NAMIBIA

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 Namibia (henceforth 'Namibia') is a large (~824,000 km2) and sparsely populated country (~3 people/km2, the least dense population in Africa) on the west coast of Southern Africa, sharing borders with South Africa, Botswana, Zambia and Angola. Within Namibia's population of ~2.5 million people, it is estimated that at least ~45% live in urban areas with this figure increasing at an annual urbanisation rate of ~4.3%. In terms of total economy size, Namibia is relatively small with a total GDP of ~USD 10.3 billion but enjoys a relatively high standard of living, where annual GDP per capita is estimated to be 7th-greatest in Africa at ~USD 4,140 per capita per annum. Nevertheless, it is estimated that almost ~23% of the population subsist below the poverty line of USD 1.90 per day, and the country's GINI co-efficient score of 61 is ranked as 2nd in Africa, which indicates that there remain substantial inequalities between the wealthiest and poorest of Namibia's households. In terms of vulnerability to climate-related risks and hazards, Namibia's population is affected by both floods and droughts. As a particularly arid and water-scarce country, much of Namibia's low-lying and southern desert regions frequently experience drought and rainfall variability, and it is estimated that ~1,281,000 people were affected by drought in the period 1996–2016. With respect to vulnerability to floods, Namibia's heterogeneous landscape includes several large rivers and river basin areas which are susceptible to flooding, particularly in the northern interior of the country in the vicinity of the borders with Angola and Botswana. Floods are estimated to have impacted negatively on at least 1.1 million Namibians in the period 1996–2016. The ND-GAIN index summarizes the country's vulnerability to climate change and other global challenges in combination with its readiness to improve resilience. Namibia's index (44.8; the 12th highest in Africa) indicates that the country is less vulnerable and more ready in comparison to other African countries. This index also indicates that Namibia is on the road to responding effectively to climate change, but the adaptation needs and urgency to act are great. Key socio-economic indicators for Namibia are further presented and summarised in Table 1-1, below.

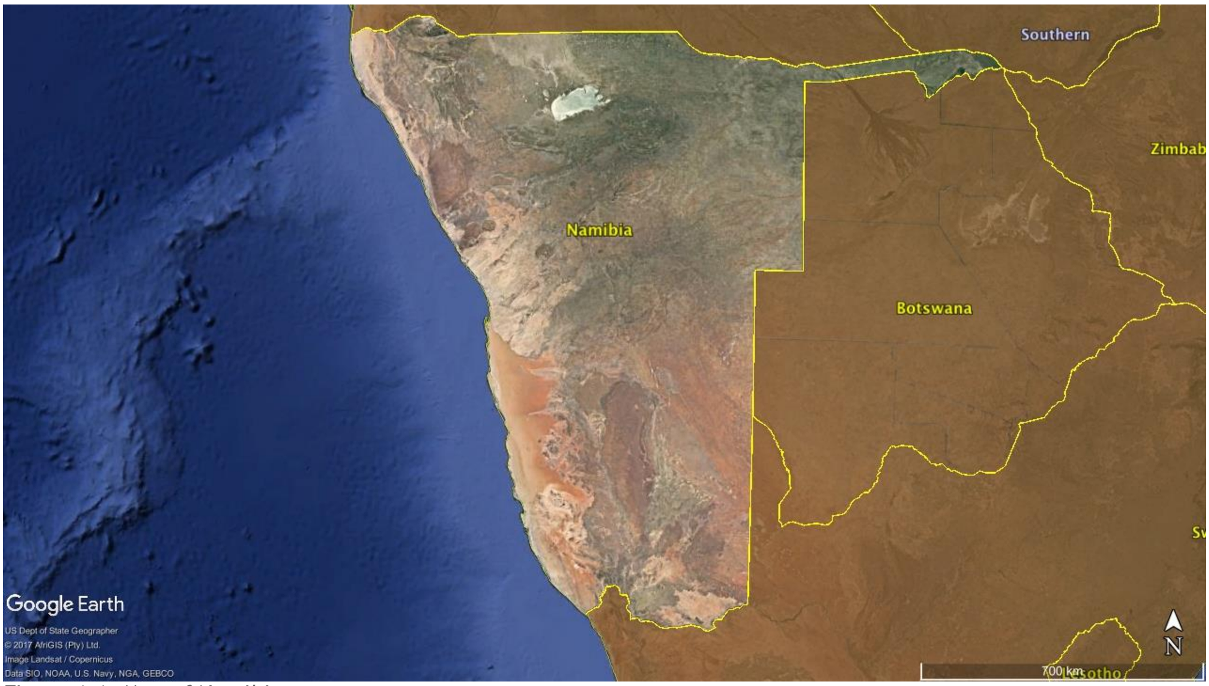


Figure 1-1: Map of Namibia

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

VARIABLE		SCORE/TOTAL	UNIT	RANK (IN AFRICA)
Geography, Socio-Economy and Demographics				
Population[1]		2,568,569	people	41
Population growth rate[1]		2.2	% population .yr^{-1}	37
Population density[1]		3	People/km^2	54
Land area[1]		828,571	km^2	15
% Urban population[1]		45.2	% population	22
% Urbanisation rate[2]		4.3	% population .yr^{-1}	14
Economy: total GDP[2]		10.3	USD billions .yr^{-1}	26
Economy: GDP by PPP[2]		26	billion international dollars .yr^{-1}	30
Economy: GDP/capita[2]		4,140	USD per capita/yr	7
Population below the poverty line[3]		22.6	% below USD 1.90 per day	35
Gender Inequality Index[4]		40.1		37
GINI co-efficient[3]		61.0		2
HDI[5]		0.64		12
Access to electricity[6]		49.6	% population	21
Summary indicators of climate change vulnerability				
Workforce in agriculture[7]		31.4	% workforce	29
Population undernourished[8]		42.3	% population	3
Number of people affected by drought[9]		1,281,000	people	25
Number of people affected by flood events[9]		1,099,450	people	16
Population living within 100 km of coast[10]		147,497	people	39
Population living in informal settlements[6]		33.2	% urban population	41
Incidence of malaria[8]		14	cases per 1000 population at risk	41
ND-Gain Vulnerability Index[10]	Total	44.8		12
	Readiness	0.44		10
	Vulnerability	0.55		27

2. CLIMATE AND WEATHER

Namibia's climate varies from warm semi-arid in the north-east to warm desert over the southern parts and along the coast, though some parts of the coast are cool due to the cold Benguela ocean current. Rainfall generally occurs during austral summer with a clearly defined dry season during winter. The water region of Namibia extends far beyond the border of the country into southern Angola and western Zambia to the north and following the Orange River catchment into South Africa and Lesotho to the south-east. Rainfall increases in the water catchments to the north of Namibia and to a lesser degree to the south-east.

Variations in the characteristics of rainfall within the water region of Namibia are large and therefore 6 sub-regions are used in this analysis. Only three of these regions (Zambezi/Northern, Central and Coastal/Southern regions) actually fall within the country, while the other three are located higher up the river catchments in Angola and Zambia (Northern Rivers region) and in South Africa and Lesotho (Orange Arid and Orange Headwaters regions).

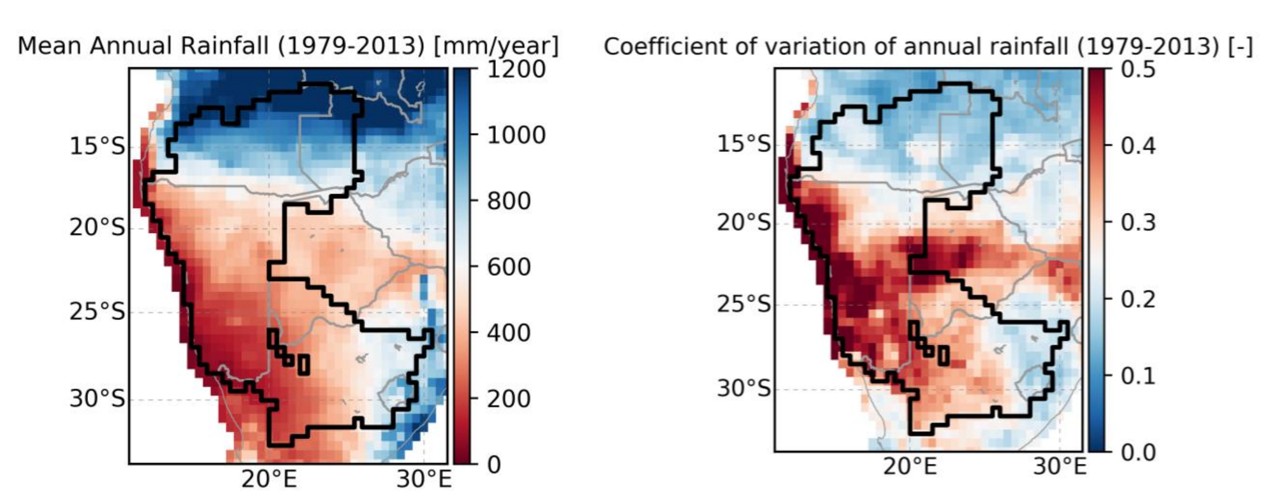
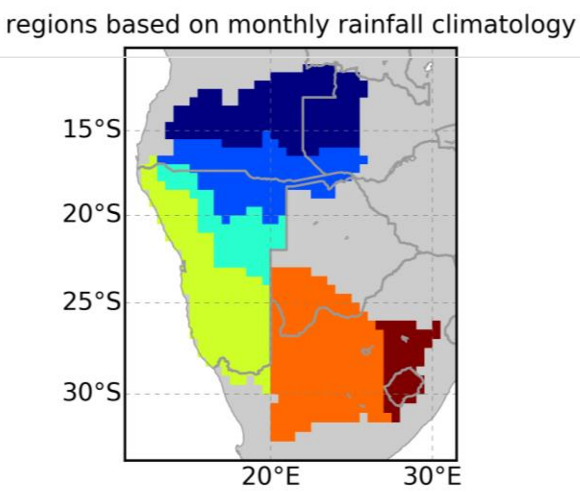


Figure 2-1: Main characteristics (magnitude and variability) of rainfall in Namibia and its region



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

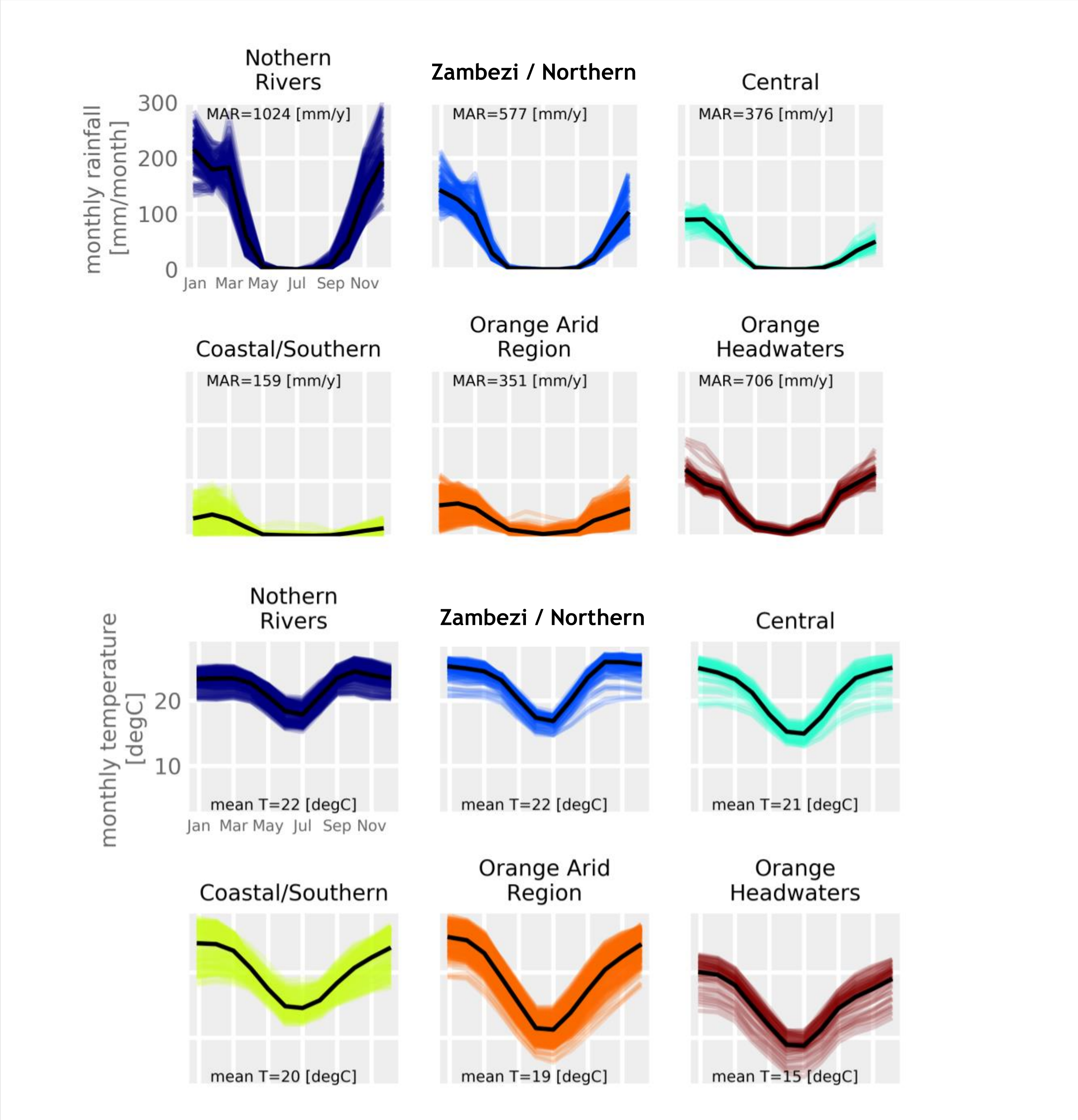


Figure 2-2: Rainfall regions of Namibia based on similarity of standardised rainfall climatology, and their rainfall and temperature climatologies

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

NORTHERN RIVERS	A wet region with annual total rainfall reaching 1020mm/year and daily mean temperature of 22° C. Rainfall amounts are highest over the far north of the region, decreasing towards the south. Variability of rainfall from year to year is relatively low. Rainfall occurs in a single austral summer season from October to March with values reaching around 200mm/month from December to March. A distinct dry season occurs from May to September. A clear seasonal cycle (~7° C) in temperature is evident with warmest temperatures from September to April and coolest temperatures in June and July.
ZAMBEZI/NORTHERN	A semi-arid region with annual total rainfall of around 580mm/year and daily mean temperature of 22° C. Rainfall amounts are highest over the far north of the region decreasing towards the south. Moderate variability of rainfall from year to year is evident over this region. Rainfall occurs in a single austral summer season peaking above 100mm/month from December to March. A distinct dry season occurs during the austral winter with no rainfall from May to September. A clear (~8° C) seasonal cycle in temperature is evident with warmest temperatures from September to April and coolest temperatures in June and July.
CENTRAL	A semi-arid region with annual total rainfall of just under 380mm/year and daily mean temperature of 21° C. Rainfall amounts are highest over the north-east and decrease towards the escarpment to the south-west. Moderate to high variability of rainfall from year to year is evident over the region. Rainfall occurs during the austral summer season peaking at around 100mm/month in January and February. A very clearly defined dry season occurs during austral winter with no rainfall from May to September. A clear seasonal cycle in temperature is evident (~10° C) with warmest temperatures from October to March and coolest temperatures in June and July.
COAST/SOUTHERN	A very arid region with annual total rainfall of only 160mm/year and daily mean temperature of 20° C. Rainfall values are especially low along the coast but increase slightly as one moves inland. High variability from year to year is evident in the annual total rainfall amounts. Rainfall generally occurs during January and February; however, the coastal parts often experience thick fog throughout the year. A clear seasonal cycle in temperature is evident (~10° C) with warmest temperatures in austral summer and cooler temperatures in winter.
ORANGE ARID	An arid region with annual total rainfall of 350mm/year and daily mean temperature of 19° C. Rainfall amounts increase from the west to the east of the region and the region experiences moderate levels of rainfall variability from year to year. Rainfall is most common during the austral summer; however, some rainfall occurs during the rest of the year, especially over the south western parts which receive some winter rainfall. A clear seasonal cycle in temperature is evident (~12° C) with warmest temperatures in austral summer and cooler temperatures in winter.
ORANGE HEADWATERS	A semi-arid region with annual total rainfall of around 710 mm/year and a daily mean temperature of 15° C. Rainfall is highest over the eastern escarpment of Lesotho and the region moderate to low levels of interannual rainfall variability. A clear seasonal cycle in temperature is evident (~11° C) with warmest temperatures in austral summer and cooler temperatures in winter.

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2.1 Observed historical climate variations and climate change trends

The majority of Namibia experiences **relatively high rainfall variability** on an inter-annual basis, with the higher rainfall areas of the water catchment areas having lower variability. On **decadal time scales** Namibia also experiences **significant 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 **increasing temperatures** over the period 1979 – 2015, although the trends appear to be slightly weaker in the last decade of that period. Long term trends in total annual rainfall are all positive and, with the exception of the two regions within South Africa, all are statistically significant. The frequency of rainfall events and extreme rainfall events also show positive trends, most of which are also statistically significant. Long term trends and variability in the Namibia 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 Namibia (1979 - 2015)

REGION	MEAN T [DEG C/DECADE]	TOTAL RAINFALL [MM/DECADE]	EXTREME RAINY DAYS [DAYS/DECADE]	RAINY DAYS [DAYS/DECADE]
Northern Rivers	+0.11	+53.6	+1.4	+1.88
Zambezi/ Northern	+0.17	+35.0	not detectable	+5.1
Central	+0.19	+40.4	+2.3	+4.1
Coastal / Southern	+0.19	+23.9	+2.3	+2.7
Orange Arid	+0.16	+15.9	+1.4	+2.7
Orange Headwaters	+0.21	upwards	upwards	not detectable

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

Projected changes in main attributes of climate for the Namibia 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 can 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 Namibia regions show a pattern of **potential decreasing rainfall** emerging in the second half of the century. These patterns appear to be consistent across the majority of CMIP5 model in the ensemble, but this is in contrast to positive trends evident in the historical trends presented earlier. Relative magnitudes of potential decreased rainfall for the Central and Coastal/Southern regions are in the order of 250mm/year and 70mm/year dryer by 2100 which equates to 30% and 60% of the baseline normal. **The increase in rainfall** seems to be strongly associated with **increase in the rainfall events** but no clear signal is evident in extreme rainfall events. It must be noted that these results are derived from GCM projections which may not accurately represent changes in extreme rainfall dynamics.

2.2.2 Projected changes in temperature from present to 2100

Air temperature is projected to be between 1.5°C and 4°C warmer in the Namibia regions by the 2050s. By 2100 the range of projected temperatures is greater with the coastal regions showing projected increases of 4°C to 7°C.

Table 2-3: Summary of projected climate changes across regions of Namibia 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]
Northern Rivers	**Increasing** +1.5°C to +3.5°C by 2050s but changes evident in next decades	**Normal to slight decreasing**, could become evident after 2060s	No consistent signal in projections	**Normal to decreasing**, could become evident after 2050s
Zambezi / Northern	**Increasing** +1.5°C to +3.5°C by 2050s but changes evident in next decades	**Normal to decreasing**, could become evident after 2040s		**Normal to decreasing**, could become evident after 2040s
Central	**Increasing** +2°C to +4°C by 2050s but changes evident in next decades	**Normal to decreasing**, could become evident after 2050s		**Normal to decreasing**, could become evident after 2050s
Coastal / Southern	**Increasing** +2°C to +3°C by 2050s but changes evident in next decades	**Normal to decreasing**, could become evident after 2050s		**Normal to decreasing**, could become evident after 2040s
Orange Arid	**Increasing** +2°C to +3.5°C by 2050s but changes evident in next decades	**Normal to decreasing**, could become evident after 2040s	**Normal to decreasing**, could become evident after 2050s	**Normal to decreasing**, could become evident after 2040s
Orange Headwaters	**Increasing** +1.5°C to +3°C by 2050s but changes evident in next decades	**Normal to decreasing**, could become evident after 2070s	No consistent signal in projections	**Normal to decreasing**, could become evident after 2030s

2.3 Expected climate vulnerabilities

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

Large and sparsely populated Namibia is a particularly arid and water scarce country, where water is one of the primary factors limiting development. With increasing temperature trends and indications that annual rainfall trends may be normal to decreasing, the future may see Namibia's already limited water resources under substantive further pressure and exacerbate the stress on the already drought prone lower-lying and southern desert regions. Water stress and increasing temperatures is of further concern for both the economy and for food security, given the important role of agriculture, a highly climate sensitive sector on which the economy at large and a large portion of the rural population depends. While many enjoy a relatively high standard of living in Namibia, about one fifth of the population lives below the poverty line, which implies that people's capacity to adapt to increasing temperatures and increased water stress varies widely. While only a small portion of the population resides in coastal areas, the Namibian coast features some of the most productive fishing grounds in the world, and forms one of the pillars of the national economy. The potential direct impacts of sea-level rise and associated stressors on fishing activities, as well as the complex dynamics that may impact fish productivity and diversity, including increasing ocean temperatures and acidity, is thus a concern.

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

SECTOR	IMPACTS
Agriculture	- Crop loss owing to droughts, lower total rainfall and shifting rainfall patterns, including delayed onset of rainy season - Increased evaporation rates and increased salinization of the soil
Fisheries	- Decreasing fish stocks owing to warming of the Benguela current - Increased jelly fish populations southwards from northern Angola - Increased productivity of inland fisheries, owing to increased river flow in the North Central parts of the country - Changed productivity of inland fisheries owing to less predictable flow and more frequent flood and drought events
Water resources	- Increased water scarcity, owing to normal to decreased annual rainfall - Reduced quality and quantity of groundwater, owing to contamination and low recharge
Built infrastructure and human settlements	- Damage to and destruction of infrastructure due to coastal flooding from increased sea levels and storm surge, with Walvis Bay harbour at particular risk
Human health	- Increased prevalence of vector-borne diseases such as malaria and sleeping sickness, owing to better breeding conditions of mosquitoes and tsetse flies - Increased prevalence of water-borne diseases, such as cholera - Increased potential for malnutrition and stunting owing to increased crop failure - Increased number of people at risk of heat-stress

3. GREENHOUSE GAS EMISSIONS AND ENERGY USE

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

3.1 National energy production and consumption

The total national energy production for Namibia is relatively small at 0.5 MTOE, supplying less than one third of total national energy consumption of 1.7 MTOE. National energy production is mainly in the form of biomass fuels to supply domestic energy needs (0.3 MTOE) plus small quantities of hydroelectricity and other forms of renewable energy (<0.2 MTOE). Total electricity consumption, estimated at 0.3 MTOE, includes approximately ~0.1 MTOE contributed by local hydroelectricity facilities, while as much as ~70% of total national electricity consumed is imported from neighbouring South Africa. The other major contributors to national energy consumption include imported oil, which contributes 1.2 MTOE of the country's total national consumption of 1.7 MTOE.

The productive sectors which account for the majority of fuel consumption include the transport sector (0.7 MTOE or ~41%), agriculture (0.3 MTOE or ~18%) and industry (0.2 MTOE or ~12%). In addition, the residential sector accounts for 0.1 MTOE while other non-specified uses account for the remainder of energy consumption. 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]. The tables and figures below describe Namibia's energy sector, including total national energy production, primary energy supply and national energy consumption by fuel carrier and sector.

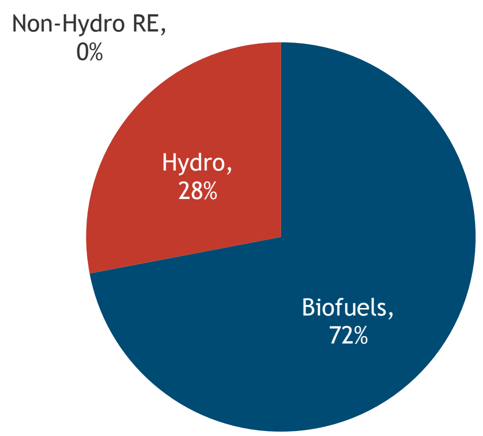

Figure 3-1: Distribution of Namibia's national energy production between major energy carriers (2014-2016)

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

NATIONAL ENERGY PRODUCTION		
Source	**Total (MTOE)** [1]	**% of total energy production**
Hydro[12]	0.13	27.71
Biofuels[12]	0.33	71.86
Non-Hydro RE[12]	<0.01	0.4
Total national energy production	0.46	
Electricity[6]	Hydro	99.1
	Oil	0.9

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

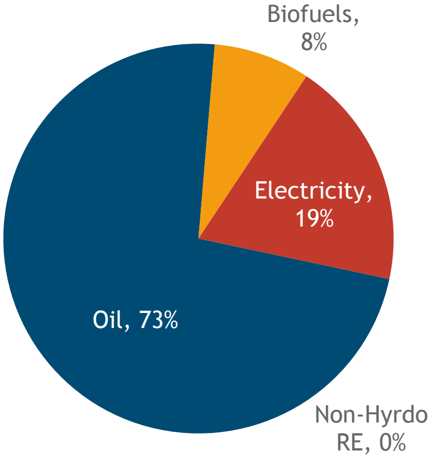

Figure 3-2: Distribution of Namibia's national energy consumption by major energy carriers

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

CONSUMPTION BY ENERGY SOURCE[12]	
Source	**Total (MTOE)**
Oil	1.20
Biofuels	0.13
New RE	<0.01
Electricity	0.32
Total national energy consumption by source	1.65

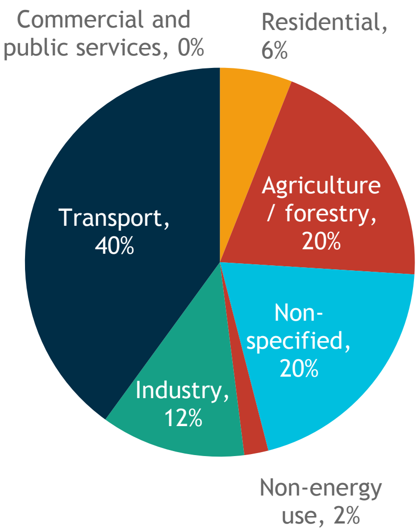

Figure 3-3: Distribution of Namibia's national energy consumption by sector (2014-2016)

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

CONSUMPTION BY ENERGY SOURCE[12]	
Source	**Total (MTOE)**
Industry	0.20
Transport	0.66
Residential	0.10
Commercial and public services	<0.01
Agriculture / forestry	0.33
Non-specified	0.34
Non-energy use	0.02
Total national energy consumption by sector	1.65

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

TOTAL PRIMARY ENERGY SUPPLY[12]	
Source	**Total (MTOE)**
Oil	1.21
Hydro	0.13
Biofuels	0.23
New RE	<0.01
Electricity	0.24
Total primary energy supply	1.81

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, 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.

3.2.1 GHG emissions from fuel combustion, by source and sector

The distribution of Namibia's GHG emissions reflect the dominant fuel sources and energy-consuming sectors described in 3.1, above. Oil is the main contributor to GHG emissions from fuel combustion (3.4 MT CO_2e per annum), in addition to which coal supplies a small amount (~0.1 MT CO_2e). The majority of Namibia's national fuel consumption is accounted for by the transport sector (1.9 MT CO_2e, of which 1.8 MT CO_2e is accounted for by road transport) and 'other non-residential consumers' (~1.2 – 1.5 MT CO_2e), the latter of which may potentially be accounted for by mining and industrial processes such as smelting. Emissions resulting from electricity and heat production account for only 0.1 MT CO_2e, or ~3% of total national emissions from fuel combustion.

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

NATIONAL GHG EMISSIONS FROM FUEL COMBUSTION BY FUEL SOURCE AND SECTOR [13]		
Source / Sector		**Total emissions (MT CO_2e)**
Coal		0.06
Oil		3.38
Total fuel source emissions		3.43
Electricity and heat production		0.08
Manufacturing industries and construction		0.29
Transport	Road	1.76
	Other	0.11
	Total	1.87
Other	Residential	0.01
	Non-residential	1.19
	Total	1.20
Total sector emissions		3.43

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

As described in 3.2.1, above, the sectors of transport and various unspecified industrial processes account for the majority of Namibia's emissions from fuel combustion in the energy sector (totalling ~3.7 MT CO_2e). However, Namibia's largest sources of GHG emissions are not from direct applications in the energy sector but rather as a result of various activities in sectors including Land Use Change & Forestry (9.5 MT CO_2e), agriculture (6.8 MT CO_2e), industrial processes and waste management (0.4 MT CO_2e).

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Table 3-6: Namibia's national greenhouse gas emissions from primary energy consumption (estimated for 2014-2016)

NATIONAL GHG EMISSIONS FROM PRIMARY ENERGY CONSUMPTION BY SOURCE AND SECTOR [14]		
Source / Sector		**Total emissions (MT CO_2e)**
Energy	Electricity and heat	0.08
	Manufacturing and construction	0.30
	Transport	1.87
	Other fuel combustion	1.48
	Energy sub-total	3.73
Industrial processes		0.35
Agriculture		6.82
Waste		0.38
Land use change and forestry (LUCF)		9.54
Total emissions (including LUCF)		20.84

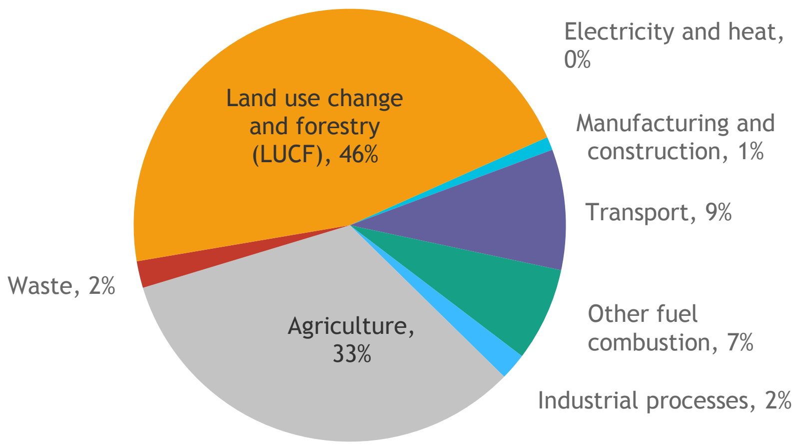

Figure 3-4: Distribution of Namibia's GHG emissions by major sectors

3.2.3 GHG emissions from agricultural practices

As described in Section 3.2.2, above, the agriculture and land use change sectors are the largest contributors to Namibia's GHG emissions. With respect to emissions from Namibia's agriculture sector, both crop agriculture as well as livestock husbandry contribute to total emissions of ~6.1 MT CO2e per annum. Burning of savanna areas, enteric fermentation by livestock, and emissions from livestock manure left on pastures are the primary drivers of emissions from the agriculture sector.

In the land use change sector, emissions from forest lands and burning of biomass contribute ~9 MT CO2e out of total national GHG emissions of 20.8 MT CO2e (Table 3-7). The activities which result in the large emissions from this sector include conversion of woodland and forest habitat for agriculture, unmanaged fires, and collection of biomass fuels (firewood as well as charcoal) for domestic consumption and export. Namibia's landscape includes ~1.57 million hectares of '10-30% cover' woodland, and addition to which the country has some very small remaining extents of dense semi-deciduous forest (<2,500 hectares) with canopy cover >50% (Table 3-8). The latter dense hardwood forests are mainly confined to the northern interior of the Zambezi strip and are subjected to rapid land use changes and deforestation, with an estimated deforestation rate of up to ~4.3%. Global Forest Watch estimates the total aboveground carbon biomass content of Namibia's wooded areas is ~202 million tonnes of carbon.

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

VARIABLE		ANNUAL EMISSIONS (MT CO_2E)
Annual GHG emission from agricultural practices [15]	Burning - crop residues	<0.01
	Burning - savanna	2.03
	Crop residues	0.01
	Enteric fermentation	2.22
	Manure management	0.10
	Manure applied to soils	0.04
	Manure left on pasture	1.64
	Synthetic fertilizers	0.02
	Sub-total (Agricultural practices)	6.06
Annual GHG emission from land use change [17]	Forest land	6.06
	Burning biomass	7.89
	Sub-total (Land use change)	1.06
Total emissions		15.01

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

VARIABLE		TOTAL (HECTARES)	TOTAL (% OF LAND AREA)	UNIT
Total tree cover [18]	10-30% canopy cover	1,568,351	1.90	% of total land area
	30-50% canopy cover	2,280	<0.01	
	50-100% canopy cover	150	<0.01	
	Total	1,570,782	1.9	
Land use change and agricultural expansion	Historical annual rate of deforestation[17]	10-30% canopy cover	0.05	% of previous year
		30-50% canopy cover	1.9	
		50-100% canopy cover	4.3	
	Area of agricultural land[18]	38,857,031	47.1	% of total land area

4. SUMMARISED NATIONAL PRIORITIES FOR CLIMATE CHANGE ADAPTATION AND MITIGATION

Namibia'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 document includes detailed descriptions of Namibia'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).

"Namibia aims at a reduction of about 89% of its GHG emissions at the 2030-time horizon compared to the BAU scenario. The projected GHG emissions to be avoided in 2030 is of the order of 20000 Gg CO_2-eq inclusive of sequestration in the AFOLU sector and compared to the BAU scenario." Namibia's NDC estimates that the cost of implementation of all priority actions will require investments of at least ~USD 33 billion, of which the unconditional national investment is expected to contribute ~10% of the total costs.

Table 4-1, below, gives details on Namibia'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 Namibia'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
22.49	BAU	89 percent	2030	CO_2, CH_4, N_2O; Energy, industrial processes and product use, AFOLU, waste	Not Mentioned	IPCC Guidelines for land-use accounting

4.1 National priorities for climate change mitigation

Namibia's NDC identifies multiple adaptation priorities for sectors including energy, transport, AFOLU, Industry, and Waste Management, respectively. 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). Priorities identified for Namibia's AFOLU sector are particularly detailed and ambitious, and include multiple measures to reduce emissions from livestock production (including reduced enteric fermentation from feedlots, increased production of biogas from feedlot manure), crop fertilisation (including measures that promote conservation and climate-smart agriculture techniques and which increase the use of organic fertilisers and composts) and reduced emissions from deforestation and land use change (reduced deforestation rate, promotion of reforestation, and reduced conversion of grasslands). With respect to the transport sector, Namibia's mitigation priorities aim to reduce emissions from road transport through multiple measures including inter alia development of a mass transit system for Windhoek, promotion of a carpooling system to reduce traffic and emissions, and improved freight transit to reduce the reliance on light-load vehicles. Namibia's mitigation priorities for the energy sector, which is a small but growing contributor to national GHG emissions, are chiefly focused on increasing the share of renewable energy in the national electricity infrastructure, specifically aiming to increase the share of renewable energies from ~33% to ~70% by 2030. Other priorities for the energy sector include programmes to increase efficiency of energy use by at least ~10% by 2030. Finally, Namibia's mitigation priorities for sectors such as waste management aim to increase the efficiency of energy recovery from waste management sites that can be integrated into the national supply infrastructure.

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

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PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE[2]
Energy	Increase share of renewable energy (hydro, solar, wind and biomass) electricity production from 33% in 2010 to about 70% in 2030	1
	Implement an energy efficiency programme to reduce consumption by about 10% in 2030	1, 5, 6
Transport	Commission of a mass transport system in City of Windhoek to reduce number of cars (taxis and private) by about 40%;	2, 8
	Implement a car pooling system to reduce fossil fuel consumption	2, 8
	Improve freight transportation through bulking to reduce the number of light load vehicles by about 20%	2, 8
AFOLU	Increasing the number of livestock heads in feedlots to reduce enteric fermentation by some 4%	4, 9
	Reducing N2O emissions by about 10% through production of biogas from the feedlot manure	4, 9
	Reducing chemical fertilizers by 20% through conservation and climate smart agricultural practices, use of organic manure and composts	4, 9
	Reducing deforestation rate by 75% in 2030	4, 9
	Reforesting 20 000 ha annually as from 2018	4, 9
	Implementing agroforestry systems over 5000 ha annually during the commitment period as from 2018	4, 9
	Converting 5000 ha of grassland annually as from 2018 to arboriculture up to 2030	4, 9
Industry	Replacement of clinker coal fuel in cement production	1
Waste	Converting waste to energy	1, 4, 9
	Waste valorisation	1, 4

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

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

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

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

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

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

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

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

8. Increased use of low-carbon transport.

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

4.2 National priorities for climate change adaptation

Namibia's NDC includes detailed identification of adaptation needs and priorities, for sectors including AFOLU, Water, Human Health, Coastal Zones, and other assorted community-based actions. Namibia'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). Considering the widespread reliance of local populations on natural resource-based livelihoods, the adaptation priorities for Namibia's AFOLU sector are quite detailed and include actions specific to crop agriculture (*inter alia* promotion of conservation agriculture and other climate-smart approaches across ~80,000 hectares by 2030, promotion of irrigation and improved crop varieties), livestock (restoration of grasslands and pastureland, including control of invasive bush encroachment), and sustainable management of forest and grassland resources (reduced removal of wood from forests, improved control of fires, and establishment of community-managed reserves). As a particularly water-scarce and arid country, Namibia identifies several adaptation priorities related to the water sector, including measures to improve water supply to vulnerable rural households as well as large scale measures to increase aquifer recharge, recycle urban water and support rational distribution of water to competing sectors. Adaptation measures proposed for Namibia's coastal zone, which is vulnerable to storm surges and coastal erosion, include increased protection of shoreline and beaches, and increased protection and dredging of the Walvis Bay lagoon and port area. In terms of community-based actions for adaptation, Namibia aims to develop improved early warning systems to reduce losses and impacts on various vulnerable groups which will need to be tailored to the specific context and hazards of different sectors and regions.

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

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE[3]
AFOLU	Reducing wood removal in forests by 50%	4, 9
	Combating forest and grassland fires	4, 9
	Restoring 15 million ha of grasslands by 2030	4, 9
	Conservation agriculture is practiced over about 80 000 ha by 2030	4, 7, 9
	Elimination and control of the invader bush to restore pastureland to their original state	1, 4
	Promotion of Climate Smart Agriculture and Conservation Agriculture	1, 7
	Urban and peri-urban agriculture	2, 7

[3] *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.

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PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE[4]
AFOLU cont.	The green scheme (establishing of irrigation schemes along the perennial rivers of Namibia for food security)	1, 2
	Promotion of better adapted crop varieties and livestock species	2, 7
	Biodiversity conservation	4
	Protection of forests	1, 4, 7
	Community forest management	1, 4
Water	Rationalization of the use of water resources for different economic sectors	2
	Improved rural water supply	1, 2
	Recycling of Windhoek's wastewater into potable water	2, 7
	Artificial recharge of aquifers – 'banking water	2, 7
Community based	Risk reduction to lower the vulnerability of the people and production systems	1, 2
	Setting up appropriate early warning systems to avoid losses and reduce impacts	6
Coastal zone	Protection of the shoreline and beaches	1, 4
	Dredging of the port of Walvis Bay	1
	Surveillance of the lagoon protecting the port of Walvis Bay	1, 4
Health	Surveillance and prevention of diseases	1, 6

[4] 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.

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 Namibia. Long term (1979 to 2013) trends as well as inter-annual variability (decade to decade) has been analysed for total annual rainfall, number of rainfall days, number of extreme rainfall days, and daily mean temperatures (1979-2014) for each of the six climate regions across Namibia. 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 Central region has very high inter-annual (200mm in some years to 800mm in other years) and moderate decadal variability (300mm in some decades to 450mm in other decades). The long term trend is statistically significant and could be around 120mm over the 30 year period.

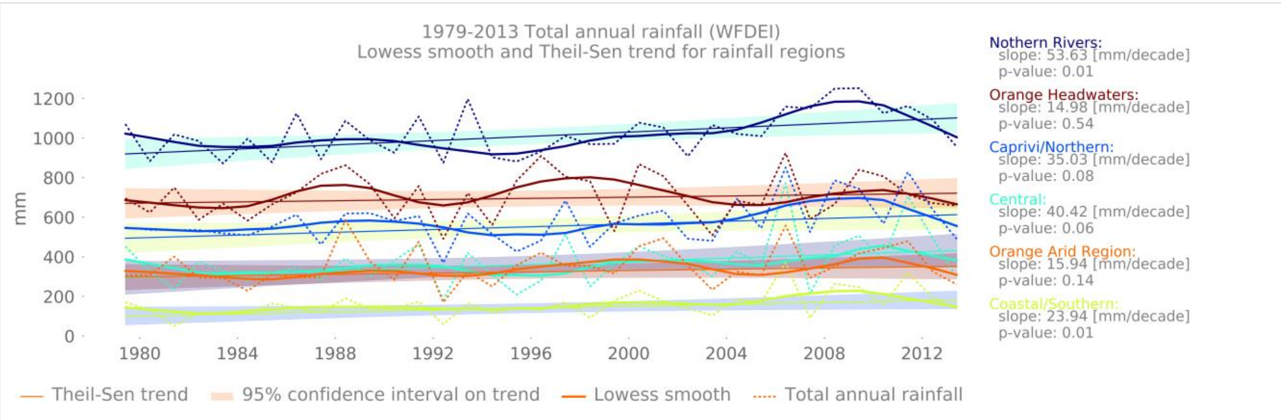

Figure A-1: Long term trends and variability in total annual rainfall for rainfall regions

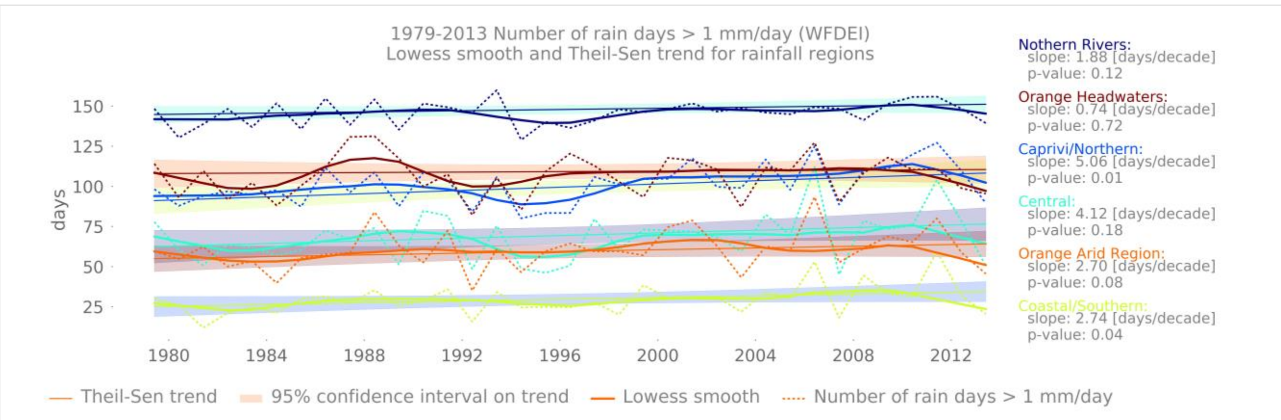

Figure A-2: Long term trends and variability in frequency of rainfall events for rainfall regions

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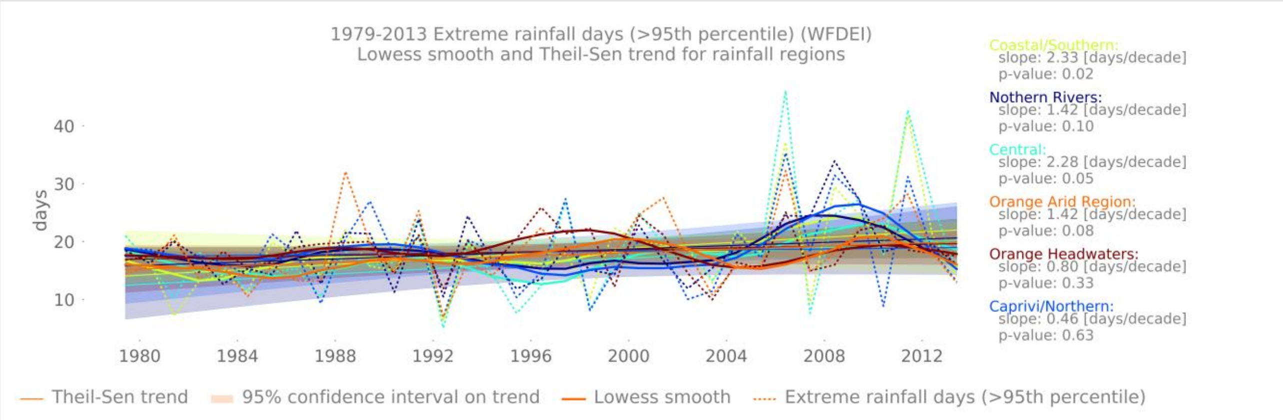

Figure A-3: Long term trends and variability in extreme rainfall events for rainfall regions

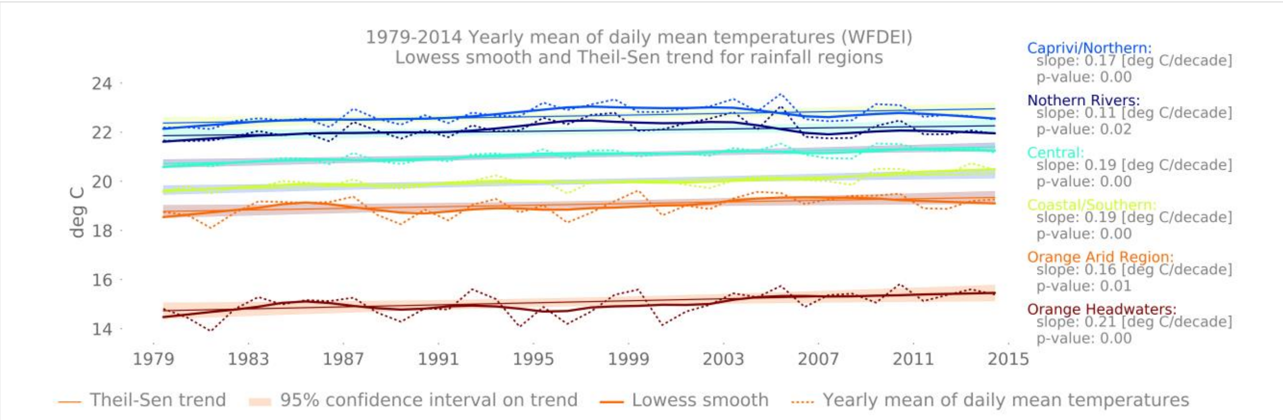

Figure A-4: Long term trends and variability in daily mean air temperatures for rainfall regions

1.c Climate projections visualizations

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

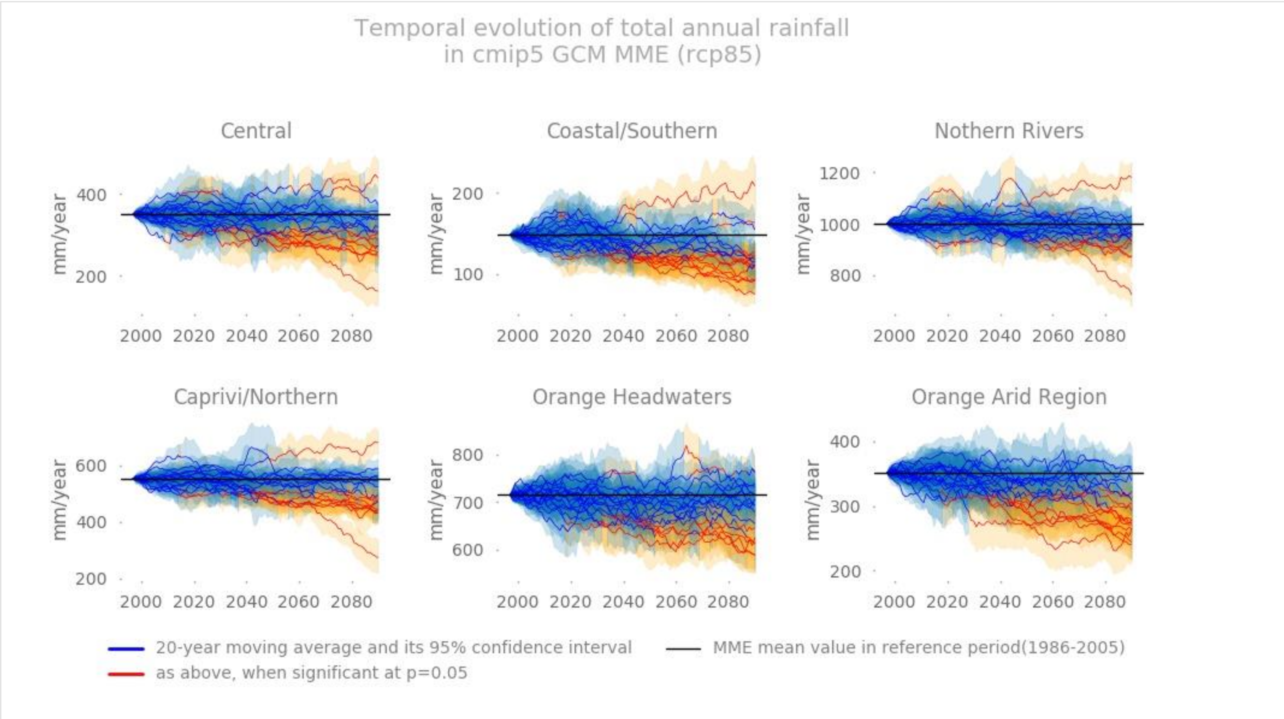

Figure A-5: Projected changes and emergence of changes in total annual rainfall

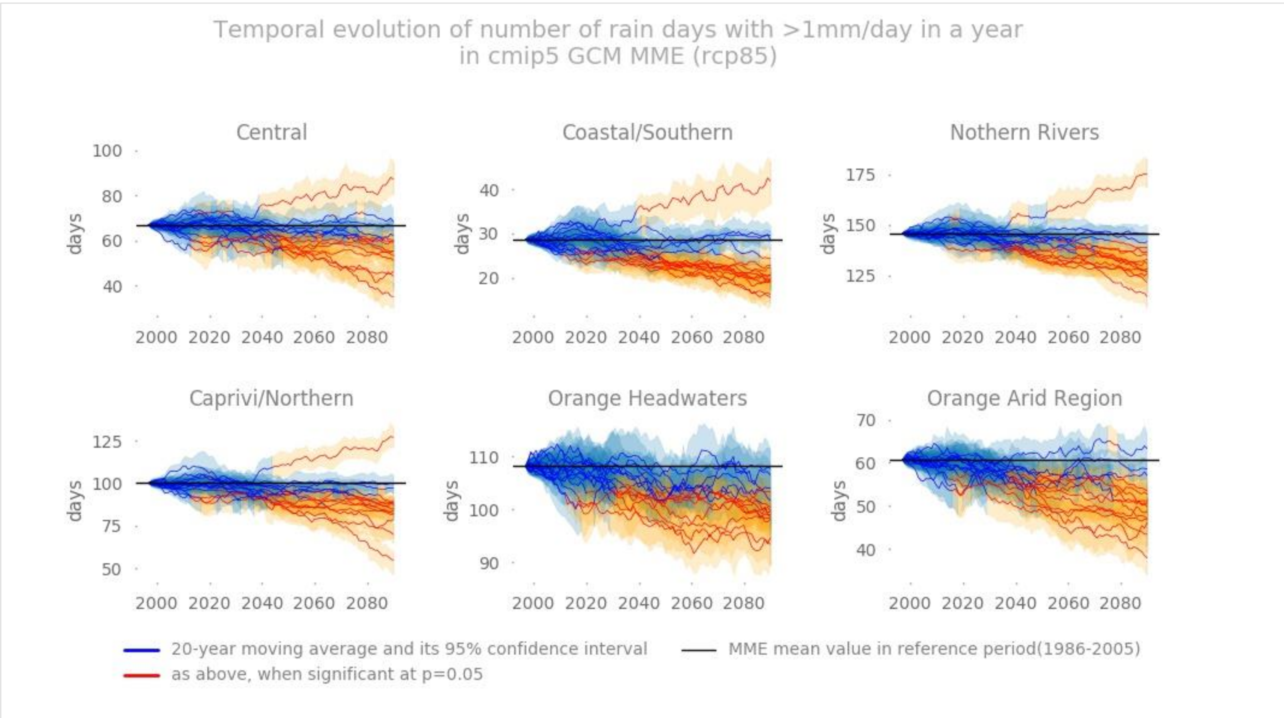

Figure A-6: Projected changes and emergence of changes in number of rain days per year

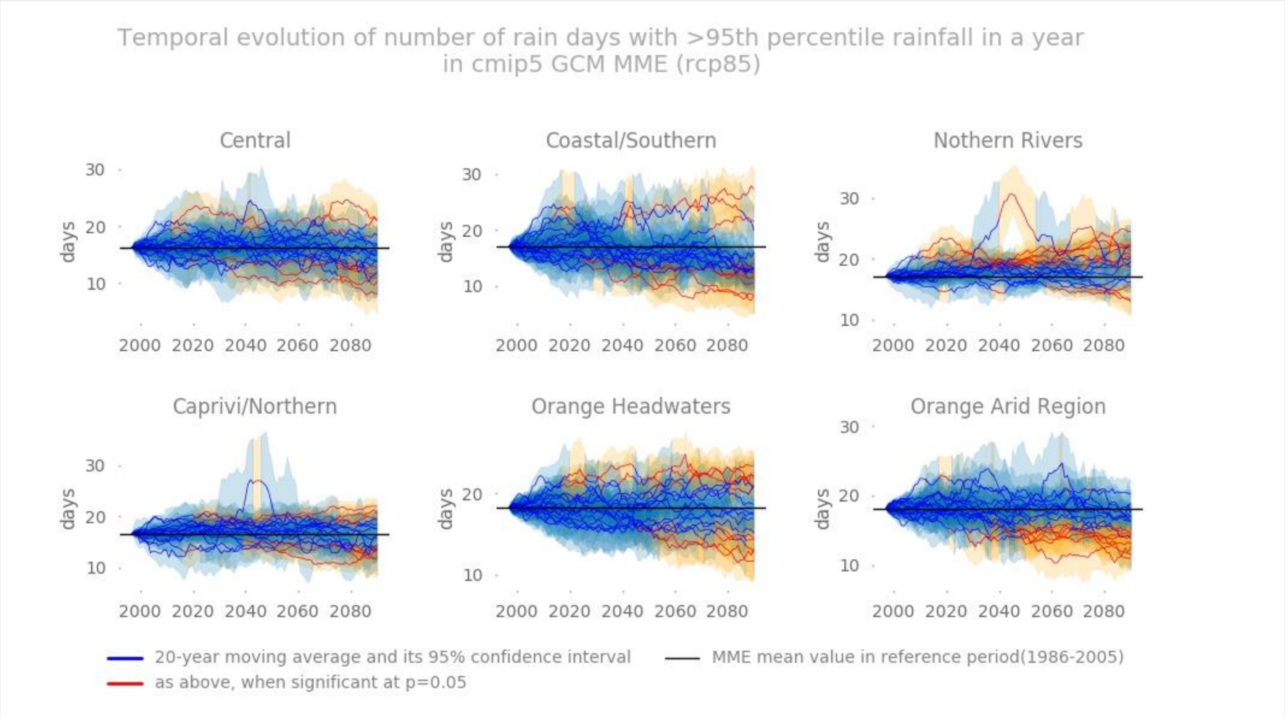

Figure A-7: Projected changes and emergence of changes in number of very heavy rainfall days (greater than 95th percentile) per year

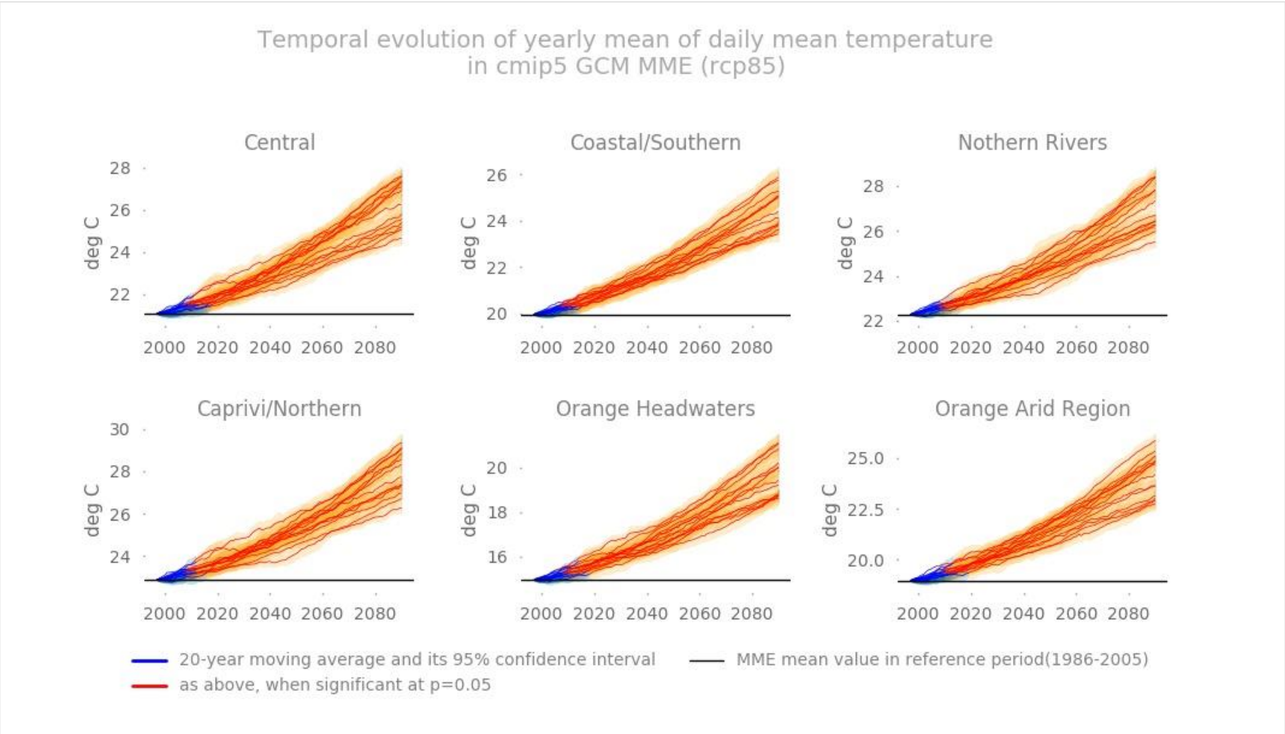

Figure A-8: Projected changes and emergence of changes in annual mean daily mean temperatures

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