the negative impacts include: i) the significant emission of GHGs through deforestation and carbonization of wood; as well as downstream impacts that include ii) ecosystem degradation, desertification, reduced supply of ecosystem services and increased vulnerability to natural disasters. In addition to describing the negative environmental impacts of the domestic use and exports of charcoal within the energy sector, Somalia's NDC includes detailed emphasis on the importance of livelihoods based on natural resources such as livestock, crops, fisheries and wildlife to climate-vulnerable populations. In consequence, Somalia's NDC describes multiple activities and priorities which target cross-sectoral actions including interventions in land use, energy and agricultural activities while increasing the capacity of vulnerable populations – many of which are likely to deliver adaptation and mitigation co-benefits.

The majority of Somalia's proposed actions to respond to climate change described in the NDC are incorporated into the design of nine "ready for implementation and planned adaptation and mitigation NDCs projects", including indicative estimated costs for seven of the nine projects (required preliminary financial support of at least ~USD 103 million), listed below. Project concepts which are mainly focused on adaptation include:

- Sustainable Land Management to Build Resilient Rural Livelihoods and Enable National Food Security (USD 6.45 m);
- Integrated Water Resources Management to Ensure Water Access and Supply to Vulnerable Populations and Sectors (USD 8.1 m);
- Reducing Risks among Vulnerable Populations from Natural Disasters (USD 4.1 m);
- Project for Domestication of Indigenous and the Introduction of Economically Important Plant Species (USD 1.043 m); and
- Marine and Coastal Environmental Governance and Management of Somalia (USD 31.35 m).

Project concepts which are mainly focused on mitigation include:

- Rehabilitation of Fanoole Hydro-Electric Dam and Irrigation Infrastructure (USD 28.175 m); and
- Up-scaling the Use of Solar Energy (costs to be determined).

In addition to the abovementioned project concepts, Somalia's NDC identifies cross-cutting project concepts which explicitly address adaptation and mitigation impacts such as:

- Charcoal Production from Prosopis and Replacement with Crop Production (costs to be determined); and
- UN Joint Programme on Sustainable Charcoal Production and Alternative Livelihoods (PROSCAL) (USD 23.67 m).

Table 4-1, overleaf, gives details on Somalia's GHG reduction targets outlined in the country's NDC, with information on target gases and sectors, the use of international markets in achieving targets (e.g. the use of carbon credits), and accounting methods used to quantify GHG emissions (e.g. inclusion of land use and land use change).

Table 4-1: Summary of Somalia's NDC commitments for reduction of GHG emissions

GHG EMISSIONS REPORTED IN NDC (MT CO2E/YR)	BASE LEVEL	REDUCTION TARGET	TARGET YEAR	SECTORS AND GASES	USE OF INTERNATIONAL MARKETS	LAND-USE INCLUSION / ACCOUNTING METHOD
N/A	N/A	A series of policies and projects on mitigation and adaptation	N/A	land use, renewable energy, coastal resource management	Not mentioned	N/A

4.1 National priorities for climate change mitigation

As described above, the majority of Somalia's climate change priorities include a focus on adaptation as well as mitigation. Furthermore, some of the project concepts (such as proposed project 'Upscaling the Use of Solar Energy') require additional elaboration and development. Therefore, selected highlights of Somalia's major priorities for actions and investments related to climate change mitigation are summarised in Table 4-2, below, categorised according to sector. Proposed activities and investments within each sector are further categorised according to 'Technology Type', based on the categories of technologies listed by the Green Climate Fund's (GCF) impact indicators for mitigation projects (key for technology types provided below Table 4-2). The below-mentioned technology types and specific actions represent Somalia's immediate national priorities for investments in climate change mitigation and reflect recent and ongoing policy-level measures to reduce GHG emissions and increase energy efficiency - however it is anticipated that other detailed mitigation measures will be identified and described in the future.

Table 4-2: Mitigation priorities in Somalia's NDC

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE[2]	PROPOSED PROJECT
Energy / Community-based / AFOLU	Formulation and adoption of Regional Charcoal Policy Framework	4, 5, 9	UN Joint Programme on Sustainable Charcoal Production and Alternative Livelihoods (PROSCAL)
	Establishment of Monitoring Systems of Charcoal Production, Reporting and Movement in Somalia		
	Establishment of Charcoal Trade Regulatory Committee at the Regional Level		
	Capacity building of government institutions, communities and local governments		
	Mass awareness on the impacts of charcoal on environment, livelihoods and national economy		
	Accelerated diffusion of energy efficient cook-stoves for reduction in charcoal consumption		
	Sustainable and efficient production of charcoal (green charcoal) for local consumption		
	Energy Plantations managed sustainably to meet the local demand of charcoal and fuel wood		
	Establishment of Liquefied Petroleum Gas (LPG) market in main urban centres		
	Introduction of Biogas as an alternative source of energy in areas with heavy loads of biodegradable feedstock		
	Establishment of Solar energy market and accelerated diffusion of solar energy equipment to reduce local charcoal production		
	Rehabilitation of the dam and the hydroelectric network		Rehabilitation of Fanoole Hydro Electric Dam and Irrigation Infrastructure
	Rehabilitation of Dam and its hydroelectric equipment		
	Provision of electricity to towns downstream of the dam		
	Rehabilitation of Primary and Secondary Canals and Reversing of the Flow of River to its Origin		
	Rebuilding of Offices and Residential Houses and Allocation of Land to Investors and Local Farming Community		

[2] *GCF Technology Type Key (derived from GCF's Results Framework for mitigation)*

1. Reduced emissions through increased lower emission energy access and power generation.

2. Reduced emissions through increased access to low-emission transport.

3. Reduced emissions from buildings, cities, industries and appliances.

4. Reduced emissions from land use, deforestation, forest degradation, and through sustainable management of forests and conservation and enhancement of forest carbon stocks.

5. Strengthened institutional and regulatory systems for low-emission planning and development.

6. Increased number of small, medium and large low-emission power suppliers.

7. Lower energy intensity of buildings, cities, industries, and appliances.

8. Increased use of low-carbon transport.

9. Improved management of land or forest areas contributing to emissions reductions.

4.2 National priorities for climate change adaptation

In terms of climate change adaptation, Somalia's NDC includes detailed national priorities for sectors including AFOLU, Water, Coastal Zones and Human Health. Somalia's proposed activities and investments related to adaptation are further categorised according to 'Technology Type', based on the categories of technologies listed by the Green Climate Fund's (GCF) impact indicators for adaptation projects (key for technology types provided below Table 4-3). In the AFOLU sector, Somalia's priorities include a strong focus on increasing resilience to climate risks through promoting the adoption of integrated, sustainable land management practices to reduce erosion, increase soil fertility, reduce crop losses, reduce burning, enhanced forest, shrub and grazing vegetation. Areas to be prioritised for restoration and demonstration of sustainable management practices include rangeland, woodland, cropland and watershed areas. Another important measure prioritised for the AFOLU sector in Somalia is the establishment of a seasonal early warning system to target the pastoral livestock sector and provide timeous warnings of risks to food security such as drought and outbreaks of pests and disease.

With respect to the waster sector, Somalia's adaptation priorities include inter alia detailed measures for integrated water resource management, construction of large-scale water capture and storage facilities, development of small-scale water harvesting and storage infrastructure (such as berkeds, shallow wells, ponds), and increased physical protection of flood-prone wadis, low-lying areas and water distribution infrastructure through construction of checkdams, gabions and anti-flooding embankments. In the coastal zone, Somalia's adaptation priorities are relatively undetailed and mainly relate to the establishment of an appropriate legal framework to manage and protect Somalia's coastal resources. Additional adaptation priorities relating to Somalia's coastal zones includes some activities relating to the establishment of coastal nurseries to supply seedlings for restoration/replanting of mangroves and other coastal vegetation areas, protection of coastal ecosystems such as mangroves and coral reefs, and improved measures to protect against environmental hazards such as illegal fishing, waste dumping and oil spills.

With respect to overall objectives for reducing the vulnerability of local Somalis to the impacts of climate change, Somalia's adaptation priorities do include detailed measures to strengthen the National and Regional Disaster Risk Management Authorities, as well as improve coordination and information-sharing between the primary stakeholders engaged in disaster risk management. Somalia's NDC notes the need to enable increased collection and analysis of data relating to climate-related disasters and risks to support effective decision-making on DRM and DRR, which may include increased emphasis on community-level mapping of high vulnerability areas to risks of drought and flooding, dusts storms and strong winds, and integration into local disaster risk management plans and responses. Somalia's high-level adaptation priorities ultimately include the establishment of a national Early Warning System with a particular focus on climate-related risks in areas of high vulnerability.

Table 4-3: Adaptation priorities in Somalia's NDC

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE[3]	PROPOSED PROJECT
AFOLU / Community-based	Introduce integrated land use management (rangeland, reforestation, agro-forestry and watershed management) planning principles to district and community stakeholders	4, 5, 9	Sustainable Land Management to Build Resilient Rural Livelihoods and Enable National Food Security
	Rehabilitation and reinstatement of degraded ecosystems, in particular rangeland areas, forests and areas with a high potential for cultivation		
	Demonstrate sustainable land management measures (reduce erosion, increase soil fertility, reduce crop losses, reduce burning, enhanced forest, shrub and grazing vegetation) to increase resilience to climate risks		
	Seasonal early warning system (easily accessible and understandable) and forecasting for pastoral livelihood security and farmers food security.		
	Reforestation and rehabilitation of degraded lands for environmental conservation and sustainable production of food, fuel and fodder		
Water	Government-led participatory mechanism for water sector coordination based on IWRM principles	4, 5, 9	Integrated Water Resources Management to Ensure Water Access and Supply to Vulnerable Populations and Sectors
	Climate risk and vulnerability assessments with a specific focus on drought prone areas and conflict sensitive areas		
	Construction of large scale water capture and storage facilities and equitable distribution and access systems		
	Construction and rehabilitation of community level infrastructure including berkeds, shallow wells, ponds and other appropriate technologies		
	Construction of embankments/gabions and check-dams to protect flood-prone areas		
	Physical protection of critical water resources (rivers, springs, wells, groundwater)		

[3] **GCF Technology Type Key (derived from GCF's Results Framework for adaptation)*

1. Increased resilience and enhanced livelihoods of the most vulnerable people, communities, and regions.

2. Increased resilience of health and wellbeing, and food and water security

3. Increased resilience of infrastructure and the built environment to climate change threats

4. Improved resilience of ecosystems and ecosystem services

5. Strengthened institutional and regulatory systems for climate responsive planning and development

6. Increased generation and use of climate information in decision making

7. Strengthened adaptive capacity and reduced exposure to climate risks

8. Strengthened awareness of climate threats and risk reduction processes

SOMALIA

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE[4]	PROPOSED PROJECT
Community-based	Strengthen the National and Regional Disaster Risk Management Authorities	4, 5, 9	Reducing Risks among Vulnerable Populations from Natural Disasters
	Awareness raising for senior officials and policy makers in key sectors for linkages between disaster risk management and climate related risks		
	Data collection and analysis on incidence of key climate related disaster events		
	Institutional establishment of national early warning system with a focus on climate related risks in areas of high vulnerability.		
	Community level mapping of high vulnerability areas to risks of drought and flooding, dusts storms and strong winds, and integration into local disaster risk management plans and responses.		
	Promote National Disaster Management Authority (NDMA)-led coordination and information sharing and disaster risk management and climate risk reduction.		
Coastal	Studies of the Status of the Marine Environment	4, 5, 9	Marine and Coastal Environmental Governance and Management of Somalia
	Environmental Policies and Legal Framework Formulation and Implementation		
	Establishment of 10 Coastal Nurseries		
	Protection and Replanting of Coastal Mangroves and Protection of Coral Reefs		
	Protection Against Illegal Fishing and Dumping of Waste and Oil Spill		
	Coastal Infrastructural Development		

[4] **GCF Technology Type Key (derived from GCF's Results Framework for adaptation)*

1. Increased resilience and enhanced livelihoods of the most vulnerable people, communities, and regions.

2. Increased resilience of health and wellbeing, and food and water security

3. Increased resilience of infrastructure and the built environment to climate change threats

4. Improved resilience of ecosystems and ecosystem services

5. Strengthened institutional and regulatory systems for climate responsive planning and development

6. Increased generation and use of climate information in decision making

7. Strengthened adaptive capacity and reduced exposure to climate risks

8. Strengthened awareness of climate threats and risk reduction processes

5. ASSUMPTIONS, GAPS IN INFORMATION AND DATA, DISCLAIMERS

The observed and projected climate trends described in Section 2 'Climate and Weather' are derived from a combination of publicly-available observational data and CMIP5 climate models. Detailed information is included in Section 6. Appendix 1, including '6.1.b. Historical Trends and Variability Analysis' and '6.1.c. Climate Projections Visualisations'.

Unless stated otherwise, all statistics reported in Section 1 ('Geographic and Socio-Economic Context' and Section 3 'Climate change mitigation, greenhouse gas emissions and energy use') are derived from databases of publicly available datasets managed by international or multilateral agencies including inter alia The World Bank Group, the United Nations, World Resources Institute and International Energy Agency.

Unless stated otherwise, all energy and greenhouse gas emission figures are derived from UN Stats (2014); World Energy Council (2016); the World Resources Institute (2013), and the International Energy Agency (2016). Agriculture & forestry-related emissions are also reported from Food and Agriculture Organisation (2014-2017) and Global Forest Watch. (2015-2017). Full references are provided as a supplementary appendix.

As a result of the use of standardised methodologies and data sources across the 25 countries included in this AfDB Climate Change Profile, statistics and estimates reported herein may differ from other publicly available datasets or national estimates. Readers are advised to always check for updated publications and newly released national datasets.

This AfDB Climate Change Profile series is intended to provide a brief touch-stone reference for climate change practitioners, project managers and researchers working in African countries. The figures and estimates provided herein are intended to inform the reader of the main climate-related challenges and priorities, however these should be used to inform a process of additional research and in-country consultations. The University of Cape Town, the African Development Bank and its Boards of Directors do not guarantee the accuracy of figures and statements included in this work and accept no responsibility for any consequences of its use.

6. APPENDIX 1

1.a Supporting evidence

The climate projections detailed in Chapter 2 (above) are supported by rigorous analysis of observed and model projections data. More details of this analysis and supporting figures can be found below.

1.b Historical trends and variability analysis

The analysis of historical trends and variability of key climate variables is presented below. This analysis uses the WATCH Climate Forcing dataset which has been selected as the most broadly representative of station observations across Somalia. Long term (1979 to 2013) trends as well as inter-annual variability (decade to decade) has been analysed for total annual rainfall, number of rainfall days, number of extreme rainfall days, and daily mean temperatures (1979-2014) for each of the three climate regions across Somalia. The plots below detail **inter-annual variability** (dotted lines), **decadal variability** (smooth bold solid curves) and **long-term trends** (thin straight lines) for each region and statistic. This allows for comparison of different types of variability against the long-term trend. It can be seen that for rainfall statistics, inter-annual and decadal variability are typically fairly large compared to long term trends. For example, for total annual rainfall, the Coastal/Central region has very high inter-annual (350mm in some years to 900mm in other years) and moderate decadal variability (400mm in some decades to 500mm in other decades). The long-term trends is not statistically significant but could be around 30mm over the 30-year period

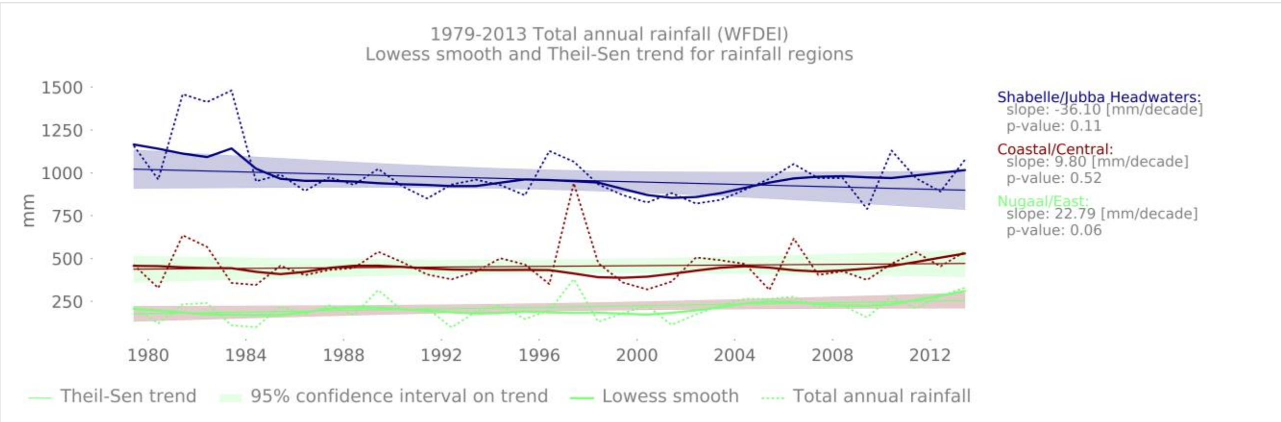


Figure A-1: Long term trends and variability in total annual rainfall for rainfall regions

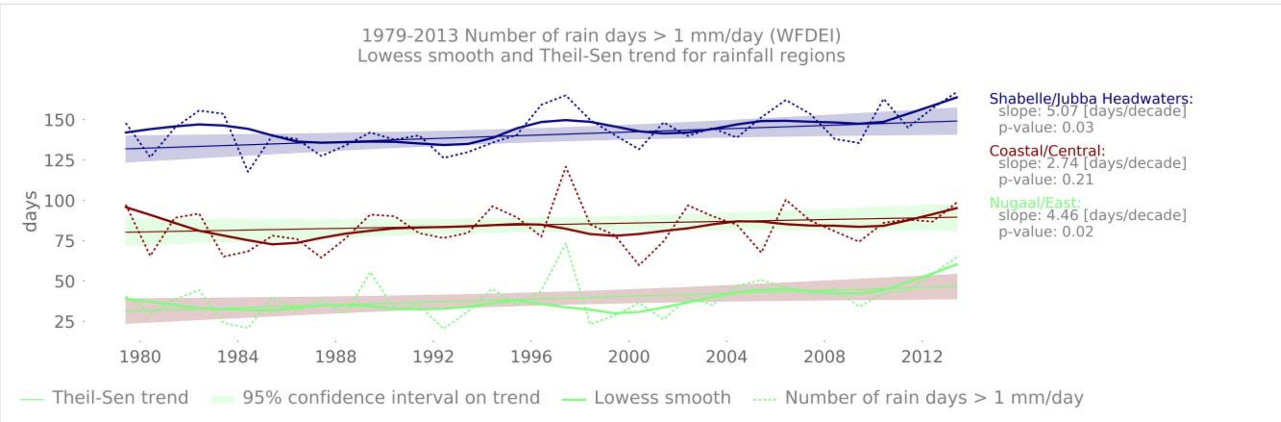


Figure A-2: Long term trends and variability in frequency of rainfall events for rainfall regions

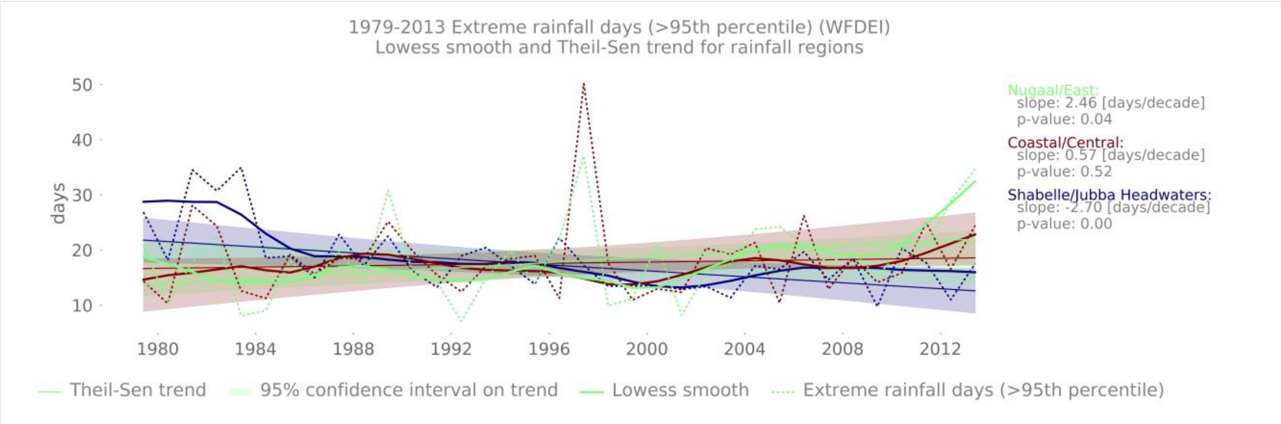


Figure A-3: Long term trends and variability in extreme rainfall events for rainfall regions

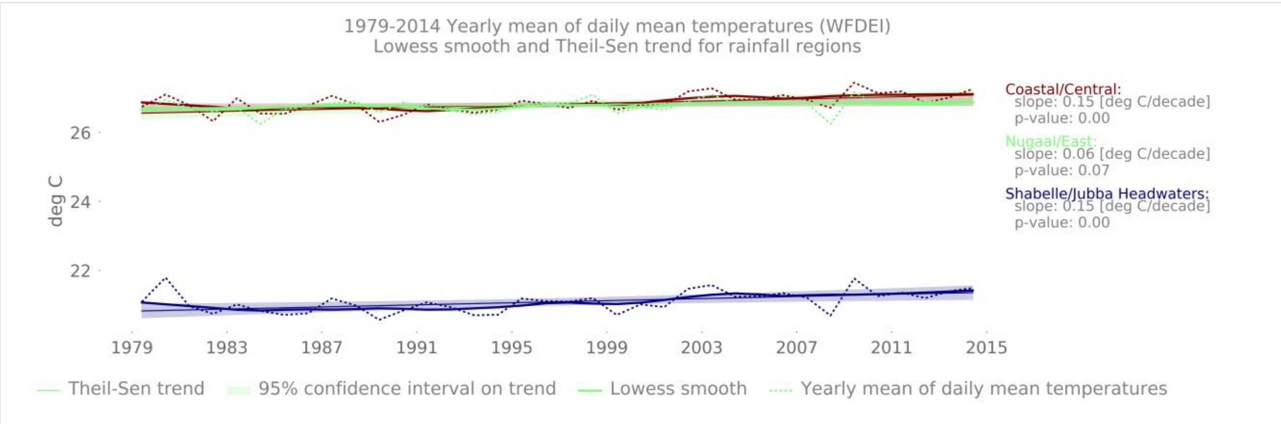


Figure A-4: Long term trends and variability in daily mean air temperatures for rainfall regions

1.c Climate projections visualizations

The plots below (Figures A-5 – A-8) are called plume plots and they are used to represent the different long-term projections across the multiple climate models in the CMIP5 model archive used to inform the IPCC AR5 report. The plots show projected variations in different variables averaged over the climate regions. The blue colours indicate variations that would be considered within the range of natural variability, so in other words, not necessarily the result of climate change. The orange colours indicate projection time series where the changes would be considered outside of the range of natural variability and so likely a response to climate change. It is important to note that these are global climate model projections and so likely do not capture local scale features such as topography and land ocean boundary dynamics. They also may not capture small scale features such as severe thunderstorms that can have important societal impacts. Finally, these projections are averages over relatively large spatial areas and it is possible that different messages would be obtained at small spatial scales and if various forms of downscaling are performed.

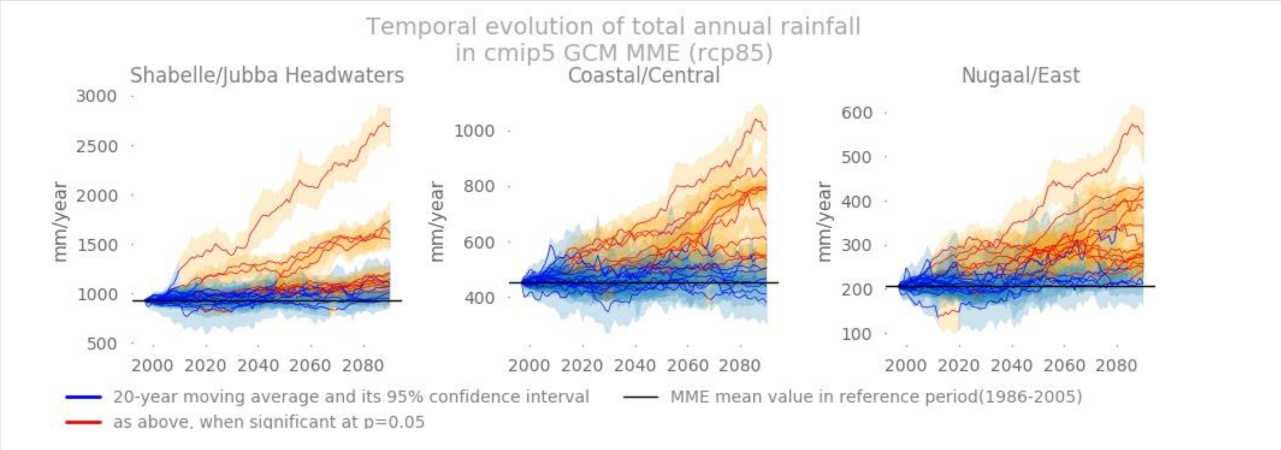


Figure A-5: Projected changes and emergence of changes in total annual rainfall

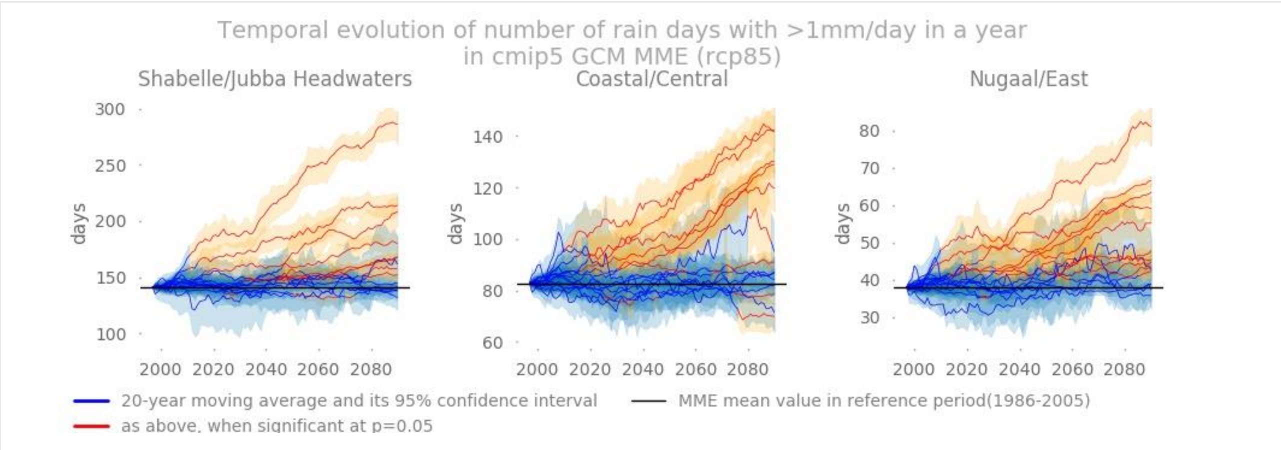


Figure A-6: Projected changes and emergence of changes in number of rain days per year

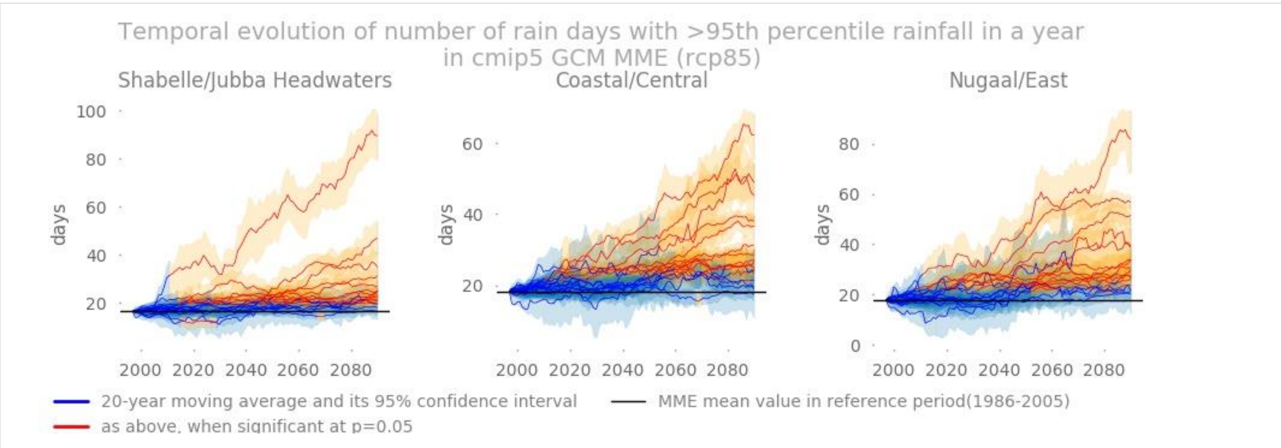


Figure A-7: Projected changes and emergence of changes in number of very heavy rainfall days (greater than 95th percentile) per year

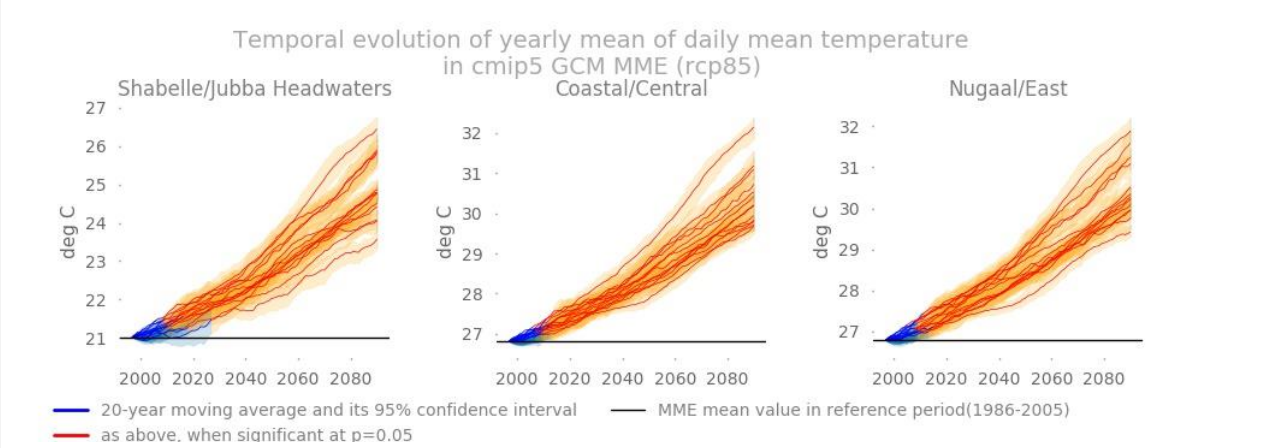


Figure A-8: Projected changes and emergence of changes in annual mean daily mean temperatures

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