SOUTH AFRICA

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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ACKNOWLEDGEMENT

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1. BACKGROUND

1.1. Geographic and socio-economic context

The Republic of South Africa (henceforth 'South Africa', shown below in Figure 1-1) is a semi-arid country in the Southern Africa region. South Africa is one of the largest economies on the African continent in terms of absolute Gross Domestic Product (GDP) and GDP/capita (3rd in Africa with a total GDP of ~USD 294.8 billion) and is ranked among the top ten African countries in terms of urban population (~63%) and total population size (~55,436,000 people). As a relatively water scarce country, South Africa is vulnerable to the effects of drought and rainfall variability and as a result it is estimated that drought affected ~17,700,000 people in the country during the period 1996-present (the fourth highest cumulative total among African countries). South Africa is one of the top 10 countries in Africa in terms of levels of human development (HDI is 0.67); however, South Africa has the highest GINI coefficient in Africa (63.4), indicating a wide disparity in wellbeing, income and access to opportunity between different groups. The ND-GAIN index summarizes a country's vulnerability to climate change and other global challenges in combination with its readiness to improve resilience. South Africa has the 4th highest ND-GAIN index in Africa composed of a relatively low vulnerability score and a high readiness score which indicate that adaptation challenges still exist, but South Africa is well positioned to adapt. Key socio economic and demographic indicators are further presented and summarised in Table 1-1, below.

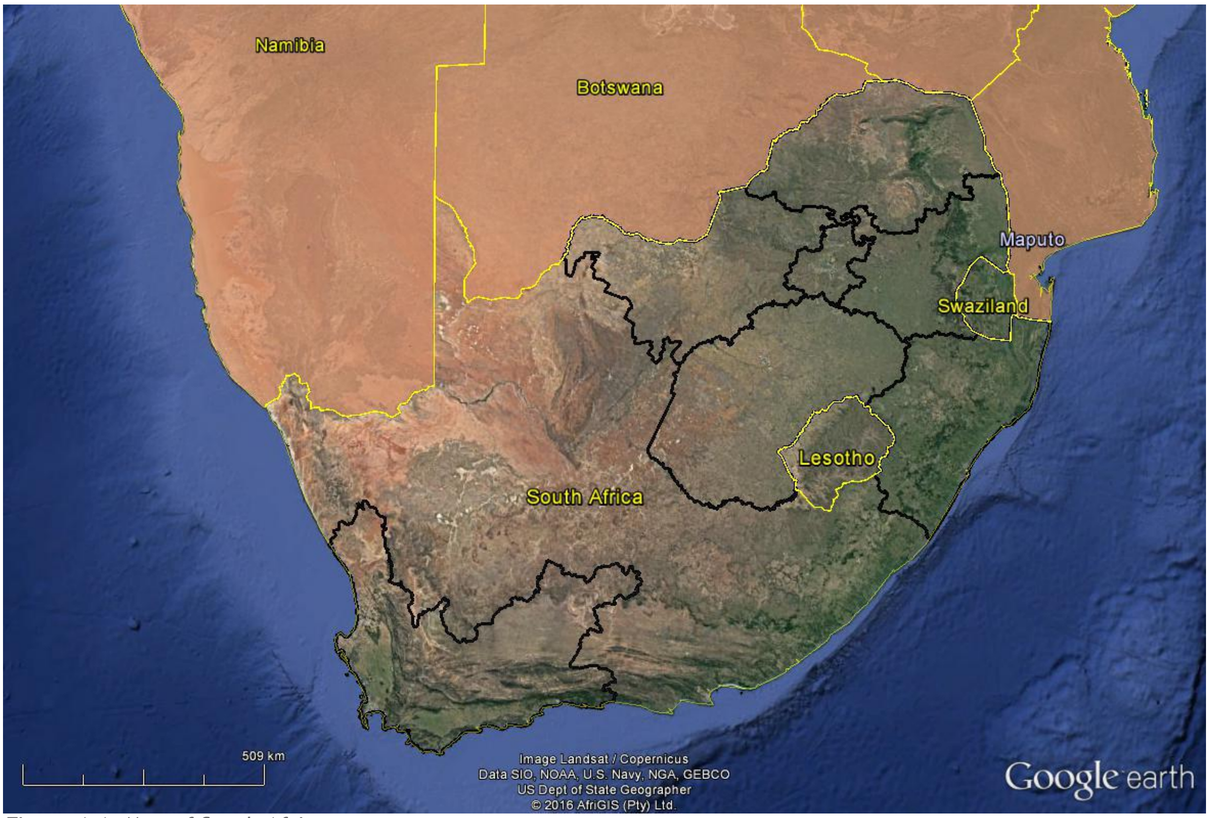

Figure 1-1: Map of South Africa

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

<table>
<tr><th colspan="2">VARIABLE</th><th>SCORE/TOTAL</th><th>UNIT</th><th>RANK (OUT OF 54)</th></tr>
<tr><td colspan="5">Geography, Socio-Economy and Demographics</td></tr>
<tr><td colspan="2">Population[1]</td><td>55,436,360</td><td>people</td><td>6</td></tr>
<tr><td colspan="2">Population growth rate[1]</td><td>0.8</td><td>% population. yr-1</td><td>53</td></tr>
<tr><td colspan="2">Population density[1]</td><td>46</td><td>People/km2</td><td>32</td></tr>
<tr><td colspan="2">Land area[1]</td><td>1,213,049</td><td>km2</td><td>9</td></tr>
<tr><td colspan="2">% Urban population[1]</td><td>63.4</td><td>% population</td><td>10</td></tr>
<tr><td colspan="2">% Urbanisation rate[2]</td><td>2.4</td><td>% population. yr-1</td><td>41</td></tr>
<tr><td colspan="2">Economy: total GDP[2]</td><td>294.8</td><td>USD billions. yr-1</td><td>3</td></tr>
<tr><td colspan="2">Economy: GDP by PPP[2]</td><td>739</td><td>billion international dollars. yr-1</td><td>3</td></tr>
<tr><td colspan="2">Economy: GDP/capita</td><td>5,274</td><td>USD per capita/yr.</td><td>6</td></tr>
<tr><td colspan="2">Population below the poverty line[3]</td><td>16.6</td><td>% below USD 1.90 per day</td><td>39</td></tr>
<tr><td colspan="2">Gender Inequality Index[4]</td><td>40.7</td><td></td><td>36</td></tr>
<tr><td colspan="2">GINI co-efficient[3]</td><td>63.4</td><td></td><td>1</td></tr>
<tr><td colspan="2">HDI[5]</td><td>0.67</td><td></td><td>9</td></tr>
<tr><td colspan="2">Access to electricity[6]</td><td>86.0</td><td>% population</td><td>10</td></tr>
<tr><td colspan="5">Summary indicators of climate change vulnerability</td></tr>
<tr><td colspan="2">Workforce in agriculture[7]</td><td>5.6</td><td>% workforce</td><td>41</td></tr>
<tr><td colspan="2">Population undernourished[7]</td><td>5.0</td><td>% population</td><td>36</td></tr>
<tr><td colspan="2">Number of people affected by drought[8]</td><td>17,700,000</td><td>people</td><td>4</td></tr>
<tr><td colspan="2">Number of people affected by flood events[8]</td><td>483,471</td><td>people</td><td>19</td></tr>
<tr><td colspan="2">Population living within 100 km of coast[9]</td><td>19,307,400</td><td>people</td><td>5</td></tr>
<tr><td colspan="2">Population living in informal settlements[6]</td><td>23.0</td><td>% urban population</td><td>44</td></tr>
<tr><td colspan="2">Incidence of malaria[7]</td><td>3</td><td>cases per 1000 population at risk</td><td>43</td></tr>
<tr><td rowspan="3">ND-Gain Vulnerability Index[10]</td><td>Total</td><td>53.3</td><td></td><td>4</td></tr>
<tr><td>Readiness</td><td>0.45</td><td></td><td>6</td></tr>
<tr><td>Vulnerability</td><td>0.39</td><td></td><td>52</td></tr>
</table>

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2. CLIMATE AND WEATHER

South Africa's climate ranges from a subtropical in the north, through to a mid-latitude or Mediterranean climate in the far south west. Most of the country experiences rainfall during the austral summer season (Dec - Jan) along with higher temperatures, and low rainfall during the austral winter (Jun-Aug) along with colder temperatures. The south west of the country experiences rainfall during austral winter (Jun-Aug) along with cold temperatures, and low rainfall during the austral summer (Dec - Jan) along with warmer temperatures. The south coast receives rainfall all year round but warmer temperatures during summer and cooler temperatures during winter.

South Africa can be divided into 6 climatic regions based on annual total rainfall as well as variations in the seasonal cycle of rainfall. These zones are illustrated in **Figures 2-1** and **2-2**, below, and summary descriptions can be found in **Table 2-1** below.

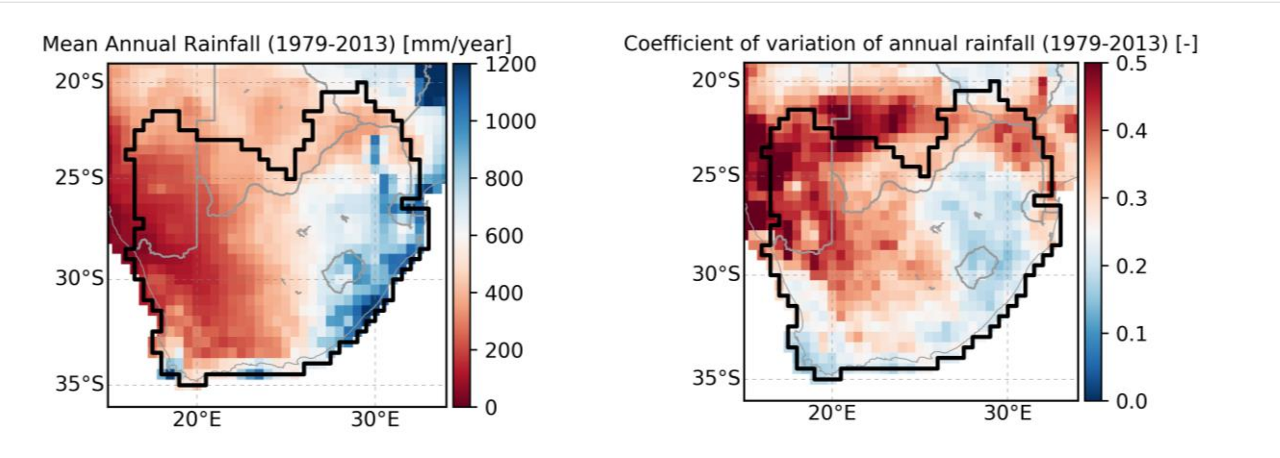
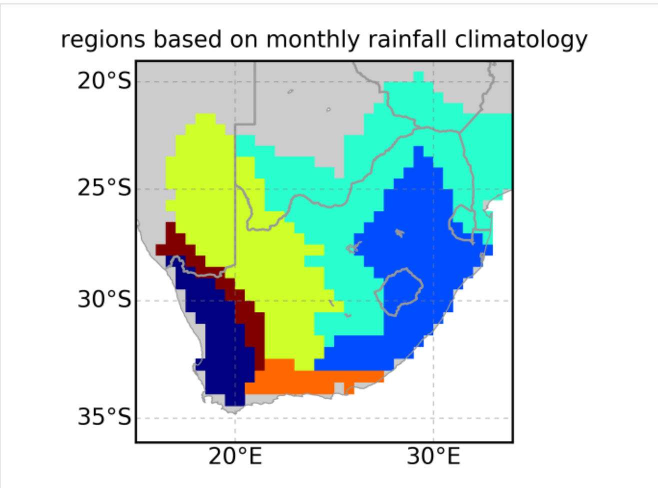


Figure 2-1: Main characteristics (magnitude and variability) of rainfall in South Africa and its regions



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

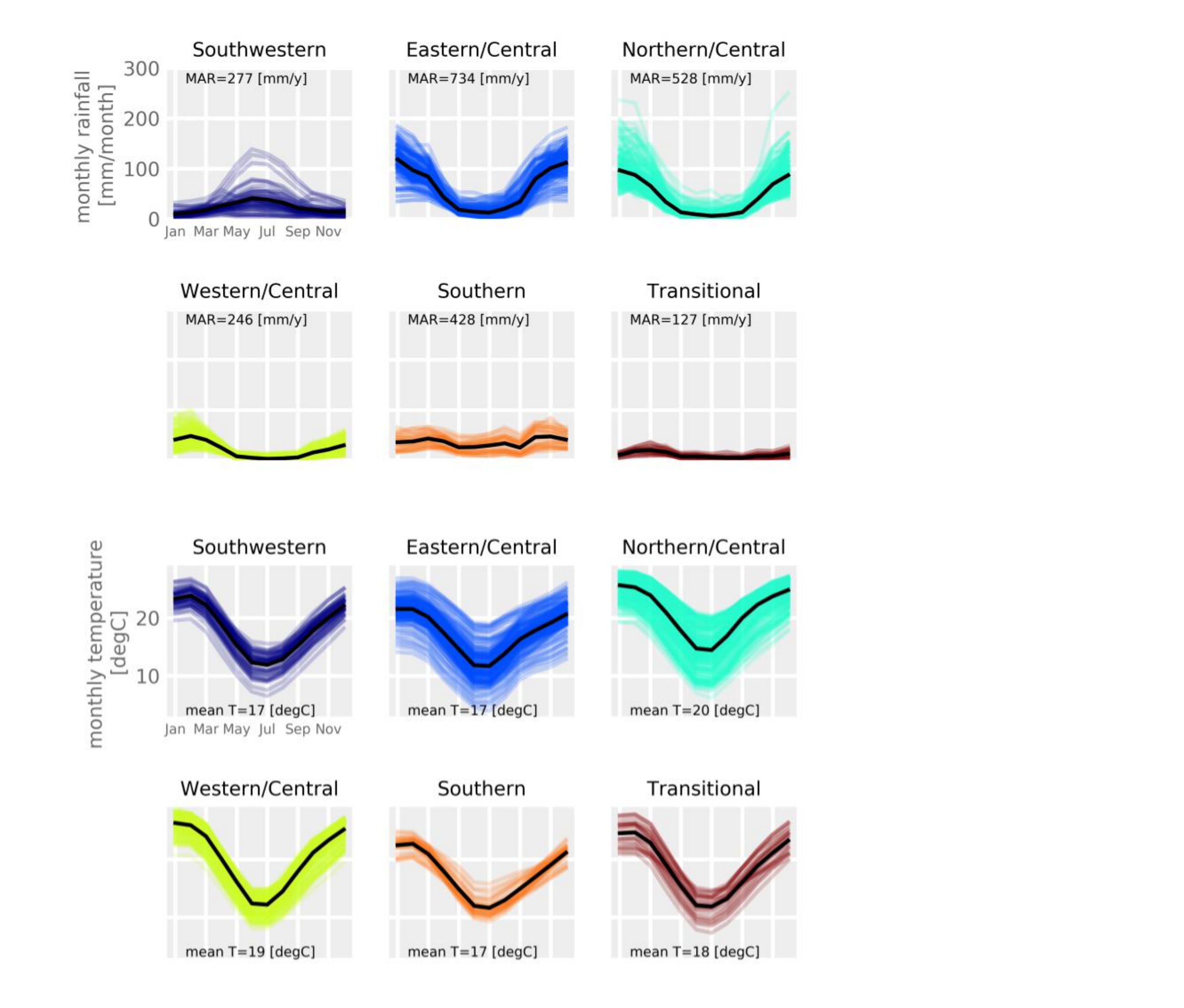


Figure 2-2: Rainfall regions of South Africa based on similarity of standardised rainfall climatology, and their rainfall and temperature climatologies

Table 2-1: Main rainfall regions of South Africa

SOUTHWESTERN	Winter rainfall region with mean annual rainfall ranging from 300 mm in the north to 1200 mm in the mountains in the south, and relatively low interannual variability. Daily mean temperature averages 17° C with a seasonal range of around 11° C. Warmest temperatures occur during austral summer and coolest temperatures during winter.
EASTERN/CENTRAL	Summer rainfall region with mean annual rainfall ranging from 600 mm in the west and north to >1000 mm at locations along the east coast. Relatively low levels of interannual variability. Daily mean temperature averages 17° C with a seasonal range of around 10° C. Warmest temperatures occur during austral summer and coolest temperatures during winter. Clear spatial differences are seen in the daily mean temperature which are strongly associated with topographical differences.
NORTHERN/CENTRAL	Summer rainfall region, transitional between the Easter/Central high rainfall region and drier regions to the west and north. Mean annual rainfall ranges between 400 and 600 mm and moderate interannual variability. Daily mean temperature averages 20° C with a seasonal range of around 10° C. Warmest temperatures occur during austral summer and coolest temperatures during winter. Clear spatial differences are seen in the daily mean temperature which are strongly associated with topographical differences.
WESTERN/CENTRAL	The arid, summer rainfall region with mean annual rainfall less than 400 mm, and strong interannual variability. Daily mean temperature averages 19° C with a seasonal range of around 12° C. Warmest temperatures occur during austral summer and coolest temperatures during winter.
SOUTHERN	All-year round rainfall region, with mean annual rainfall in the 400-600 range and relatively low interannual variability. Daily mean temperature averages 17° C with a seasonal range of around 10° C. Warmest temperatures occur during austral summer and coolest temperatures during winter.
TRANSITIONAL	The most arid region, with summer rainfall and mean annual rainfall not exceeding 250 mm and with strong interannual variability. Daily mean temperature averages 18° C with a seasonal range of around 12° C. Warmest temperatures occur during austral summer and coolest temperatures during winter.

2.1 Observed historical climate variations and climate change trends

As with many semi-arid climate regions, the majority of South Africa experiences **moderately high rainfall variability** on an inter-annual basis. On **decadal time scales** South Africa also experiences **significant variability** with some periods 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 six regions show consistent upward and clear trends of **increasing temperatures** over the period 1979 - 2015 with the most rapid increases observed in the Southwestern Region. Long term trends across the 6 regions show relatively weak and largely **insignificant trends in total annual rainfall** though generally the central parts of the country show stronger indications of increasing rainfall while coastal parts show no clear trends. The increases in total rainfall are associated with the increases in rainfall frequency, as well as increases in number of extreme intensity events. Long term trends and variability across the six climate regions 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 Africa (1979 - 2015)

REGION	MEAN T [DEG C/DECADE]	TOTAL RAINFALL [MM/DECADE]	EXTREME RAINY DAYS [DAYS/DECADE]	RAINY DAYS [DAYS/DECADE]
Southwestern	+0.24	not evident	not evident	+1.7
Eastern/Central	+0.18	not evident	not evident	not evident
Northern/Central	+0.20	upward	slight upward	slight upward
Western/Central	+0.19	+23.16	+2.4	+3.1
Southern	+0.09	not evident	slight upward	not evident
Transitional	+0.20	+10.1	+1.1	+1.6

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

Projections of future climate, based on CMIP5 GCM simulations[1] under the RCP8.5 pathway[2] indicate that all six regions show strong similarities with respect to both rainfall and temperature projections. Projected changes for the six regions 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 six regions show a common message of **potential reduced rainfall** emerging from as early as the 2020s in some regions. Relative magnitudes of potential reduced rainfall vary across the regions with the Northern/Central region showing potential rainfall reductions as large as 400mm/year drier by 2100 which equates to 50% of the baseline normal of 800mm/year. The Eastern/Central region shows possible reductions of 200mm/year by 2100, a reduction to around 80% of the baseline normal. **The reduction in rainfall** seems to be strongly associated with **decreases in the number of rainy days** rather than changes in rainfall intensity. Projected changes in the number of heavy rainfall days per year (days > 95th percentile of daily magnitudes), show possible reductions in the frequency of such events in the future, except for the Eastern/Central region where there is a possibility of increased frequency of heavy rainfall days. It must be noted that these results are derived from GCM projections which may not accurately represent changes in extreme rainfall dynamics. Other studies have suggested that increased convective rainfall intensity (e.g. thunderstorm-related rainfall) should generally be expected in a warmer climate.

2.2.2 Projected changes in temperature from present to 2100

Projected changes in temperature are even more similar across all six regions with temperatures projected to be 2°C to 3°C warmer in most regions by the 2050s. By 2100 the range of projected temperatures is greater with the coastal regions showing projected increases of 2°C to 4°C by 2100 and the inland regions showing increases of 3°C to 6°C by 2100.

[1] The fifth iteration of the Couple Model Inter-comparison Project (CMIP) is a coordinate activity amongst international modeling centers to produce a suite of climate simulations using common experimental parameters. CMIP5 is currently the primary source of global to regional scale climate projections and extensively informed the IPCC Fifth Assessment Report (AR5)

2 Although this emissions/development pathway represents the "worst-case scenario" amongst the pathways simulated by the IPCC CMIP5 models, at this stage it is the most realistic reflection of the recent progression of anthropogenic emissions. It is presented here, in spite of the Paris agreement, as effects of its commitments remain to be shown.

Table 2-3: Summary of projected climate changes across regions of South Africa 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]
Southwestern	**Increasing** +1°C to +2°C by 2050s but changes evident in next decade	**Normal to strongly decreasing** rainfall, ranging from no change or nominal decreases to dramatic decreases (30% drier by 2100). Could become evident by the 2030s.	**Normal to decreasing**	**Normal to decreasing**
Eastern/ Central	**Increasing** +1°C to +2°C by 2050s but changes evident in next decade	**Normal to decreasing rainfall** ranging from no change or nominal decreases to dramatic decreases (20% drier by 2100). Could become evident by the 2040s.		
Eastern/ Central	**Increasing** +1°C to +2°C by 2050s but changes evident in next decade	**Normal to decreasing rainfall** ranging from no change or nominal decreases to dramatic decreases (20% drier by 2100). Could become evident by the 2040s.		
Northern/ Central	**Increasing** +1°C to +2°C by 2050s but changes evident in next decade	**Normal to strongly decreasing rainfall** ranging from no change or nominal decreases to dramatic decreases (45% drier by 2100). Could become evident by the 2030s.		
Western/ Central	**Increasing** +2°C to +3°C by 2050s but changes evident in next decade	**Normal to strongly decreasing rainfall** ranging from no change or nominal decreases to dramatic decreases (40% drier by 2100). Could become evident by the 2040s.		

REGION	AVERAGE TEMPERATURE [˚C]	TOTAL ANNUAL RAINFALL [MM/YEAR]	NUMBER OF HEAVY RAINFALL [DAYS/YEAR]	RAINY DAYS [DAYS/YEAR]
Southern	**Increasing** +1˚C to +2˚C by 2050s but changes evident in next decade	**Normal to strongly decreasing rainfall** ranging from no change or nominal decreases to dramatic decreases (40% drier by 2100)	**Normal to decreasing**	**Normal to decreasing**
Transitional	**Increasing** +1˚C to +2˚C by 2050s but changes evident in next decade	**Normal to strongly decreasing rainfall** ranging from no change or nominal decreases to dramatic decreases (40% drier by 2100). Could become evident by the 2040s.		

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.

Generally speaking South Africa is considered a water scarce country and so reductions in rainfall are likely to have impacts for many sectors. Increases in rainfall may have positive and negative impacts though the dominance of increasing temperatures often mitigates the positive impacts of increasing rainfall. Agriculture is the most clearly vulnerable sector in the country with high dependence on water both for rain fed and irrigated agriculture. Agriculture currently uses around 40% of available surface water resources in South Africa. Coastal development is likely vulnerable to sea-level rise and associated stresses. Health, particularly in the pervasive informal housing areas, is a poorly understood but potentially very vulnerable sector. Summaries of vulnerabilities are detailed in the table below.

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

SECTOR	IMPACTS
Agriculture	- **Crop loss and reduced yields owing to water logging and general damage owing to extreme rainfall** - Reduced fruit quality and yield owing to less chill units - Increased need for irrigation, owing to increasing temperatures - Increased input costs (fertiliser)
Fisheries	- Unknown/complex impacts owing to changing ocean temperatures, salinity and currents
Water resources	- Reduced catchment yield owing to reduced rainfall - Greater evaporative losses from dams owing to increased temperatures - Increased demand for irrigation water - Increased demand on water resources, owing to increasing temperatures and greater evaporation - Reduced availability of water resources owing to reduced rainfall and increasing temperatures (evaporation)
Built infrastructure and human settlements	- **Damage to or destruction of infrastructure owing to extreme rainfall and flooding** - Increased energy consumption for air conditioning owing to increased temperatures - Increased erosion and storm damage in coastal areas owing to increased storm surges
Human health	- **Increased exposure to infections in flooded or damaged areas owing to extreme rainfall** - Increased number of people at risk of heat-related medical conditions, owing to increased temperatures - **Increased prevalence of vector-borne diseases such as malaria, owing to higher temperatures and extreme rainfall** - **Reduced water quality owing to higher fresh water temperatures and extreme rainfall**

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

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

3.1 National energy production and consumption

In South Africa, over 85% of national energy production and ~93% of electricity generation is derived from coal (World Bank, 2013; IEA, 2014) (Table 3-1, below). The sectors that account for the majority of national energy consumption include industry (27.4 MTOE per year), transport (17.9 MTOE) and the residential sector (16.8 MTOE) (IEA, 2014) (Table 3-4, overleaf). The primary carriers of the energy consumed by the latter sectors include oil (25.1 MTOE per year or 34 %), coal (19.5 MTOE or 26 %), and electricity (17 MTOE per year or 23%) (IEA, 2014) (Tables 3-2 and 3-3, below). 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].

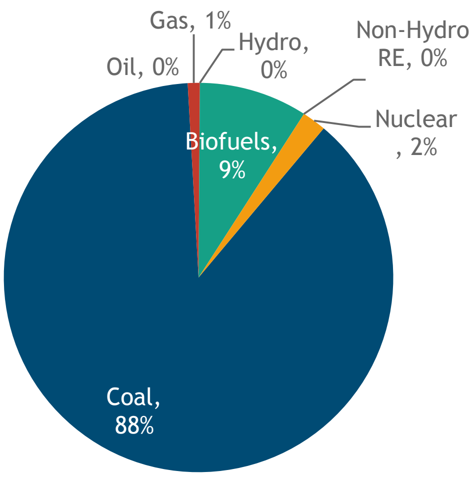

Figure 3-1: Distribution of South Africa's national energy production between major energy carriers (2014-2016)

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

NATIONAL ENERGY PRODUCTION		
Source	**Total (MTOE) *[3]**	**% of total energy production**
Coal[11]	147.5	87.6
Oil[11]	0.2	0.1
Gas[11]	0.9	0.5
Hydro[11]	0.1	0.1
Biofuels[11]	15.8	9.4
Non-Hydro RE[11]	0.3	0.2
Nuclear[11]	3.6	2.1
Total national energy production	168.3	0.4
Electricity[6]	Hydro	1.0
	Non-Hydro renewable	5.5
	Nuclear	93.0
	Coal	0.1
	Oil	

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

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

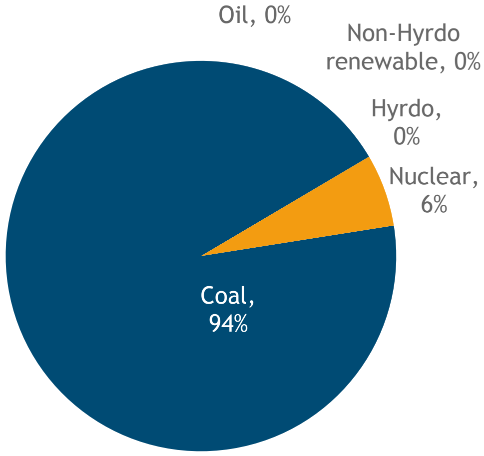

Figure 3-2: Distribution of South Africa's national energy consumption by major energy carriers

CONSUMPTION BY ENERGY SOURCE[11]	
Source	**Total (MTOE)**
Coal	19.5
Oil	25.1
Gas	1.7
Hydro	0.0
Biofuels	11.4
New RE	0.1
Electricity	17.0
Nuclear	0.0
Total national energy consumption by source	74.8

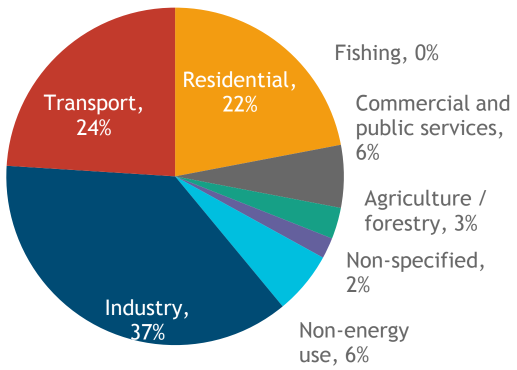

Figure 3-3: Distribution of South Africa's national energy consumption by sector (2014-2016)

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

CONSUMPTION BY SECTOR[11]	
Source	**Total (MTOE)**
Industry	27.4
Transport	17.9
Residential	16.8
Commercial and public services	4.4
Agriculture / forestry	2.1
Fishing	0.1
Non-specified	1.8
Non-energy use	4.3
Total national energy consumption by sector	74.8

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

TOTAL PRIMARY ENERGY SUPPLY[11]		
Source		**Total (MTOE)**
Coal		102.1
Oil	Crude Oil	21.4
	Oil Products	0.4
Gas		3.8
Hydro		0.1
Biofuels		15.5
New RE		0.3
Electricity		-0.2
Nuclear		3.6
Total primary energy supply		147.0

3.2 National greenhouse gas emissions by source and sector

Coal is the largest contributor to South Africa's greenhouse gas (GHG) emissions from fuel combustion (~343 MT CO_2e), followed by oil (~73 MT CO2e) *4. The sectors that account for the largest proportion of national GHG emissions are electricity and heat production (~281 MT CO2e), other uses within the energy sector (~43 MT CO2e, primarily accounted for by the conversion of coal to liquid and gas fuels), transport (55.3 MT CO2e), and the sectors of manufacturing, construction and industry (52.4 MT CO2e) (IEA, 2013).

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). The latter figures are based on statistics from the International Energy Agency (IEA). Section 3.2.2, further below, describes GHG emissions from all sectors of national energy consumption, which therefore includes emissions from fuel combustion, industrial/manufacturing processes, household-level energy consumption and AFOLU (Agriculture, Forestry and Other Land Use). The latter figures are compiled by the World Resources Institute's Climate Access Indicator Tools (CAIT), which employs different methodologies and reporting standards to the IEA. Therefore, while there is some resultant duplication between the two datasets, each provides slightly different approaches to categorisation of major GHG emitting sectors and are both included for consideration.

Section 3.2.3 provides additional details on South Africa's Land Use and Land Use Change sector, including detailed summaries of emissions from the agriculture sector and historical land use changes.

[4] *Greenhouse gas emissions are expressed in MegaTonnes of CO_2equivalents, where 'CO_2e' indicates all known GHGs, expressed in units equivalent to the 'Global Warming Potential' of CO_2.*

3.2.1 GHG emissions from fuel combustion, by source and sector

Table 3-5: South Africa's national greenhouse gas emissions from fuel combustion

NATIONAL GHG EMISSIONS FROM FUEL COMBUSTION BY FUEL SOURCE AND SECTOR[12]		
Source / Sector		**Total emissions (MT CO_2e)**
Coal		343.0
Oil		73.4
Gas		4.0
Total fuel source emissions		420.4
Electricity and heat production		234.6
Other energy industry own use*		43.8
Manufacturing industries and construction		52.4
Transport	Road	51.4
	Other	3.9
	Total	55.3
Other	Residential	15.9
	Non-residential	18.4
	Total	34.3
Total section emissions		420.4

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

3.2.2 GHG emissions from primary energy consumption, by source and sector

Table 3-6: South Africa's National Greenhouse Gas Emissions from Primary Energy Consumption (estimated for 2014-2016)

NATIONAL GHG EMISSIONS FROM FUEL COMBUSTION BY FUEL SOURCE AND SECTOR[13]		
Source / Sector		**Total emissions (MT CO_2e)**
Energy	Electricity and heat	281.4
	Manufacturing and construction	52.4
	Transport	55.3
	Other fuel combustion	41.4
	Fugitive emissions	8.7
	Energy sub-total	439.1
Industrial processes		21.4
Agriculture		30.5
Waste		19.2
Land use change and forestry (LUCF)		2.0
Total emissions (including LUCF)		512.2

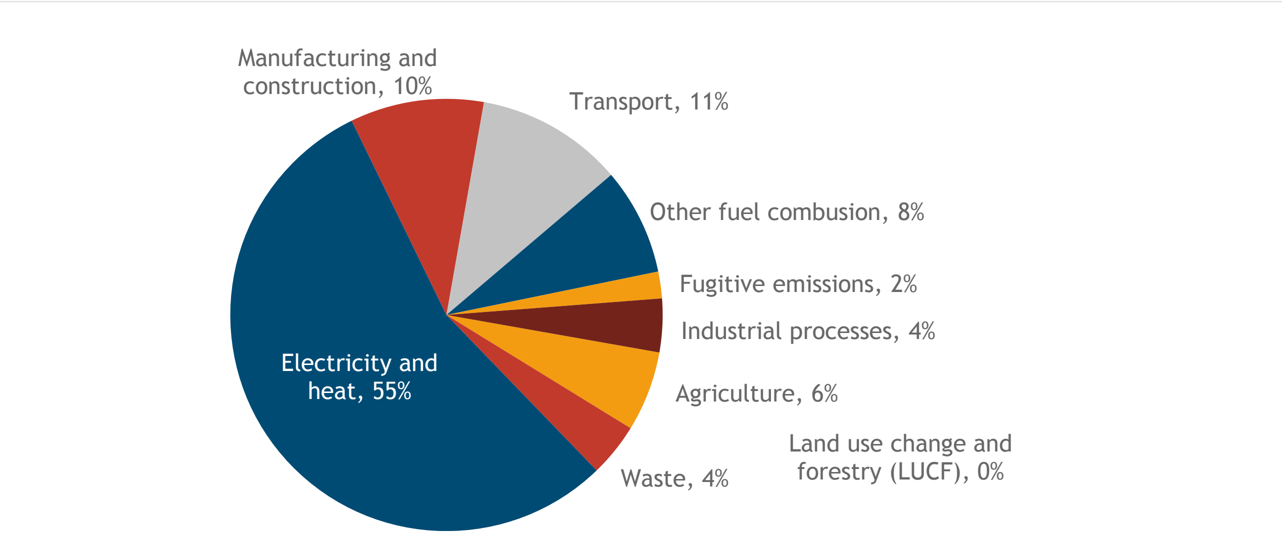

Figure 3-4: Distribution of South Africa's GHG emissions by major sectors

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3.2.3 GHG emissions from agricultural practices

Table 3-7, below, summarises GHG emissions from South Africa's agriculture sector (derived from Food and Agriculture Organisation statistics). Although there are multiple agricultural practices which contribute to GHG emissions, in the case of South Africa the livestock production sector is by far the largest contributor to agricultural GHG emissions. In particular, enteric fermentation and manures left in pastures contributes over 90% of total GHG emissions from this sector.

Table 3-7: National annual greenhouse gas emissions from agricultural practices, forestry and other land use in South Africa (estimated for 2014-2017)

VARIABLE		ANNUAL EMISSIONS (MT CO_2E)
Annual GHG emission from agricultural practices [14]	Burning - crop residues	0.29
	Burning - savanna	2.34
	Crop residues	1.03
	Cultivation of organic soils	0.03
	Enteric fermentation	12.53
	Manure management	0.87
	Manure applied to soils	0.41
	Manure left on pasture	9.68
	Rice cultivation	0.01
	Synthetic fertilizers	2.82
	Sub-total (Agricultural practices)	30.00
Annual GHG emission from land use change [14]	Grassland	0.01
	Cropland	0.25
	Burning biomass	2.07
	Sub-total (Land use change)	2.32
Total emissions		32.32

Table 3-8, overleaf, summarises the recent historical changes in land use in South Africa 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. Global Forest Watch reports the total aboveground carbon stock of South Africa's forest biomass as ~806.9 million tonnes.

Table 3-8: Vegetation cover and land use change in South Africa (estimated for 2015)

<table>
<tr><th colspan="3">VARIABLE</th><th>TOTAL (HECTARES)</th><th>TOTAL (% OF LAND AREA)</th><th>UNIT</th></tr>
<tr><td rowspan="4">Total tree cover [15]</td><td colspan="2">10-30% canopy cover</td><td>16,022,675</td><td>13.1</td><td rowspan="4">% of total land area</td></tr>
<tr><td colspan="2">30-50% canopy cover</td><td>2,660,647</td><td>2.2</td></tr>
<tr><td colspan="2">50-100% canopy cover</td><td>2,077,073</td><td>1.7</td></tr>
<tr><td colspan="2">Total</td><td>20,760,395</td><td>17.0</td></tr>
<tr><td rowspan="4">Land use change and agricultural expansion</td><td rowspan="3">Historical annual rate of deforestation[16]</td><td colspan="2">10-30% canopy cover</td><td>0.1</td><td rowspan="3">% of previous year</td></tr>
<tr><td colspan="2">30-50% canopy cover</td><td>0.3</td></tr>
<tr><td colspan="2">50-100% canopy cover</td><td>2.0</td></tr>
<tr><td colspan="2">Area of agricultural land[17]</td><td>96,856,701</td><td>79.5</td><td>% of total land area</td></tr>
<tr><td></td><td colspan="2">Historical annual area converted to agricultural land[17]</td><td>-512,018</td><td>-0.5</td><td>% of previous year</td></tr>
</table>

4. SUMMARISED NATIONAL PRIORITIES FOR CLIMATE CHANGE ADAPTATION AND MITIGATION

South Africa's intended responses to the challenge of climate change are described through national-level policy frameworks as well as sectoral and provincial (i.e. sub-national) policies and strategies. In addition to the development of detailed national- and sub-national level priorities for climate change, South Africa'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. The latter document includes detailed descriptions of South Africa's major commitments and priorities related to GHG mitigations (Table 4-2, below) as well as major priorities related to adaptation, derived from the draft National Adaptation Plan (NAP) (Table 4-3, further below).

South Africa's emissions will be in a range between 398 and 614 Mt CO_2e by 2025 and 2030, as defined in national policy. The adaptation component of South Africa's NDC will address adaptation through six goals, underpinned by key elements of adaptation planning, costing of adaptation investment requirements, equity, and means of implementation. The activities and approach described in South Africa's NDC are based on the National Climate Policy (NCCRP) and the National Development Plan (NDP) and will be given effect through plans and legislation in sectors such as energy, industry and others. South Africa's NDC further notes that significant investments have already been made in adaptation (increasing from ~USD 1.64 billion to USD 2.31 billion between 2010 and 2015) and mitigation (including ~USD 16 billion in the procurement of independently-produced renewable energy infrastructure generating ~243 MW, public transport infrastructural investments of ~USD 0.5 billion in 2012, and the establishment of a Green Fund with initial budget allocation of ~USD 0.22 billion). The estimated investment costs to enable the implementation of the full range of South Africa's proposed NDC actions are not fully elaborated. However, indicative costs are provided for specific mitigation-related initiatives, including inter alia: i) ~USD 3 billion per year to expand renewable energy power producer's programme (REI4P); ii) USD 349 billion to support transition to decarbonised electricity by 2050; iii) ~USD 0.45 billion for development of coal-to-liquid plant for Carbon Capture and Storage; iv) USD 513 billion for transition to electric vehicles by 2050; and v) USD 488 billion to promote adoption of hybrid electric vehicles by 2030.

Table 4-1, below, gives details on South Africa'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 Africa'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
463.75	N/A	Emissions peaking; (398 - 614 Mt CO_2e)	2025	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3; Energy, industrial processes and product use, agriculture, land use, land-use change and forestry, waste	Not mentioned	AFOLU included. The greater uncertainty in AFOLU emissions should be noted, as well as the intention to reduce uncertainty over time.

4.1 National priorities for climate change mitigation

South Africa'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 South Africa'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.

National priorities for mitigation of GHG emissions reflects South Africa's heavy reliance on fossil fuels for generation of electricity, transport and industrial applications. Correspondingly, the primary emphasis of NDC-level mitigation priorities is on reducing the use of coal while increasing the share of renewable energy in the national energy grid, complemented by investments to promote electric and hybrid vehicles. In addition to these measures, South Africa has expressed interest in Carbon Capture and Sequestration (CCS) technology and has undertaken studies to quantify the total national potential for CCS - however this novel technology remains relatively untested and is currently in a phase of research and development. Although South Africa notes the potential to reduce GHG emissions through priority actions in the Land Use Change/Agricultural sectors, however at present there are relatively few details available of what specific actions South Africa may implement related to Land Use Change.

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

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE*[5]
Energy	Substantial investment in renewable energy and two new high-efficiency coal-fired power stations nearing completion as part of the ageing plant replacement programme.	1
	Expanding the Renewable Energy Independent Producer Procurement Programme (REI4P) in the next ten years	
	Carbon Capture and Storage: 23 Mt CO2 from the coal-to-liquid plant	
	Decarbonized electricity by 2050	
Transport	Investment in public transport infrastructure investments are expected to grow at 5% year	5
	Hybrid electric passenger vehicles to increase to 20% by 2030	
AFOLU	South Africa's mitigation will cover the scope of IPCCs major categories, which include AFOLU (agriculture, forestry and other land use)	4
	Exempt from tax ex-factory buses used for public transportation	

[5] **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 national priorities for climate change adaptation, South Africa's national-level policies and strategies are relatively undetailed. All priority adaptation actions noted in South Africa's NDC are institutional-level objectives and are indicative of a general direction of policy rather than the identification of sector- or province-specific actions. It is envisaged that South Africa's major priorities for climate change adaptation will be articulated at the sub-national level through provincial- and municipal-level plans for adaptation. South Africa's proposed activities and investments related to adaptation are 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).

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

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE[6]
Institutional	Develop a National Adaptation Plan, and begin operationalisation as part of implementing the NCCRP for the period from 2020 to 2025 and for the period 2025 to 2030	5
	Take into account climate considerations in national development, sub-national and sector policy frameworks for the period 2020 to 2030	
	Build the necessary institutional capacity for climate change response planning and implementation for the period 2020 to 2030	
	Develop an early warning, vulnerability and adaptation monitoring system for key climate vulnerable sectors and geographic areas for the period 2020 to 2030, and reporting in terms of the National Adaptation Plan with rolling five-year implementation periods.	5,6

[6] **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 Africa. 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 climate regions across South Africa. 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 Eastern/Central region has a high inter-annual variability (500mm in some years to 900mm in others) and moderate decadal variability (650mm at some periods while over 800mm in other periods). The long-term trend is not statistically significant but could be around 11mm over the 30-year period.

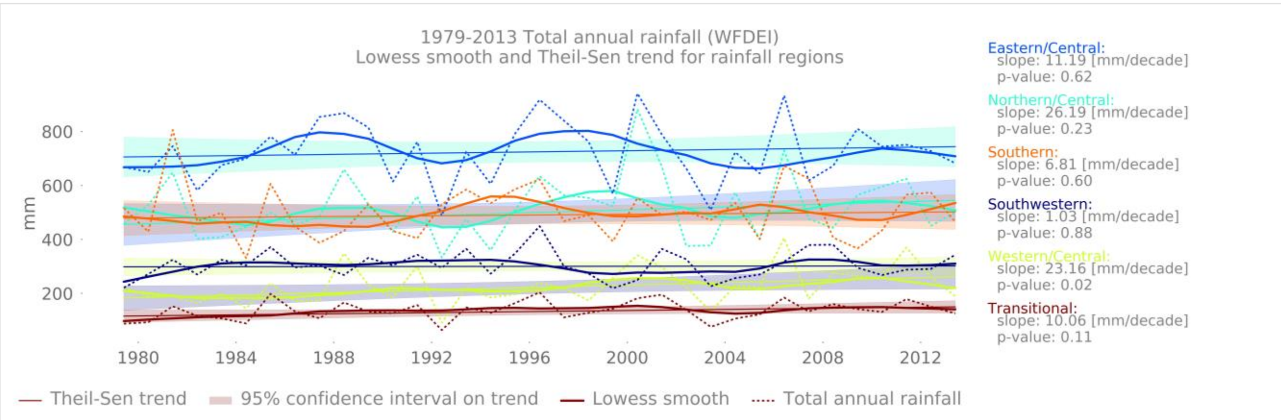

Figure A-1: Long term trends and variability in total annual rainfall for rainfall regions

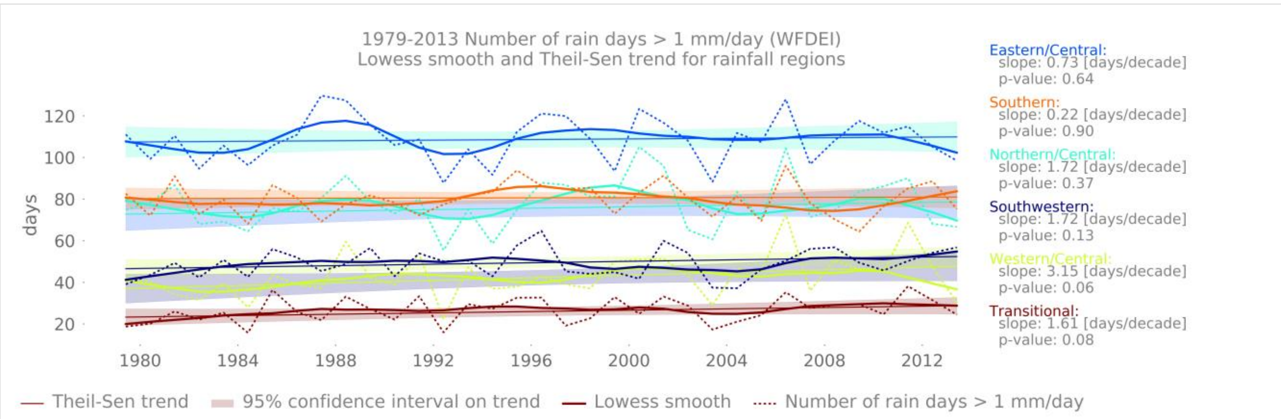

Figure A-2: Long term trends and variability in frequency of rainfall events for rainfall regions

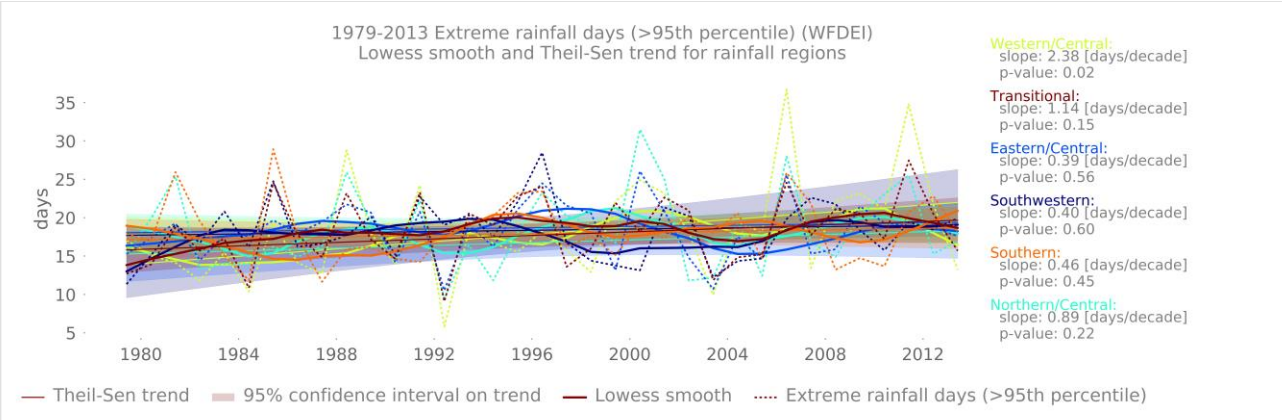

Figure A-3: Long term trends and variability in extreme rainfall events for rainfall regions

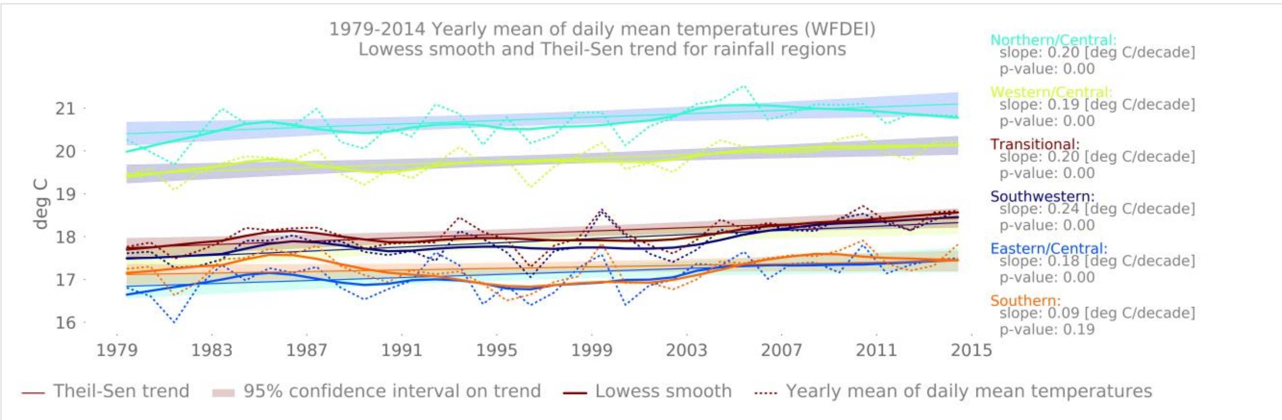

Figure A-4: Long term trends and variability in daily mean air temperatures for rainfall regions

1.c Climate projections visualisations

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.

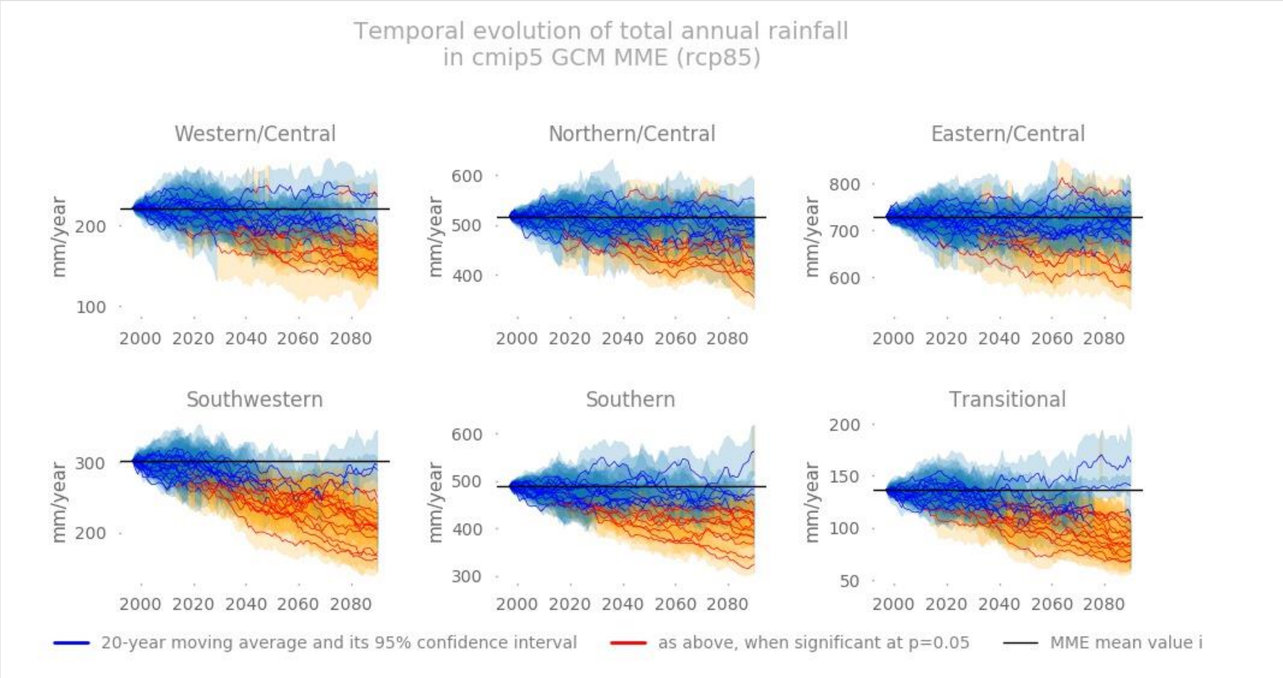

Figure A-5: Projected changes and emergence of changes in total annual rainfall

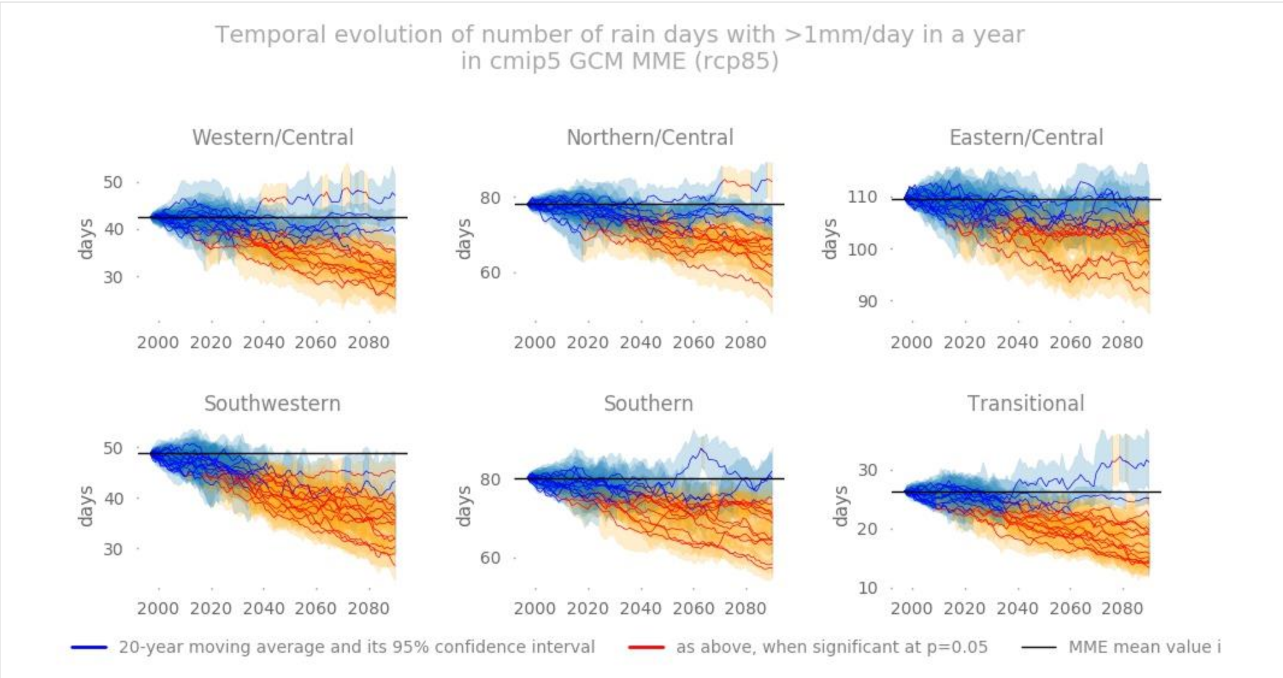

Figure A-6: Projected changes and emergence of changes in number of rain days per year

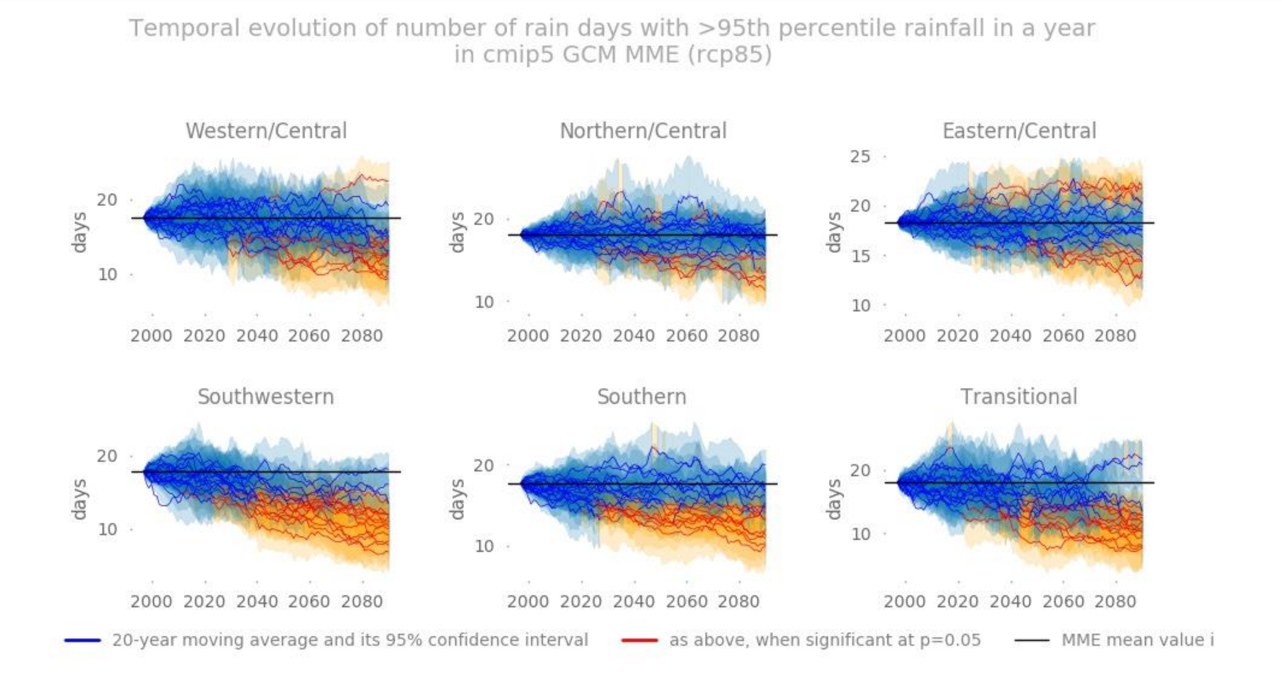

Figure A-7: Projected changes and emergence of changes in number of very heavy rainfall days (greater than 95th percentile) per year

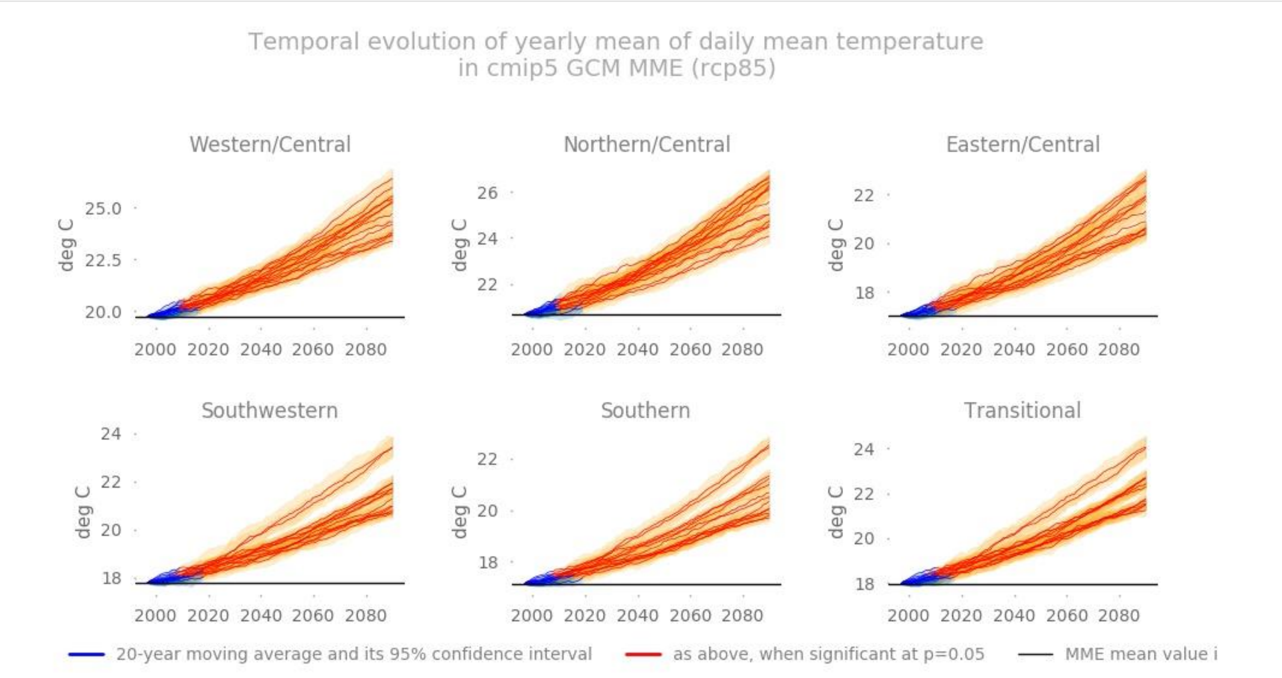

Figure A-8: Projected changes and emergence of changes in annual mean daily mean temperatures

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