SOUTH SUDAN

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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SOUTH SUDAN

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ACKNOWLEDGEMENT

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1. BACKGROUND

1.1. Geographic and socio-economic context

The Republic of South Sudan (henceforth, 'South Sudan', shown below in Figure 1-1) is a landlocked country in Northeastern Africa. South Sudan has a population of ~13,096,000 people and has a slow population growth rate of ~2.9% per year). The majority of the population is rural (~81.8%). Within the small urban population, ~95,6% of urban residents live in slum settlements (estimated to be the largest proportion among urban dwellers in African countries). The economy of South Sudan is small in terms of total GDP (~USD 9 billion per year) and GDP per capita (~759 USD per capita per year). The climate in South Sudan is similar to an equatorial or tropical climate and the country experiences a high rainfall season followed by a drier season. As a result, people are affected by both droughts and floods, which respectively affected ~7,900,000 and ~1,140,000 people during the period 1996-2016.

In terms of human development levels, South Sudan is among the lowest developed in Africa. The country has a Human Development Index of 0.42 and the lowest levels of electrification in all of Africa (~4.5% of the population have access to electricity). Key socio-economic and demographic indicators are further presented and summarised in Table 1-1, below.

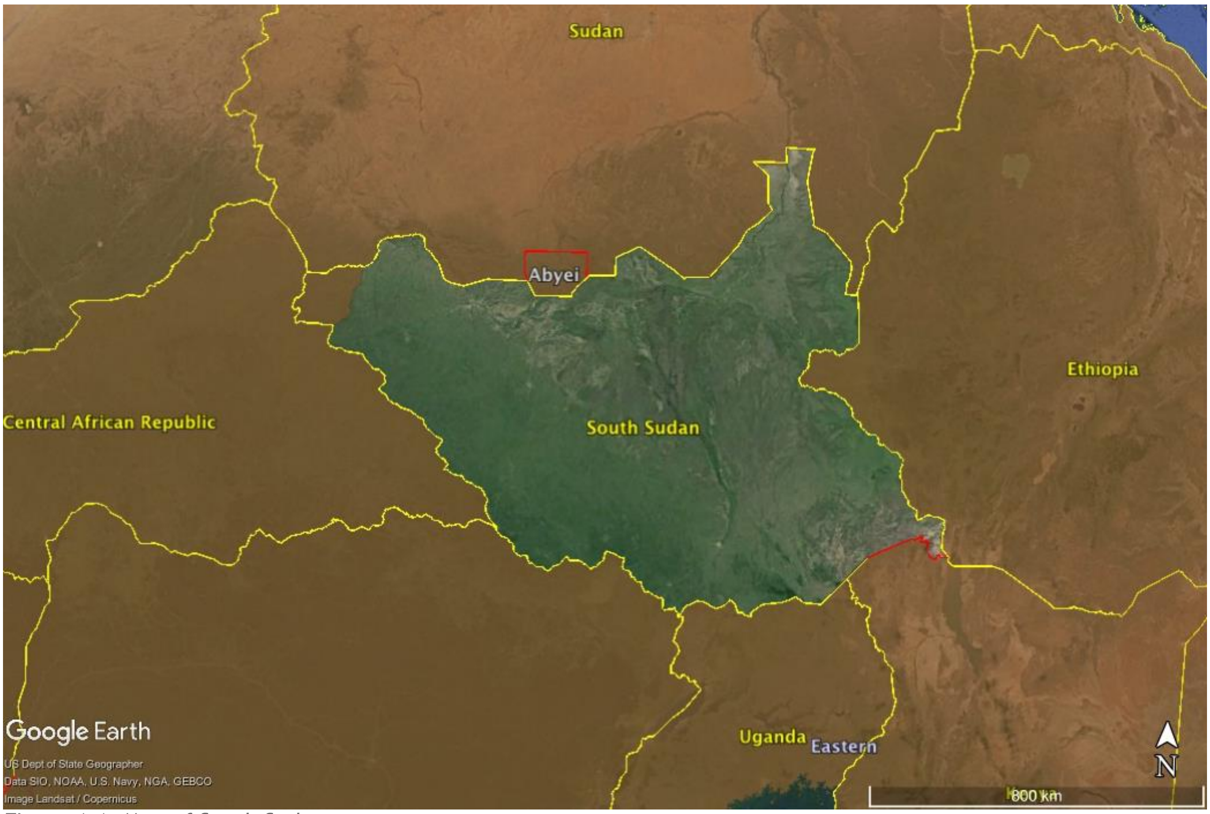


Figure 1-1: Map of South Sudan

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

VARIABLE	SCORE/TOTAL	UNIT	RANK (OUT OF 54)
Geography, Socio-Economy and Demographics			
Population[1]	13,096,190	people	27
Population growth rate[1]	2.9	% population. yr-1	15
Population density[1]	21	People/km2	41
Land area[1]	611,971	km2	20
% Urban population[1]	18.2	% population	51
% Urbanisation rate[2]	4.1	% population. yr-1	18
Economy: total GDP[3]	9.0	USD billions. yr-1	30
Economy: GDP by PPP[3]	23	billion international dollars. yr-1	32
Economy: GDP/capita[3]	759	USD per capita/yr.	32
Population below the poverty line[4]	42.7	% below USD 1.90 per day	21
GINI co-efficient[4]	46.3		17
HDI[5]	0.42		46
Access to electricity[6]	4.5	% population	54
Population[1]	13,096,190	people	27
Summary indicators of climate change vulnerability			
Number of people affected by drought[7]	7,900,000	people	9
Number of people affected by flood events[7]	1,142,791	people	14
Population living in informal settlements[6]	95.6	% urban population	1
Incidence of malaria[3]	156	cases per 1000 population at risk	26

2. CLIMATE AND WEATHER

South Sudan climate is primarily tropical savannah; however, the far northern and south-eastern parts have a warm semi-arid climate. Rainfall occurs in a single rainy season from March to November and peaks from May to September. The rainfall regions of South Sudan extends beyond the border of the country into Sudan to the north, Ethiopia to the east, and into Uganda and beyond in the south. The last two catchments generally have higher annual total rainfall and the seasonality of rainfall shifts from a single season during boreal winter to all year rainfall peaking during the long and short rains (March – May and October - November) and over the far south.

Climate variations within the rainfall regions of South Sudan are large. Therefore, three sub-regions are used in this analysis, two of which fall predominantly beyond the country's borders. The South Sudan regions are illustrated in **Figures 2-1** and **2-2**, below, and summary descriptions can be found in **Table 2-1** below.

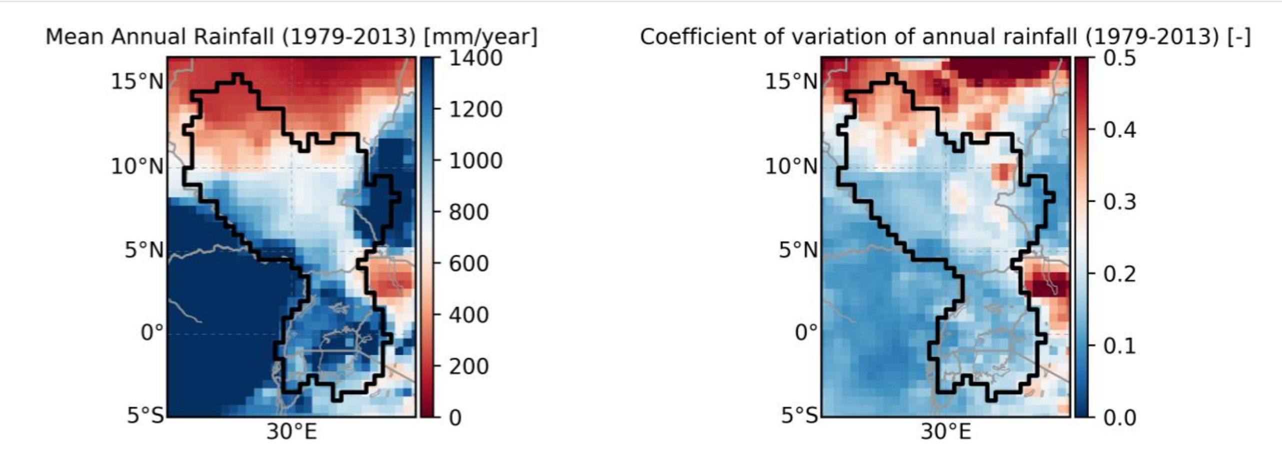
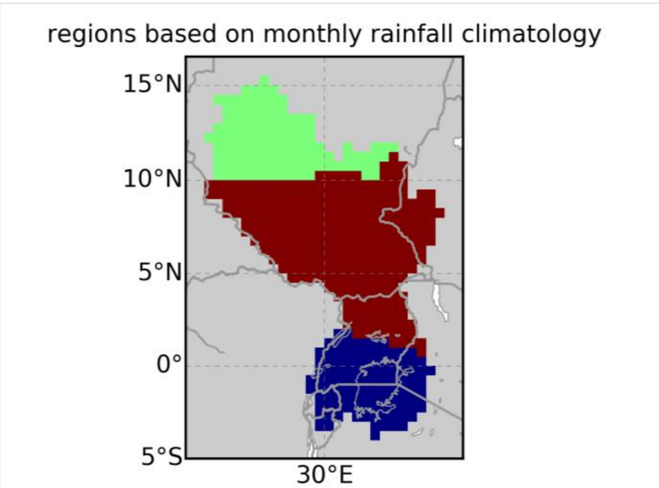


Figure 2-1: Main characteristics (magnitude and variability) of rainfall in South Sudan and its region



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

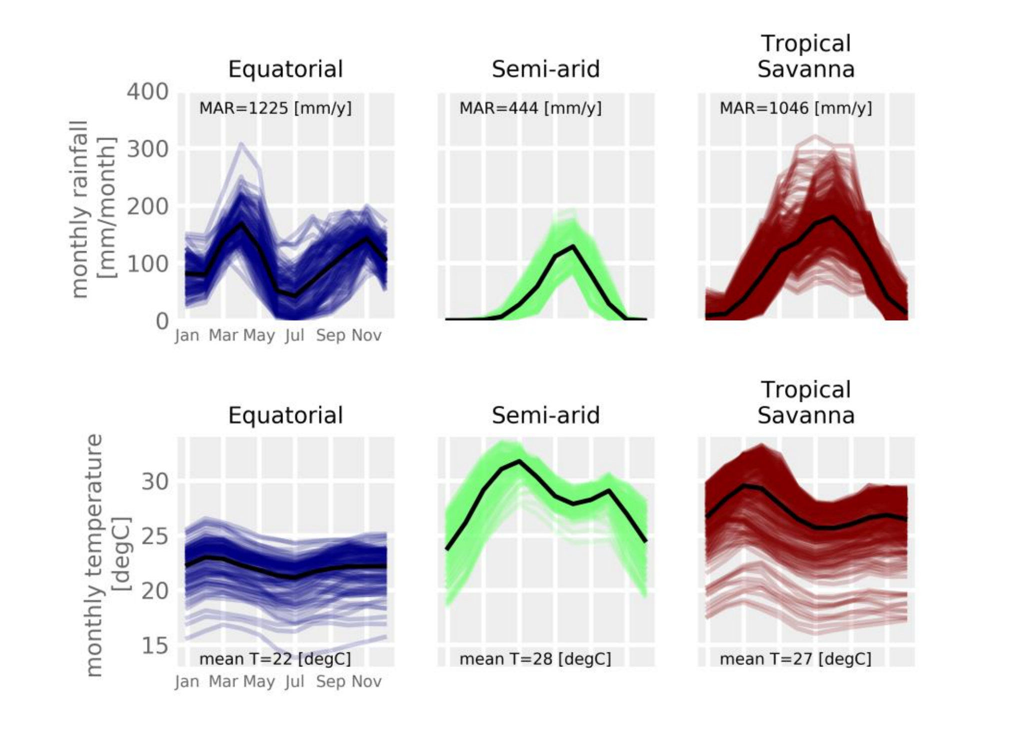


Figure 2-2: Rainfall regions of South Sudan based on similarity of standardised rainfall climatology, and their rainfall and temperature climatologies

Table 2-1: Main characteristics of rainfall of South Sudan region

SEMI-ARID	A semi-arid region with mean annual rainfall of just under 450 mm/year. Rainfall amounts decrease, and year to year variability increases towards the north. Rainfall occurs in a single rainy season during boreal summer (June – September) with a clearly defined dry season from November to March. Daily mean temperature averages 28° C with a seasonal range of around 7° C. Warmest temperatures generally occur during boreal summer, peaking at the beginning and to a lesser degree at the end of the rainy season, and coolest temperatures during winter.
TROPICAL SAVANNA	A wet region with mean annual rainfall of around 1050 mm/year. Rainfall is highest over the parts of the region within south-west Ethiopia and along the Democratic Republic of Congo border. Rainfall variability from year to year is relatively low. Rainfall occurs during one long rainy season from March to November, exceeding 100 mm/month from May – October. Daily mean temperature averages 27° C with a small seasonal range of around 4° C. Warmest temperatures generally occur during March-May (beginning of the long rains) with a secondary peal in October (tail of the rainy season), with coolest temperatures during July. Strong spatial differences, primarily related to elevation are seen in this region.
EQUATORIAL	A wet region with a mean annual rainfall of just under 1230 mm/year. Rainfall is generally highest around Lake Victoria with relatively low year to year variability. Rainfall in this region falls throughout the year, but peaks at 180 mm/month the long rains from March to May and at 150mm/month in the short rains during November. Daily mean temperature averages 22° C with a small seasonal range of around 2° C. Warmest temperatures generally occur during February – March (beginning of the long rains) with coolest temperatures during December – January and also August. Strong spatial differences, primarily related to elevation are seen in this region.

2.1 Observed historical climate variations and climate change trends

The majority of South Sudan experiences **relatively low rainfall interannual variability** with the exception of the semi-arid region which experiences moderate interannual rainfall variability. On **decadal time scales** South Sudan, and the semi-arid Tropical Savannah regions, 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 the regions show **very strong increasing temperatures** over the period 1979 – 2015, although the trends appear to be weaker in the second half of that period. No statistically significant trends in rainfall are evident in any region over the period 1979-2014. However non-statistically significant upward trends are seen in total rainfall and the frequency of extreme rain events for the Semi-arid and Equatorial regions. Long term trends and variability in the South Sudan 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 South Sudan (1979 - 2015)

REGION	MEAN T [DEG C/DECADE]	TOTAL RAINFALL [MM/DECADE]	EXTREME RAINY DAYS [DAYS/DECADE]	RAINY DAYS [DAYS/DECADE]
Semi-arid	+0.37	upward	upward	slight downward
Tropical Savanna	+0.41	not evident	slight upward	not evident
Equatorial	+0.46	upward	upward	not evident

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

Projected changes in main attributes of climate for the South Sudan 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 South Sudan regions show a pattern of potential increased rainfall emerging over the second half of the century. That pattern appears to be consistent across the majority of CMIP5 model within the ensemble. Relative magnitudes of potential increased rainfall in the Tropical Savanna region could reach up to 600mm/year wetter by 2100 which equates to 150% of the baseline normal. The increase in rainfall seems to be strongly associated with increase in the high intensity rainfall events rather than in the frequency of rainy days. 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 temperatures are projected to be between 1.5°C and 2.5°C warmer in the South Sudan regions by the 2050s. By 2100 the range of projected temperatures is greater with the coastal regions showing projected increases of 3°C to 6°C.

Table 2-3: Summary of projected climate changes across regions of South Sudan 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]
Semi-arid	**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 40%. Change could become evident after 2050s	**Increasing,** ranging from no change to an increase of up to 100%. Change could become evident in the 2050s	**Normal to increasing,** could become evident in the 2060s
Tropical Savannah	**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 30%. Change could become evident after 2080s	**Normal to increasing,** ranging from no change to an increase of up to 100%. Change could become evident in the 2050s	No consistent sign in projections
Equatorial	**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%. Change could become evident after 2070s	**Normal to increasing,** ranging from no change to an increase of up to 100%. Change could become evident in the 2050s	No consistent sign in projections

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.

In tropical, landlocked and largely rural South Sudan possible increase in extreme rainfall events and increasing temperatures is likely to increase the pressure on water resources, and further complicate access to safe drinking water. The pressure on water resources, as well as the direct impacts of increasing temperatures and more extreme rainfall, will likely put further strain on the agricultural sector on which the majority of the population depends. Large dependence on rain-fed subsistence agriculture, and large-scale food insecurity even in times of good harvests, makes the climate sensitive agricultural sector a primary concern. Poverty in combination with long-term conflict and civil war has had harmful implications on South Sudanese communities, impacting their capacity to adapt to increase in extreme temperatures and rainfall events, as well as to the slower knock-on effects that climate change may have on income generating activities. Already prone to both droughts and flooding, a potential increase in extreme rainfall events is a cause for concern. With malaria currently affecting a large proportion of the population potential changes in prevalence and geographic distribution, as a result of increasing temperatures and changing rainfall patterns, should be monitored closely.

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

SECTOR	IMPACTS
Agriculture	- Desertification and loss of agricultural and grazing land - Crop loss and reduced crop yields owing to increased temperatures and changing rainfall patterns - Increased potential for conflict between farmers and pastoralists - Decreased water and fodder availability for livestock - Increased death and heatstroke in livestock
Fisheries	- Reduced fish populations and aquatic diversity owing to reduced river flow and drying of wetlands - Reduced aquatic diversity owing to increased water temperatures - Decreased access to fishing sites during increased flooding
Water resources	- Reduced availability of water resources, owing to changing rainfall patterns and, in particular, increased temperatures - Increased potential for conflict over limited water resources - **Decreased water quality, especially during droughts and floods**
Built infrastructure and human settlements	- Damage to or destruction of inland infrastructure due to extreme events, especially flooding - Increased potential for damage to infrastructure from extreme temperatures - Increased potential for migration from rural to urban areas
Human health	- **Increased potential for malnutrition and stunting, especially during drought** - **Increased incidence of water-borne diseases, especially during floods and droughts** - Increased potential for death and disease owing to conflict

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

The major carriers of South Sudan'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 South Sudan's agriculture sector, historical land use change and vegetation cover.

3.1 National energy production and consumption

South Sudan, Africa's newest country, is also one of Africa's largest oil producers. As a result, the vast majority of national energy production (~98%) and consumption (~63%) is from oil. However, due to the export of oil, the amount of energy the country consumes (~0.5 MTOE) is very little in comparison to energy production (~8 MTOE). The use of oil is further reflected in South Sudan's energy consumption by sector where transport consumes the largest amount of energy (~59%). In addition to oil, biofuels contribute to energy production (~2%) and consumption (~30%). This is also reflected in the residential sector's energy consumption (31%).

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].

The tables and figures below describe South Sudan's energy sector, including total national energy production, primary energy supply and national energy consumption by source and sector.

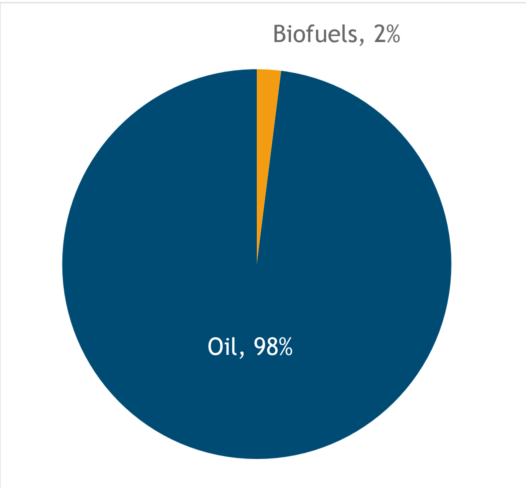


Figure 3-1: Distribution of South Sudan's national energy production between major energy carriers (2014-2016)

Table 3-1: National energy and electricity production in South Sudan (2014-2016

NATIONAL ENERGY PRODUCTION		
Source	**Total (MTOE)[1]**	**% of total energy production**
Oil[8]	7.9	97.6
Biofuels[8]	0.2	2.4
Total national energy production	8.1	
Electricity[6]	Non-Hydro renewable	0.4
	Oil	99.6

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

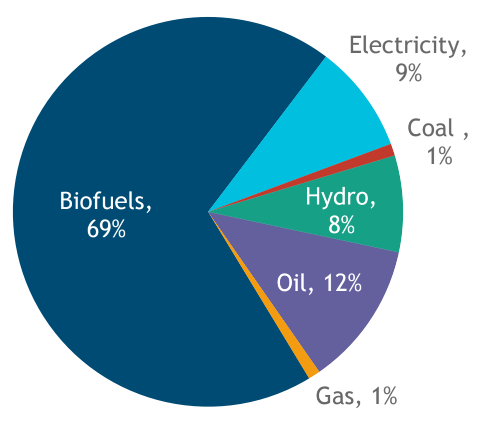


Figure 3-2: Distribution of South Sudan's national energy consumption by major energy carriers

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

CONSUMPTION BY ENERGY SOURCE[8]	
Source	**Total (MTOE)**
Oil	0.3
Biofuels	0.2
Electricity	0.04
Total national energy consumption by source	0.54

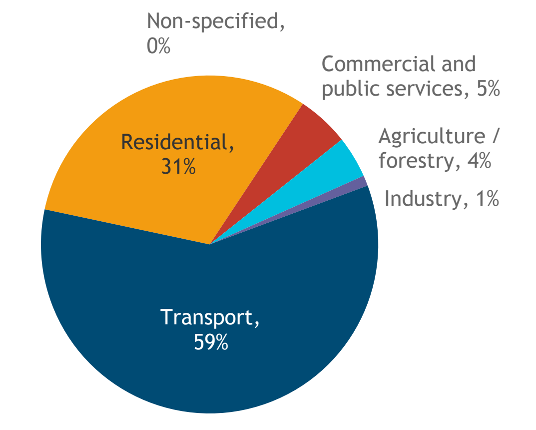


Figure 3-3: Distribution of South Sudan's national energy consumption by sector (2014-2016

Table 3-3: South Sudan's national energy consumption by sector (2014-2016

CONSUMPTION BY SECTOR[8]	
Source	**Total (MTOE)**
Industry	<0.01
Transport	0.3
Residential	0.2
Commercial and public services	0.02
Agriculture / forestry	0.02
Non-specified	<0.01
Total national energy consumption by sector	0.5

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

TOTAL PRIMARY ENERGY SUPPLY[8]		
Source		**Total (MTOE)**
Oil	Crude Oil	0.02
	Oil Products	0.5
Biofuels		0.2
Electricity		0.04
Total primary energy supply		0.7

3.2 National greenhouse gas emissions by source and sector

Section 3.2.1, below, describes GHG emissions from fuel combustion – these figures include direct combustion of fuels as a primary energy carrier as well as conversion to other forms of energy (e.g. as electricity). These figures are based on statistics from the International Energy Agency (IEA). Section 3.2.2 provides additional details on South Sudan's Land Use and Land Use Change sector, including detailed summaries of emissions from the agriculture sector and historical land use changes. The use of oil accounts for the majority of South Sudan's GHG emissions from fuel combustion (~1.5 MT CO2e). The sectors that contribute significantly to these emissions through the use of oil are transport (~65%), and electricity and heat production (~27%).

3.2.1 GHG EMISSIONS FROM FUEL COMBUSTION, BY SOURCE AND SECTOR

Table 3-5: South Sudan's national greenhouse gas emissions from fuel combustion (estimated for 2014-2016)

NATIONAL GHG EMISSIONS FROM FUEL COMBUSTION BY FUEL SOURCE AND SECTOR [9]		
Source / Sector		Total emissions (MT CO_2e)
Oil		1.5
Total fuel source emissions		1.5
Electricity and heat production		0.4
Other energy industry own use*		0.05
Manufacturing industries and construction		0.01
Transport	Road	0.93
	Other	0.03
	Total	0.96
Other	Residential	0.01
	Non-residential	0.04
	Total	0.05
Total sector emissions		1.5

** Includes emissions from own use in petroleum refining, the manufacture of solid fuels, coal mining, oil and gas extraction and other energy-producing industries.*

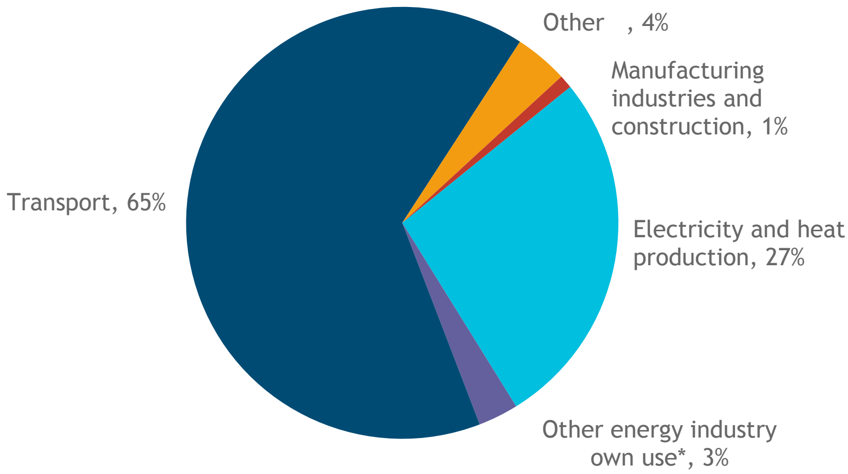


Figure 3-4: Distribution of South Sudan's GHG emissions by major sectors

3.2.2 GHG EMISSIONS FROM AGRICULTURAL PRACTICES

Table 3-6, below, summarises GHG emissions from South Sudan's agriculture sector (derived from Food and Agriculture Organisation statistics). Although there are multiple agricultural practices that contribute to GHG emissions, in the case of South Sudan, burning of savanna woodlands and grasslands is the largest contributor to GHG emissions from agricultural practices, followed by emissions from the livestock production sector in the form of enteric fermentation and manures left on pastures.

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

VARIABLE		ANNUAL EMISSIONS (MT CO_2E)
Annual GHG emission from agricultural practices [10]	Burning - crop residues	0.02
	Burning - savanna	21.5
	Crop residues	0.1
	Cultivation of organic soils	0.1
	Enteric fermentation	11.9
	Manure management	0.5
	Manure applied to soils	0.2
	Manure left on pasture	8.7
Total emissions		43.1

Table 3-7, below, summarises the recent historical changes in land use in South Sudan 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. South Sudan has extensive woody vegetation cover, where it is estimated that ~66% of total land area is under tree cover. The vegetation cover includes over ~4 million hectares of dense (50% canopy cover) forest, 7 million hectares of moderately dense woodland and forests (~30-50% canopy cover), and over 31 million hectares of woodland (most likely Sudanian Acacia savanna). Global Forest Watch reports the total aboveground carbon stock of South Sudan's forest biomass as ~495 million tonnes.

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

VARIABLE		TOTAL (HECTARES)	TOTAL (% OF LAND AREA)	UNIT
Total tree cover [11]	10-30% canopy cover	31,244,612	48.49	% of total land area
	30-50% canopy cover	7,211,244	11.2	
	50-100% canopy cover	4,043,168	6.3	
	Total	42,499,024	66.0	
Land use change and agricultural expansion	Historical annual rate of deforestation[12]	10-30% canopy cover	0.0	% of previous year
		30-50% canopy cover	0.0	
		50-100% canopy cover	0.1	

4. SUMMARISED NATIONAL PRIORITIES FOR CLIMATE CHANGE ADAPTATION AND MITIGATION

South Sudan'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 South Sudan's major commitments and priorities related to GHG mitigations (Table 4-2, below) as well as major priorities related to climate change adaptation, derived from the draft National Adaptation Plan (NAP) (Table 4-3, further below).

South Sudan aims to undertake policies and actions in following sectors: energy generation and use; Land Use and Land use Change; and Transport, to address its future emissions that are likely to result from growth strategies. These efforts are contingent on availability of technical assistance to develop the necessary regulations, policies, and standards as well as financial support for investing in low carbon options. South Sudan's NDC estimates that investments of at least ~USD 50 billion are required for all priority mitigation and adaptation actions up to 2030, however noting that these are approximate estimates and that further analysis is required to identify all requirements for support.

Table 4-1, below, gives details on South Sudan'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 South Sudan'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	Aims to undertake policies and actions; contingent on technical expertise	N/A	CO_2; Energy generation and energy end use; Transport; and Land Use and Land Use Change	Not mentioned	N/A

4.1 National priorities for climate change mitigation

South Sudan'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). These technology types and specific actions represent South Sudan's immediate national priorities for investments in climate change mitigation and reflect recent and on-going policy-level measures to reduce GHG emissions and increase energy efficiency.

South Sudan's mitigation priorities are relatively undetailed, and the main sectors prioritised are energy, transport and AFOLU. In the energy sector the actions identified are the increase in efficiency of electricity and biomass use, the increased use of clean energy (through hydro- and solar power) and the management of water resources to ensure the best use of hydropower. In the transport sector priorities are around establishing and enforcing emissions standards for vehicles. South Sudan's priorities in the AFOLU sector are to protect forests from deforestation by creating reserves and to implement reforestation and afforestation as outlined in the National Environmental Policy.

Table 4-2: Mitigation priorities in South Sudan's NDC

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE* [2]
Energy	Increase the use of clean and carbon-neutral energy	1
	Construction of a hydroelectricity plant at the Fulla rapids	1
	Increase the use of the country's high potential for solar and wind energy to meet energy demand	1
	Increase the efficiency of biomass use (particularly fuel wood and charcoal) in the traditional energy sector	1, 3, 7
	Increase efficiency of electricity usage in the formal energy sector	1, 6
	Ensuring the best use of hydropower by careful management of the water resources	1, 5
Transport	Establish emissions standards for vehicles	2, 8
	Establish exhaust testing centres and cars that fail the tests by emitting fumes above allowable emissions levels will be subjected to mandatory repairs or scrapped	2, 8
	Consider measures to restrict importation of vehicles that do not adhere to allowable emissions levels	2, 8
AFOLU	Declare approximately 20% of natural forests as reserve forests to protect it from deforestation	4, 5, 9
	Reforestation and afforestation project to plant 20 million trees over a period of ten years (2 million trees in each of its 10 states) as outlined in the National Environmental Policy	4, 5, 9

4.2 National priorities for climate change adaptation

South Sudan's major priorities for actions and investments related to climate change adaptation are summarised in Table 4-3, below, categorised according to sector. Detailed actions and priorities are identified for sectors including inter alia AFOLU, industry, energy, water, health and transport, in addition to priorities focused on community- and institutional-level actions. South Sudan'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). These technology types and specific actions represent South Sudan's immediate national priorities for investments in climate change adaptation and build on recent

*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.

policy-level measures to reduce vulnerability and increase capacity to respond to climate change at local and national levels.

Table 4-3: Adaptation priorities in South Sudan's NDC

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE[3]
AFOLU	Promoting sustainable, climate smart agriculture and livestock production and management	1, 2, 7
	Prioritise the enhancement of climate resilience in the agricultural sector (crop production, livestock, fisheries) through the promotion of climate-smart agriculture, livestock improvement, enhancement of fisheries productivity and soil erosion control	1, 2, 7
	Promote agro-forestry practices as a way of diversifying land production systems and promoting alternative livelihood options	1, 2, 4
	Promote afforestation of degraded landscapes/watersheds using multiuse forest species to increase community safety-nets and diversify livelihoods	1, 2, 4
	Develop forest reserves and management plans to protect watersheds	2, 4, 5
	Promote alternative sources of energy to reduce deforestation and the consequent loss of livelihood options	2, 4
	Improve the enforcement of environmental regulations	4, 5
	Establish conservancies and protected areas to buffer local communities	1, 2, 4
	Establish water points for wildlife in protected areas to reduce the negative effects of droughts on animal populations	1, 4
	Increase awareness of local communities on climate change and environmental protection	8
	Introduce fire management plans to prevent the spread of wildfires during periods of drought	2, 5
Industry	Introduce an integrated natural resource management approach	4, 5
	Incorporate adaptation criteria for public investment projects, particularly those to be carried out under the Comprehensive Agriculture Development Plan and the Irrigation Development Master Plan	2, 7
	Ensure that land-use plans and building codes reflect the expected impacts of climate change	

[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

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE[4]
Water	Water technologies for water savings, recycling, harvesting, irrigation and sustainable management for agricultural purposes	2, 7
	Promoting the harvesting and retention of water for different uses	2, 7
Health	Conduct comprehensive vulnerability assessments concerning human health and well-being under current and future climate scenarios	2, 6
Community based	Enhance access to water in light of growing climate threats through integrated watershed management, wetland management and improved waste management	1, 2, 4
	Enhance food security under a changing climate through the introduction of climate-smart agricultural techniques and irrigated agriculture	1, 2, 7
	Ensure capacity building and participation of the society, local communities, indigenous peoples, women, men, youth, civil organizations and private sector in national and subnational climate change planning	5, 7
	Establish/rehabilitate the hydro-meteorological monitoring network to collect climatic information and provide flood and drought early warning	6, 8
	Strengthen the adaptive capacity of the population through transparent and inclusive mechanisms of social participation in the implementation of adaptation interventions, designed with a gender and human rights approach	2, 6, 8
	Reduce vulnerability of population by integrating climate change considerations into land use planning	1, 4, 7
	Increase investments in disaster prevention mechanisms, such as early warning systems, rather than disaster response mechanisms	5, 6
	Improve environmental health-related infrastructure to reduce the spread of water-borne diseases which will be exacerbated by climate change	2, 3
	Create buffer zones and relocate vulnerable communities away from flood-prone areas	1, 6, 7
	Access to climate information systems in order to monitor hydrometeorological events in real time and establish early warning systems	6, 7

[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

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE[5]
Transport	Transportation technologies that are resilient to the adverse effects of climate change in particular for roads and large-scale transportation of goods. Technologies for the protection of infrastructure, particularly infrastructure in flood-prone areas	3, 7
Institutional	Availability of methods and tools to assess climate impacts, vulnerability and adaptation in specific sectors and regions	1, 2
	Assemble, analyse, predict and disseminate climate information through improve climate monitoring and data management systems.	6, 8
Energy	Renewable energy technologies	1, 7

[5] **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 South Sudan. 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 for each of the three climate regions across South Sudan. 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 Tropical Savannah region has very high inter-annual (700mm in some years to 1200mm in other years) and moderate decadal variability (950mm in some decades to 1100mm in other decades). The long-term trends is not statistically significant and is only around 7mm over the 30-year period.

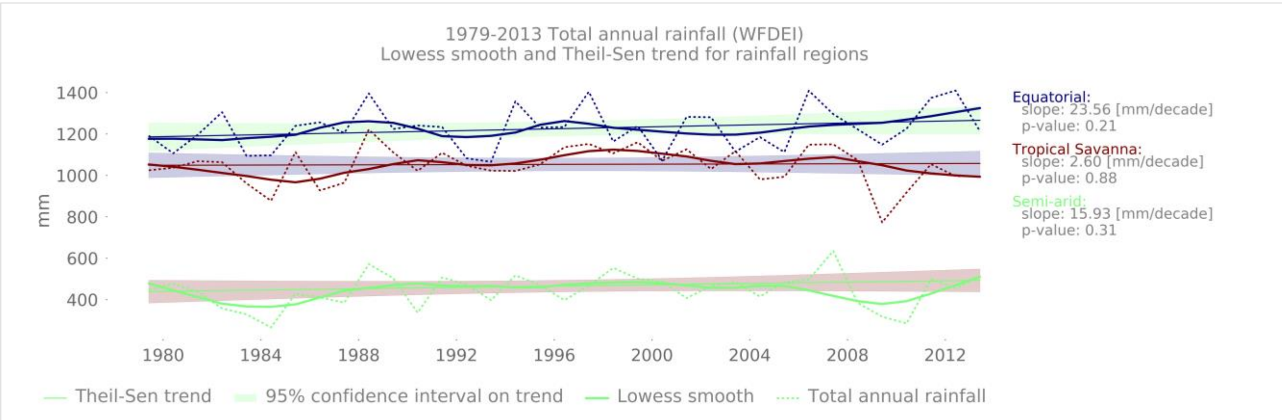


Figure A-1: Long term trends and variability in total annual rainfall for rainfall regions

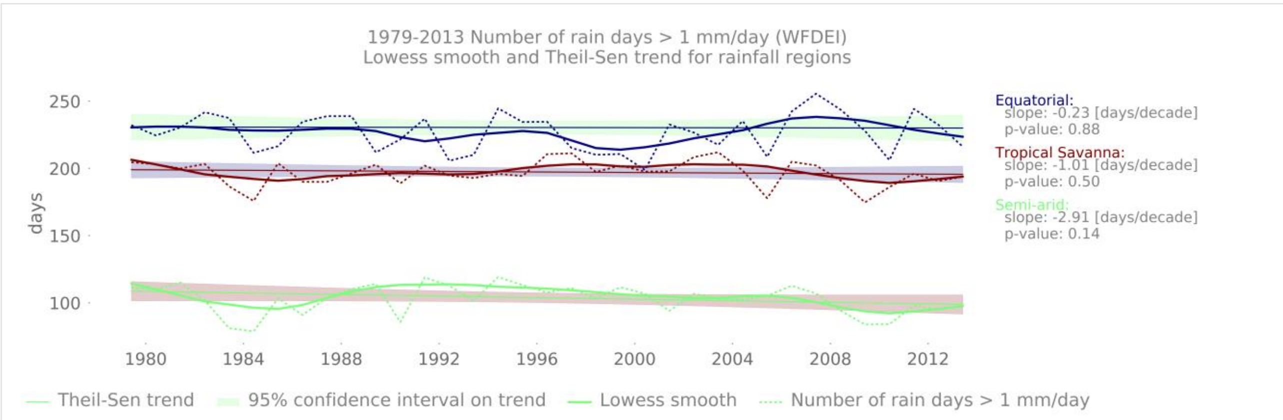


Figure A-2: Long term trends and variability in frequency of rainfall events for rainfall regions

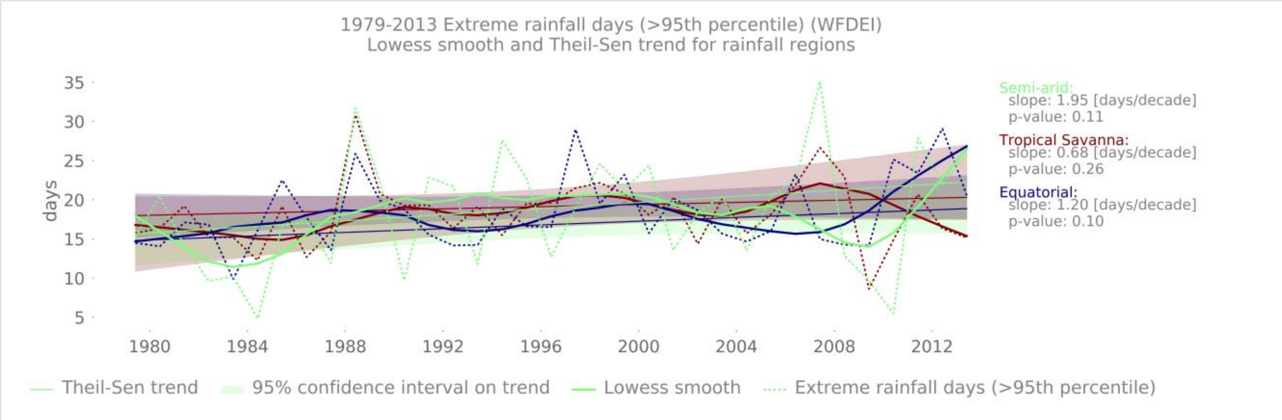


Figure A-3: Long term trends and variability in extreme rainfall events for rainfall regions

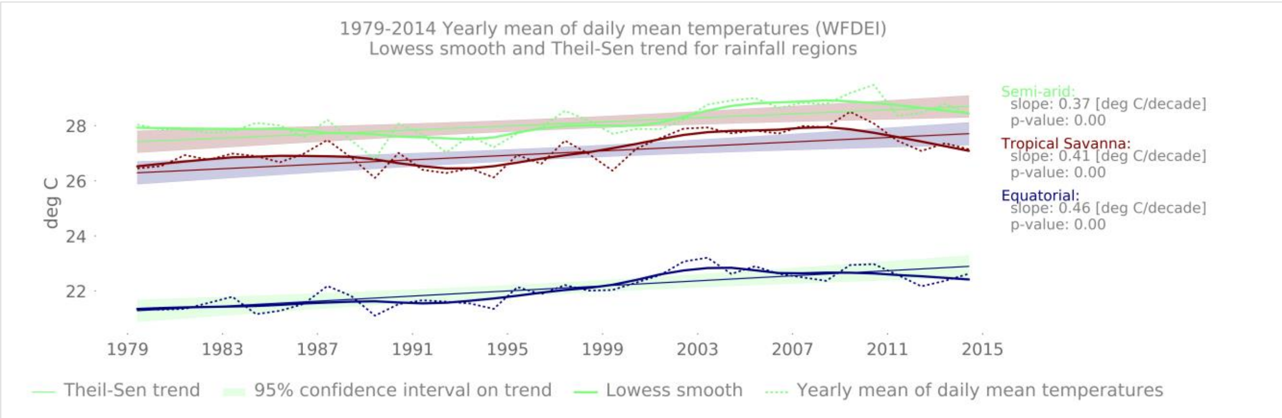


Figure A-4: Long term trends and variability in daily mean air temperatures for rainfall regions

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.

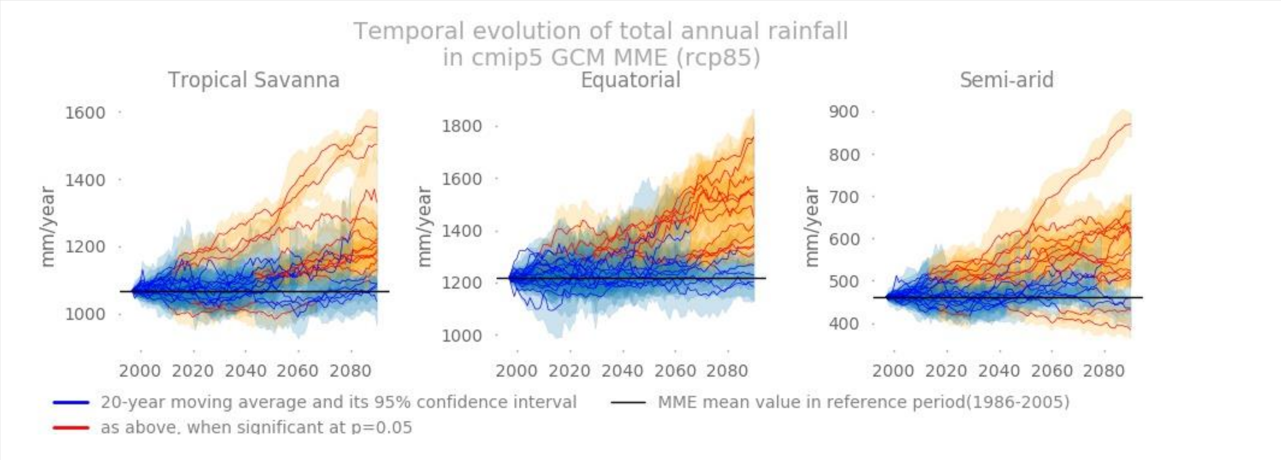


Figure A-5: Projected changes and emergence of changes in total annual rainfall

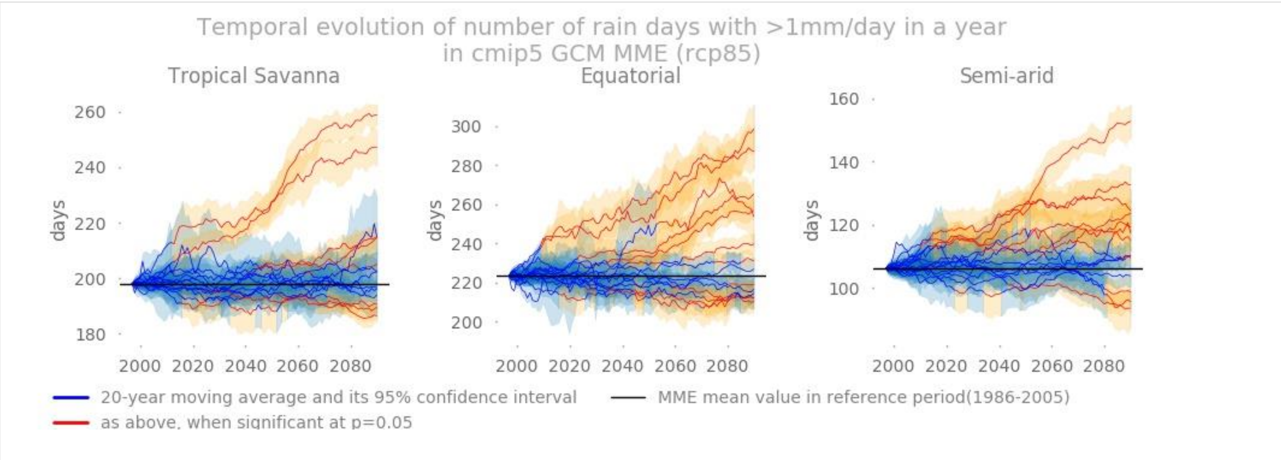


Figure A-6: Projected changes and emergence of changes in number of rain days per year

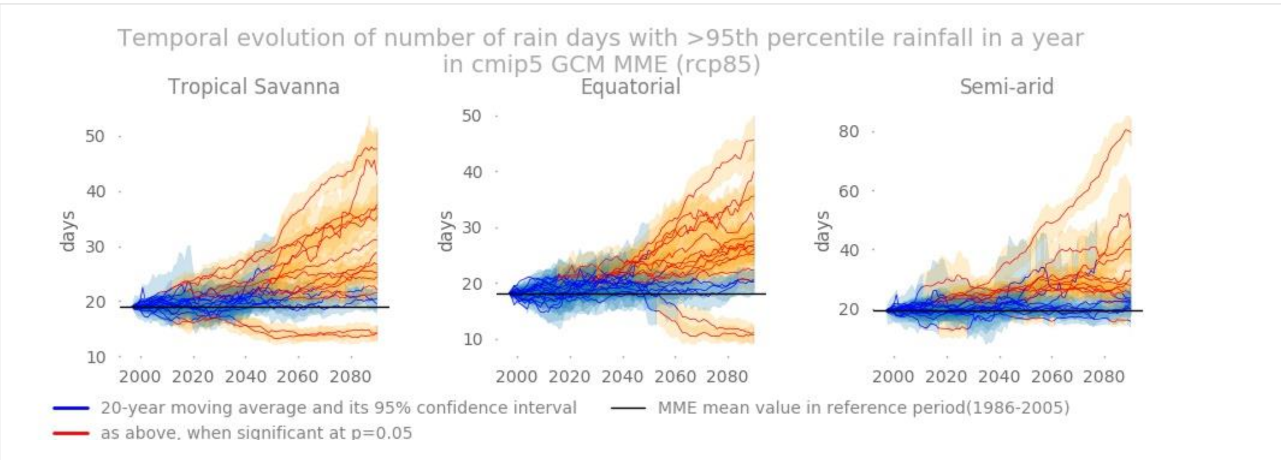


Figure A-7: Projected changes and emergence of changes in number of very heavy rainfall days (greater than 95th percentile) per year

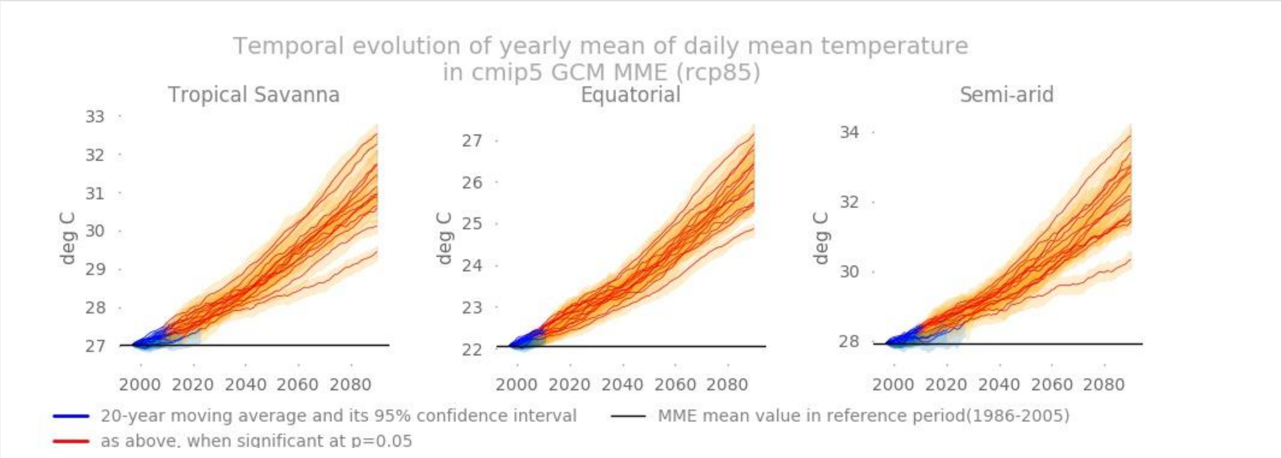


Figure A-8: Projected changes and emergence of changes in annual mean daily mean temperatures

7. REFERENCES

1. Worldometers. (2017). African countries by population. Retrieved from http://www.worldometers.info/population/countries-in-africa-by-population/
2. World Bank. (2016). Data Bank. Retrieved from http://databank.worldbank.org/data/home.aspx
3. World Bank. (2015). Data Bank. Retrieved from http://databank.worldbank.org/data/home.aspx
4. African Economic Outlook. (2009). Statistics. Retrieved from http://www.africaneconomicoutlook.org/en/statistics
5. UNDP. (2016). *Human Development Report (Data for 2015)*. Retrieved from http://hdr.undp.org/sites/default/files/2016_human_development_report.pdf
6. World Bank. (2014). Data Bank. Retrieved from http://databank.worldbank.org/data/home.aspx
7. Emergency Events Database. (2017). Disaster List (1996-2016). Retrieved from http://emdat.be/emdat_db/
8. International Energy Agency. (2014). Energy balances. Retrieved from www.iea.org/statistics/statisticssearch/
9. International Energy Agency. (2013). CO2 emissions. Retrieved from http://www.iea.org/statistics/topics/CO2emissions/
10. Food and Agriculture Organisation. (2014). FAOSTAT Data. Retrieved from http://www.fao.org/faostat/en/#data
11. Derived from Global Forest Watch. (2017). Country Profiles. Retrieved from http://www.globalforestwatch.org/
12. Derived from Global Forest Watch. (2015). Mean 2001-2014. Retrieved from http://www.globalforestwatch.org/