NIGERIA

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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# CONTENTS


1. Background ... 4
1.1 Geographic and socio-economic context ... 4
2. Climate and weather ... 6
2.1 Observed historical climate variations and climate change trends ... 8
2.2 Projected (future) climate change trends, including temperature, precipitation and seasonality ... 9
2.3 Expected climate vulnerabilities ... 10
3. Climate change mitigation, greenhouse gas emissions and energy use ... 12
3.1 National energy production and consumption ... 12
3.2 National greenhouse gas emissions by source and sector ... 14
4. Summarised national priorities for climate change adaptation and mitigation ... 19
4.1 National priorities for climate change mitigation ... 20
4.2 National priorities for climate change adaptation ... 21
5. Assumptions, gaps in information and data, disclaimers ... 23
6. Appendix 1 ... 24
7. References ... 28


# LIST OF TABLES


Table 1-1: Socio-Economic Context of Nigeria ... 5
Table 2-1: Main rainfall regions of Nigeria ... 8
Table 2-2: Summary of trends in rainfall and temperature attributes in Nigeria ... 9
Table 2-3: Summary of projected climate changes across regions of Nigeria for key climate variables ... 10
Table 2-4: Broad scale sectoral vulnerabilities and potential climate change impacts in Nigeria ... 11
Table 3-1: National energy and electricity production in Nigeria ... 12
Table 3-2: Nigeria's national energy consumption by energy source ... 13
Table 3-3: Nigeria's national energy consumption by sector ... 13
Table 3-4: Nigeria's national total primary energy supply ... 14
Table 3-5: Nigeria's national greenhouse gas emissions from fuel combustion ... 15
Table 3-6: Nigeria's National Greenhouse Gas Emissions from Primary Energy Consumption ... 16
Table 3-7: National annual greenhouse gas emissions from agricultural practices in Nigeria ... 17
Table 3-8: Vegetation cover and land use change in Nigeria ... 18
Table 4-1: Summary of Nigeria's NDC commitments for reduction of GHG emissions ... 19
Table 4-2: Mitigation priorities in Nigeria's NDC ... 20
Table 4-3: Adaptation priorities in Nigeria's NDC ... 22

## LIST OF FIGURES

Figure 1-1: Map of Nigeria ........ 4
Figure 2-1: Main characteristics (magnitude and variability) of rainfall in Nigeria and its region ........ 6
Figure 2-2: Rainfall regions of Nigeria based on similarity of standardised rainfall climatology, and their rainfall and temperature climatologies ........ 7
Figure 3-1: Distribution of Nigeria's national energy production between major energy carriers ........ 12
Figure 3-2: Distribution of Nigeria's national energy consumption by major energy carriers ........ 13
Figure 3-3:: Distribution of Nigeria's national energy consumption by sector ........ 13
Figure 3-4: Distribution of Nigeria's GHG emissions by major sectors ........ 16
Figure A-1: Long term trends and variability in total annual rainfall for rainfall regions ........ 24
Figure A-2: Long term trends and variability in frequency of rainfall events for rainfall regions........ 24
Figure A-3: Long term trends and variability in extreme rainfall events for rainfall regions ........ 25
Figure A-4: Long term trends and variability in daily mean air temperatures for rainfall regions ........ 25
Figure A-5: Projected changes and emergence of changes in total annual rainfall ........ 26
Figure A-6: Projected changes and emergence of changes in number of rain days per year ........ 26
Figure A-7: Projected changes and emergence of changes in number of very heavy rainfall days (greater than 95th percentile) per year ........ 27
Figure A-8: Projected changes and emergence of changes in annual mean daily mean temperatures ........ 27

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# 1. BACKGROUND

## 1.1 Geographic and socio-economic context

The Federal Republic of Nigeria (henceforth 'Nigeria', shown below in Figure 1-1) is the most populated (~191,835,936 people) country in Africa. Over 47% of the population is urban and the country has an urbanisation rate of ~4.3% per year. Nigeria is the largest economy in Africa in terms of total GDP and GDP by PPP. However, despite the large size of Nigeria's economy in absolute terms, ~53% of the population (more than 90,000,000 people) live below the poverty line of USD 1.90 per day. Floods are prevalent in some areas of Nigeria and cumulatively affected ~9,500,000 people during the period 1996-2016 (one of the largest numbers of flood victims in Africa). Although EM-DAT provides no summary data on the number of people affected by drought in Nigeria, much of the country is prone to aridity and drought (particularly in the northern regions). The ND-GAIN index for Nigeria is 40.1, composed of relatively low vulnerability and readiness scores. This index summarizes the country's vulnerability to climate change and other global challenges in combination with its readiness to improve resilience and indicates that Nigeria has both a great need for investment and innovations to improve readiness and a great urgency for action. Key socio-economic and demographic indicators are further presented and summarised in Table 1-1 below.


*Figure 1-1: Map of Nigeria*

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

| VARIABLE | | SCORE/TOTAL | UNIT | RANK (OUT OF 54) |
|---|---|---|---|---|
| **Geography, Socio-Economy and Demographics** | | | | |
| Population[1] | | 191,835,936 | people | 1 |
| Population growth rate[1] | | 2.6 | % population. yr-1 | 23 |
| Population density[1] | | 211 | People/km2 | 6 |
| Land area[1] | | 910,902 | km2 | 13 |
| % Urban population[1] | | 47.8 | % population | 20 |
| % Urbanisation rate[2] | | 4.3 | % population. yr-1 | 12 |
| Economy: total GDP[2] | | 405.1 | USD billions. yr-1 | 1 |
| Economy: GDP by PPP[2] | | 1,091 | billion international dollars. yr-1 | 1 |
| Economy: GDP/capita[2] | | 2,178 | USD per capita/yr. | 16 |
| Population below the poverty line[3] | | 53.5 | % below USD 1.90 per day | 13 |
| GINI co-efficient[3] | | 43.0 | | 26 |
| HDI[4] | | 0.53 | | 22 |
| Access to electricity[5] | | 57.7 | % population | 18 |
| **Summary indicators of climate change vulnerability** | | | | |
| Workforce in agriculture[6] | | 30.6 | % workforce | 30 |
| Population undernourished[7] | | 7.0 | % population | 32 |
| Number of people affected by flood events[8] | | 9,517,429 | people | 1 |
| Population living within 100 km of coast[8] | | 36,373,544 | people | 2 |
| Population living in informal settlements [5] | | 50.2 | % urban population | 33 |
| Incidence of malaria[7] | | 381 | cases per 1000 population at risk | 3 |
| ND-Gain Vulnerability Index[9] | Total | 40.1 | | 23 |
| | Readiness | 0.28 | | 43 |
| | Vulnerability | 0.48 | | 41 |

## 2. CLIMATE AND WEATHER

Nigeria's climate ranges from humid tropical in the south to arid in the north. The Nigerial region experiences rainfall during the boreal summer (April-October) with the duration and magnitude of rains decreasing from the south towards the north. The rainy season and dry season are associated with lower temperatures, and hottest periods occur at the transition between the seasons, i.e. in March and November.

Nigeria and its rainfall region can be divided into 5 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.

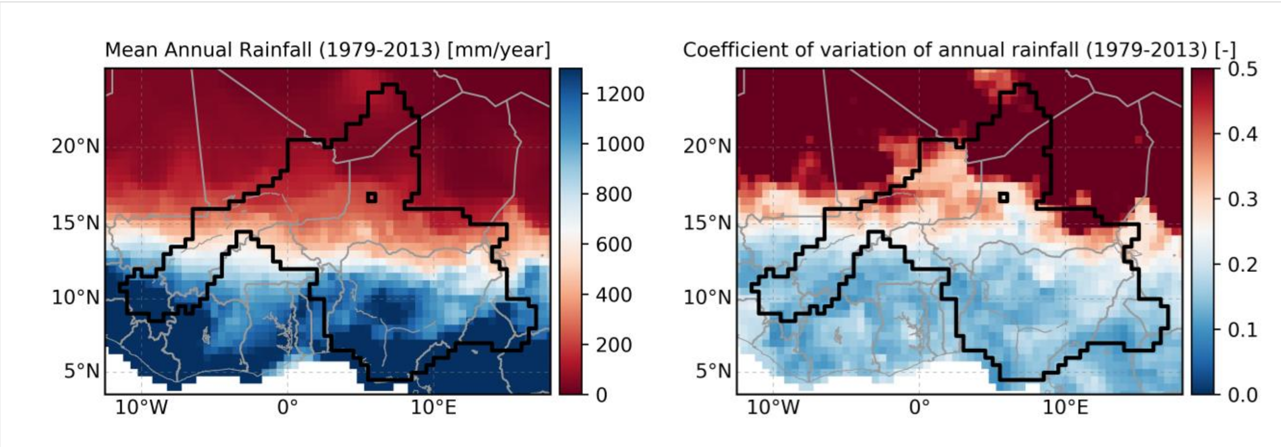
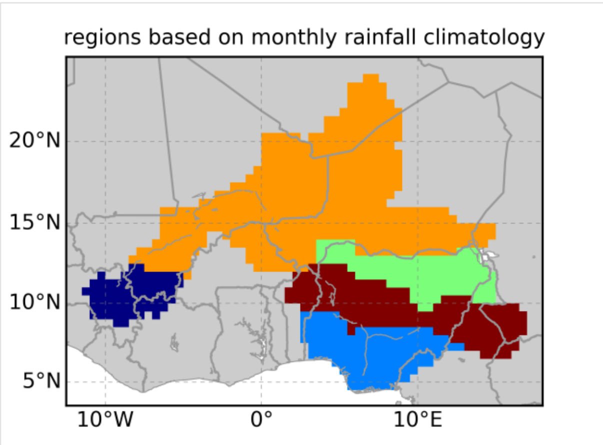



*Figure 2-1: Main characteristics (magnitude and variability) of rainfall in Nigeria and its region*




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

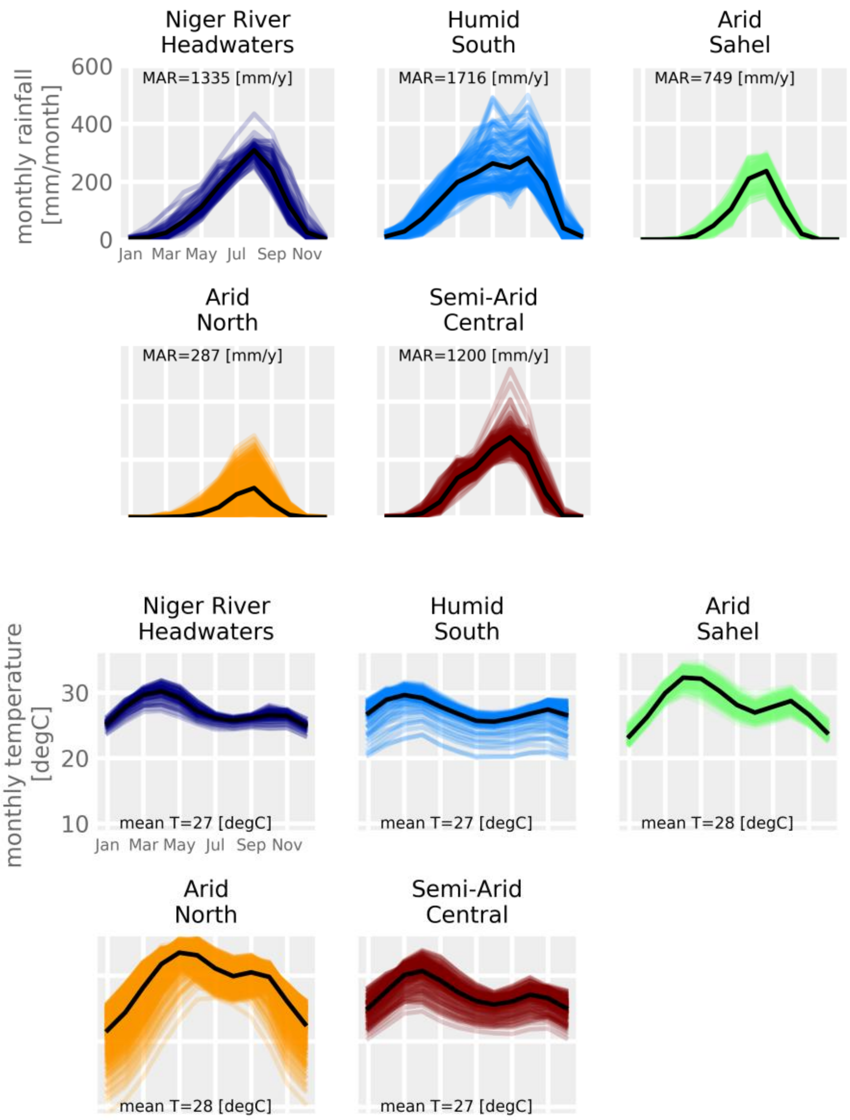



*Figure 2-2: Rainfall regions of Nigeria based on similarity of standardised rainfall climatology, and their rainfall and temperature climatologies*

*Table 2-1: Main rainfall regions of Nigeria*

| | |
|---|---|
| **HUMID SOUTH** | Boreal summer rainfall region with mean annual rainfall ranging from 800 mm in the north to over 2000 mm along the coast and daily average temperature of 27° C. Relatively low interannual rainfall variability. The rainfall season occurs during May-Sep typically exceeding 200mm/month. Temperatures show a small seasonal variation of around 4° C and are highest (over 30° C) just before the rainy season in March – May with a smaller secondary peak at the end of the rainy season in October. Temperatures are coolest (26° C) during winter (December – January). |
| **SEMI-ARID CENTRAL** | Boreal summer rainfall region with mean annual rainfall ranging from 800 mm in the north to >1200 mm in the south and daily average temperature of 27° C. Relatively low levels of interannual rainfall variability. The rainfall season occurs from May to September peaking at around 300 mm/month in August. Temperature shows a seasonal variation of around 5° C with highest values (over 31° C) just before the rainy season starts in April – May. A smaller secondary peak is evident at the end of the rainy in October and coolest temperatures occur in boreal winter. |
| **ARID SAHEL** | Boreal summer rainfall region spanning the north of the country, with mean annual rainfall ranges between 500 and 800 mm and daily temperature of 28° C. Moderate interannual Rainfall variability. A short rainy season occurs between May – September peaking above 200 mm/month in July – August and a dry season lasts from November to March. Temperature shows a seasonal variation of around 10° C with highest temperatures (>32° C) just before the rainy season (April – June) and lowest temperatures (23° C) during boreal winter. |
| **ARID NORTH** | The arid, boreal summer rainfall region covering the middle reaches of the Niger River and their catchment, with mean annual rainfall less than 400 mm, and strong interannual variability. The daily mean temperature averages 28° C but there is a strong seasonal variation of 13° C. |
| **NIGER RIVER HEADWATERS** | Boreal summer rainfall region. Mean annual rainfall ranges between 600 and 1300 mm with low interannual variability and daily mean temperature of 27° C but varies by around 5° C between summer and winter. |
| **SOUTHERN COASTAL** | A coastal rainfall region with a mean annual total rainfall of 990 mm/year with moderate rainfall variability from year to year and daily mean temperatures of 24° C. Rainfall occurs throughout the year but is highest during austral summer. Temperature shows a clear seasonal cycle of roughly 8° C between austral summer and winter. |

## 2.1 Observed historical climate variations and climate change trends

The higher rainfall areas of Nigeria and the Niger River Headwaters experience generally low rainfall variability on the inter-annual basis, while the drier parts experience moderate to high rainfall variability. On **decadal time scales** Nigeria also experiences **some 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 five regions show consistent upward and clear trends of **increasing temperatures** over the period 1979 - 2015 with the most rapid increases observed in Arid North and lowest over the Niger River Headwaters Region. Long term trends across the three drier regions show relatively **upward trends in total annual rainfall** which are statistically significant over the Arid Sahel and Arid North. No clear trend is found in annual total rainfall over the two wetter regions. No statistically significant trends are found in the frequency of rain events, but most show a small decreasing trend. In contrast all regions show an increasing trend in the frequency of extreme rainfall 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 Nigeria (1979 - 2015)*

| REGION | MEAN T [DEG C/DECADE] | TOTAL RAINFALL [MM/DECADE] | EXTREME RAINY DAYS [DAYS/DECADE] | RAINY DAYS [DAYS/DECADE] |
|---|---|---|---|---|
| **Humid South** | +0.15 | not evident | not evident | Not evident |
| **Semi-arid Central** | +0.15 | +15.5 | +1.6 | -2.0 |
| **Arid Sahel** | +0.18 | +42.5 | +4.2 | -2.9 |
| **Arid North** | +0.21 | +21.2 | +1.1 | -1.7 |
| **Niger River headwaters** | 0.10 | not evident | +2.5 | downward |

## 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 four of the five regions show a common message of no change or potential increased total annual rainfall emerging from as early as the 2030s The Niger River Headwaters region does not show a consistent message of rainfall change into the future. All regions project no change or an increase in the frequency of extreme rainfall of up to 50% by the end of the century, though the humid South shows a smaller projected change. There is less agreement on how the frequency of all rainfall events will change.

### 2.2.2 Projected changes in temperature from present to 2100

**Projected changes in temperature** are even more similar across all five regions with temperatures projected to be 1.5°C to 2.5°C warmer in most regions by the 2050s. By 2100 the range of projected temperatures is greater with 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 Nigeria 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] |
|---|---|---|---|---|
| **Humid South** | **Increasing** +1.5°C to +2.5°C by 2050s but changes evident currently | **Normal**, although some models indicate conditions wetter by 10% after 2020s. | **Normal to increase** by 30% evident after 2020s | **Normal to decrease** by up to 20% |
| **Semi-arid Central** | **Increasing** +1.5°C to +2.5°C by 2050s but changes evident currently | **Normal**. Some models indicate wetting by up to 15% towards 2100. | **Normal to increase** by up to 50% | No consistent signal |
| **Arid Sahel** | **Increasing** +1.5°C to +2.5°C by 2050s but changes evident currently | **Normal to increasing.** Some models indicate increase by 75% by 2100. | | **Normal to increase** by up to 50%. |
| **Arid North** | **Increasing** +1°C to +2.5°C by 2050s but changes evident currently | **Normal**. Although some models indicate wetting by up to 50% towards 2100. | | No consistent signal, but majority of models indicate normal to increasing. |
| **Niger River headwaters** | **Increasing** +1.5°C to +2.5°C by 2050s but changes evident currently | Lack of consistent signal, but large majority of models indicate conditions within range of past variability | | **Normal to decrease** in the order of 10% |

## 2.3 Expected climate vulnerabilities

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

In the most populated country in Africa, Nigeria, the rapidly growing and increasingly urban population is increasing pressure on water resources, with the possible increase in extreme rainfall events and increasing temperatures likely to further complicate access to safe drinking water. Nigeria's developing economy draws its strengths from its oil and gas reserves, yet revenues are unevenly distributed and over half the population lives below the poverty line. This means that the majority of the population have very limited capacity to adapt to increase in extreme temperatures and rainfall events, as well as to the slower knock-on effects that climate change may have on the economy. Of further concern is the fact that half of the urban population, constituting around a quarter of the Nigerian population, live in slums, with lack of proper access to critical services such as health care, water supply and proper housing, deeming them particularly vulnerable to extreme temperatures and rainfall events. Some of these urban areas, such as substantial parts of Lagos and other urban areas in the Niger Delta, stand to be impacted by sea-level rise and associated stresses.

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

| SECTOR | IMPACTS |
|---|---|
| **Agriculture** | - Crop loss and reduced yields owing to increased temperatures and changing rainfall patterns, especially in the north<br>- Desertification and loss of agricultural and grazing land, especially in the north<br>- Reduced crop yields owing to salinization of the coastal aquifer, especially in the Niger River Delta<br>- Increased potential for conflict between farmers and pastoralists, especially in the north |
| **Fisheries** | - Loss of habitat and breeding grounds, especially mangroves<br>- Changed fish migratory patterns<br>- Increased migration to the coast leading to increased pressure on marine and estuary fisheries<br>- Decrease in protein consumption to due lower fishing yields<br>- Reduced size of Lake Chad, reducing fisheries catches |
| **Water resources** | - **Increased variability in run-off, leading to decreased availability of water, especially in the drier north**<br>- Increased coastal erosion and salinization of coastal aquifers<br>- **Reduced water storage, negatively affecting hydropower production**<br>- Further shrinking of Lake Chad<br>- Increased flooding in the humid south |
| **Built infrastructure and human settlements** | - Damage to or destruction of coastal oil and tourist infrastructure owing to sea level rise and increased coastal erosion<br>- Damage to or destruction of infrastructure owing to extreme events, especially flooding, with impacts of drought more of a concern in the northern parts<br>- Increased potential for migration from rural to urban areas |
| **Human health** | - Increased prevalence of water-borne diseases, such as cholera and diarrhoea, especially during flooding events<br>- Increased prevalence of vector-borne disease such as malaria<br>- Increased prevalence of respiratory diseases due to increased Harmattan winds<br>- **Increased potential for malnutrition and stunting, especially during drought in the north** |

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

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

## 3.1 National energy production and consumption

Nigeria's energy sector is characterised by a split between a well-developed and economically important fossil fuel industry (Nigeria is member of the Organisation of Petroleum Exporting Countries), and a large impoverished rural population that is largely reliant on biomass for domestic energy needs. As a result of this split, the three largest contributors to national energy production are fossil fuels such as oil (45%) and gas (13%), and biofuels (42%) (IEA, 2014) (Table 3-1, below). Electricity is mostly generated by gas turbines (82%) and hydroelectricity (18%) (IEA, 2014; World Bank, 2013). The split between Nigeria's formal and informal energy sectors is further reflected in the distribution of total energy consumption between various sectors (Table 3-2, below). The sector that accounts for the majority of national energy consumption is the residential sector (95.1 MTOE per year), which primarily consumes biomass fuel for cooking, food-processing and heating water. Industry and transport are responsible for the next largest consumption of energy, each consuming 7.3 MTOE per year (IEA, 2014). The leading primary carriers of national energy consumption include biofuel (86%), followed by oil (9%) and gas (3%) (IEA, 2014). 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 Nigeria's energy sector, including total national energy production, primary energy supply and national energy consumption by fuel carrier and sector.

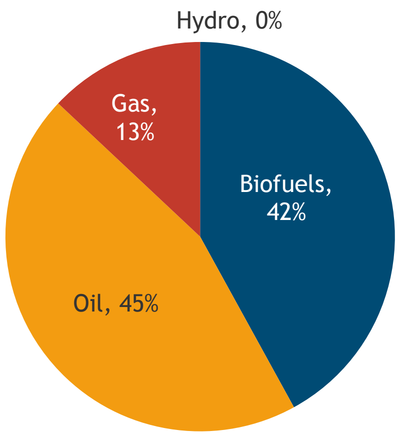



*Figure 3-1: Distribution of Nigeria's national energy production between major energy carriers (2014-2016)*

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

| NATIONAL ENERGY PRODUCTION | | |
|---|---|---|
| **Source** | **Total (MTOE) [3]** | **% of total energy production** |
| Coal[10] | 0.03 | 0.01 |
| Oil[10] | 116.29 | 44.7 |
| Gas[10] | 34.64 | 13.3 |
| Hydro[10] | 0.46 | 0.2 |
| Biofuels[10] | 108.61 | 41.8 |
| Total national energy production | 260.02 | |
| Electricity[5] | Hydro | 17.6 |
| | Gas | 82.4 |

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

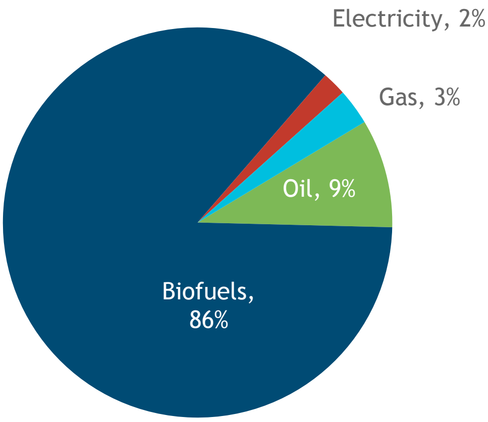



*Figure 3-2: Distribution of Nigeria's national energy consumption by major energy carriers*

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

| CONSUMPTION BY ENERGY SOURCE[10] | |
|---|---|
| **Source** | **Total (MTOE)** |
| Coal | 0.03 |
| Oil | 10.4 |
| Gas | 3.8 |
| Biofuels | 100.1 |
| Electricity | 2.1 |
| Total national energy consumption by source | 116.5 |

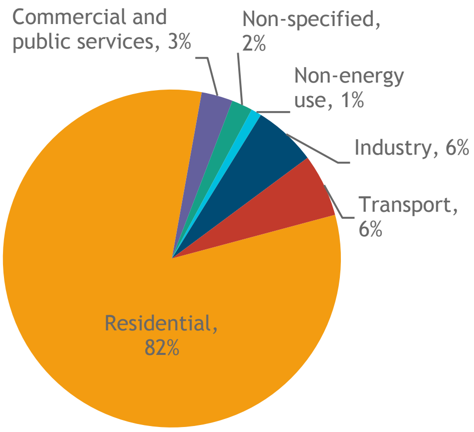



*Figure 3-3: Distribution of Nigeria's national energy consumption by sector (2014-2016)*

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

| CONSUMPTION BY ENERGY SOURCE[10] | |
|---|---|
| **Source** | **Total (MTOE)** |
| Industry | 7.3 |
| Transport | 7.3 |
| Residential | 95.1 |
| Commercial and public services | 3.2 |
| Agriculture / forestry | <0.01 |
| Non-specified | 2.1 |
| Non-energy use | 1.4 |
| Total national energy consumption by sector | 116.5 |

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

| TOTAL PRIMARY ENERGY SUPPLY[10] | | |
|---|---|---|
| **Source** | | **Total (MTOE)** |
| Coal | | 0.03 |
| Oil | Crude Oil | 3.6 |
| | Oil Products | 7.6 |
| Gas | | 14.5 |
| Hydro | | 0.5 |
| Biofuels | | 108.6 |
| Total primary energy supply | | 134.7 |

## 3.2 National greenhouse gas emissions by source and sector

Oil is the largest contributor to Nigeria's greenhouse gas (GHG) emissions from fuel combustion (~34 MT $CO_2e$), followed by gas (~26 MT $CO_2e$) (IEA, 2013). The sectors that account for the largest proportion of national GHG emissions from fuel combustion are transport, which is almost all by road (24 MT $CO_2e$), electricity and heat production (11.9 MT $CO_2e$) and other uses within the energy sector (10.9 MT $CO_2e$) (IEA, 2013). Despite the large contribution of fossil fuels to Nigeria's energy consumption and resultant GHG emissions, the largest sources of GHG emissions from all sources of primary energy consumption are Land Use Change and Forestry (LUCF) (187.4 MT $CO_2e$) - it is likely that the majority of LUCF emissions can be attributed to the use of biomass fuel. Other major sources of emissions include waste (67.6 MT $CO_2e$), agriculture (64.5 MT $CO_2e$), fugitive emissions (53.3 MT $CO_2e$) and other fuel combustion (56.3 MT $CO_2e$, 11%) (CAIT, 2013). Though not cited in this report, updated national estimates of GHG emissions from key economic sectors are also available from Nigeria's first Biennial Update Report to the UNFCCC (March 2018 [4]).

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 Nigeria's Land Use and Land Use Change sector, including detailed summaries of emissions from the agriculture sector and historical land use changes.

*4 http://unfccc.int/files/national_reports/non-annex_i_parties/biennial_update_reports/application/pdf/nigeria_bur1_final_(2).pdf*

### 3.2.1 GHG emissions from fuel combustion, by source and sector

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

| NATIONAL GHG EMISSIONS FROM FUEL COMBUSTION BY FUEL SOURCE AND SECTOR [11] | | |
|---|---|---|
| **Source / Sector** | | **Total emissions (MT $CO_2e$)** |
| Coal | | 0.1 |
| Oil | | 34.8 |
| Gas | | 26.1 |
| Total fuel source emissions | | 61.0 |
| Electricity and heat production | | 11.9 |
| Other energy industry own use* | | 10.9 |
| Manufacturing industries and construction | | 6.2 |
| Transport | Road | 23.9 |
| | Other | 0.1 |
| | Total | 24.0 |
| Other | Residential | 1.6 |
| | Non-residential | 6.4 |
| | Total | 8.0 |
| Total sector emissions | | 61.0 |

** 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

Though not cited in this report, updated national estimates of GHG emissions from key economic sectors are also available from Nigeria's first Biennial Update Report to the UNFCCC (March 2018[5]).

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

| NATIONAL GHG EMISSIONS FROM PRIMARY ENERGY CONSUMPTION BY SOURCE AND SECTOR [16] | | |
|---|---|---|
| **Source / Sector** | | **Total emissions (MT $CO_2e$)** |
| Energy | Electricity and heat | 22.8 |
| | Manufacturing and construction | 6.5 |
| | Transport | 24.0 |
| | Other fuel combustion | 56.3 |
| | Fugitive emissions | 53.3 |
| | Energy sub-total | 162.7 |
| Industrial processes | | 9.3 |
| Agriculture | | 64.5 |
| Waste | | 67.5 |
| Land use change and forestry (LUCF) | | 187.4 |
| Total emissions (including LUCF) | | 491.5 |

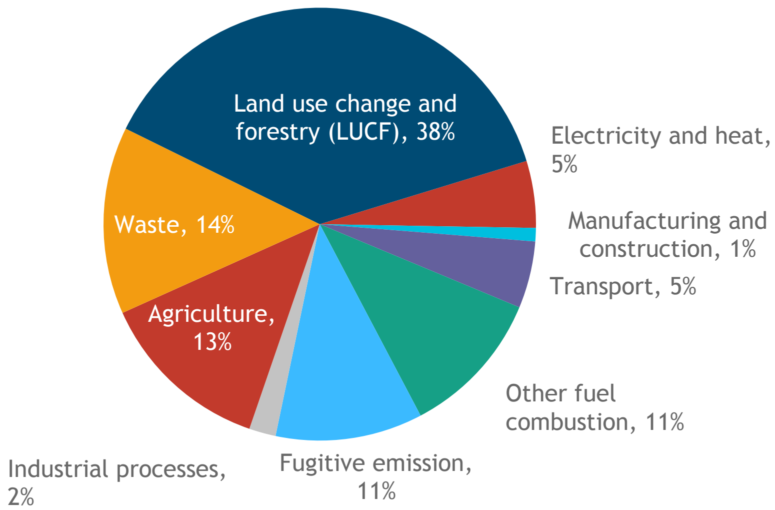



*Figure 3-4: Distribution of Nigeria's GHG emissions by major sectors*

5 *http://unfccc.int/files/national_reports/non-annex_i_parties/biennial_update_reports/application/pdf/nigeria_bur1_final_(2).pdf*

### 3.2.3 GHG emissions from agricultural practices

Table 3-7, below, summarises GHG emissions from Nigeria'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 Nigeria forest land use change is by far the largest contributor to agricultural GHG emissions, contributing over 70% of emissions from this sector. The livestock production sector also has a notable contribution due to enteric fermentation and manure left on pastures.

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

| VARIABLE | | ANNUAL EMISSIONS (MT $CO_2E$) |
|---|---|---|
| **Annual GHG emission from agricultural practices [13]** | Burning - Crop residues | 0.6 |
| | Burning - Savanna | 2.3 |
| | Crop Residues | 2.1 |
| | Enteric Fermentation | 25.8 |
| | Manure Management | 2.3 |
| | Manure applied to Soils | 1.2 |
| | Manure left on Pasture | 21.0 |
| | Rice Cultivation | 7.1 |
| | Synthetic Fertilizers | 1.8 |
| | SUBTOTAL (Ag. practices) | 64.2 |
| **Annual GHG emission from land use change [13]** | Forest land | 183.3 |
| | Burning Biomass | 5.0 |
| | SUBTOTAL (Land use change) | 188.4 |
| **Total** | | 252.6 |

Table 3-8, below, summarises the recent historical changes in land use in Nigeria 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 Nigeria's forest biomass as ~885 million tonnes.

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

| VARIABLE | | TOTAL (HECTARES) | TOTAL (% OF LAND AREA) | UNIT |
|---|---|---|---|---|
| **Total tree cover [14]** | 10-30% canopy cover | 31,411,637 | 34.0 | % of total land area |
| | 30-50% canopy cover | 5,029,704 | 5.4 | |
| | 50-100% canopy cover | 4,470,402 | 4.8 | |
| | Total | 40,911,743 | 44.3 | |
| **Land use change and agricultural expansion** | Historical annual rate of deforestation[15] | 10-30% canopy cover | 0.2 | % of previous year |
| | | 30-50% canopy cover | 0.3 | |
| | | 50-100% canopy cover | 0.3 | |
| | Area of agricultural land[16] | 77,291,836 | 83.7 | % of total land area |

# 4. SUMMARISED NATIONAL PRIORITIES FOR CLIMATE CHANGE ADAPTATION AND MITIGATION

Nigeria's main priority actions related to climate change are described in the country's submissions to the UNFCCC through the Intended Nationally Determined Contributions (NDC) document. This document includes detailed descriptions of Nigeria'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).

Nigeria's NDC indicates that "in the event an ambitious, comprehensive legally binding global agreement is reached at COP21 in Paris, Nigeria will make an unconditional contribution of 20 per cent below BAU that is consistent with the current development trends and government policy priorities. The policies and measures that will deliver these savings are cost-effective, even at the current high interest rate, which constrains investment. They include improving energy efficiency by 20 percent, 13 GW of renewable electricity provided to rural communities currently off-grid and ending gas flaring. Nigeria can make a significant additional contribution with international support, in the form of finance and investment, technology and capacity building. The combined policies and measures described can deliver in a cost-effective manner direct development benefits to the country and reduce emissions 45 per cent below BAU."

Nigeria's NDC notes that the implementation of the full contribution is "conditional on the availability of adequate financing for investment in the mitigation actions contained therein", also noting that "further work is needed to determine the exact domestic share of the full contribution, as well as the total investment required". Preliminary estimates of investment needs for the energy- and mitigation-related activities alone (based on 2013 estimates cited in the NDC) are for investments of at least ~USD 142 billion.

Table 4-1, below, gives details on Nigeria'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 Nigeria'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 |
|---|---|---|---|---|---|---|
| 474.86 | BAU | 20 percent (unconditional); 45 percent (conditional) | 2030 | $CO_2$, $CH_4$, $N_2O$; Energy, transport, agriculture, forestry | Not mentioned | Forestry included; accounting methodology not specified |

## 4.2 National priorities for climate change mitigation

Nigeria'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 Nigeria'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 the dominance of fossil fuels in Nigeria's energy mix, with multiple priority actions identified in the energy sector. The primary emphasis of NDC-level mitigation priorities in Nigeria's NDC is on increasing energy efficiency through measures such as the use of more efficient generators, a reduction in gas flaring, the implementation of better transport systems and better technology. This priority is seen across all sectors of energy, transport and industry. In addition to this, Nigeria has expressed interest in moving towards renewable energy and in the AFOLU sector, in implementing climate smart agriculture and reforestation while reducing household reliance on biomass fuels such as charcoal.

*Table 4-2: Mitigation priorities in Nigeria's NDC*

| PRIORITY SECTOR | SECTOR-SPECIFIC ACTION | TECHNOLOGY TYPE[6] |
|---|---|---|
| **Energy** | 2% per year energy efficiency (30% by 2030) | 1 |
| | Promote use of efficient gas generators and work towards ending gas flaring by 2030 | |
| | Build multi-cycle power stations | |
| | Use of natural gas rather than liquid fuels | |
| | Decentralized renewable energy | |
| | Enforced energy efficiency | |
| | Blending Fuel-Ethanol with Gasoline and Biodiesel with Petroleum diesel for transportation fuels | 2 |

[6] **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.*

| PRIORITY SECTOR | SECTOR-SPECIFIC ACTION | TECHNOLOGY TYPE[7] |
|---|---|---|
| **Transport** | Transport shift from car to bus | 2 |
| | Modal shift from air to high speed rail | |
| | Upgrading roads | |
| | Build urban transits | |
| | Increasing use of LPG/CNG (compressed natural gas) | |
| | Road pricing | |
| | Reform petrol or diesel subsidies | |
| | Blending Fuel-Ethanol with Gasoline and Biodiesel with Petroleum diesel for transportation fuels | |
| **AFOLU** | Climate smart agriculture and reforestation | 4 |
| | Stop using charcoal | |
| **Industry** | Benchmarking against international best practise for industrial energy usage | 5 |
| | Adoption of green technology in industry | 3 |

## 4.3 National priorities for climate change adaptation

Nigeria'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). In terms of climate change adaptation, Nigeria has detailed national priorities for energy and AFOLU. Nigeria has a strong focus on strengthening and increasing the resilience of the energy sector. Nigeria's energy priorities will be carried out by sector-specific actions such as increasing standards and specifications of construction, risk assessment and reduction, strengthening infrastructure, diversifying and backing up energy systems, and improving sustainable energy sources. In the AFOLU sector, Nigeria prioritises improvement of crop and livestock systems and resource management, as well as existing programmes and policies for forestry, and the initiation of a research programme on climate change. Forestry priorities also include better management of forestry reserves, and development and maintenance of a forestry inventory system. Priorities in Nigeria's other sectors include risk reduction and improvement in transportation and communications, restoration of communities and natural forests, and increasing awareness of climate change risks and opportunities.

[7] **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.*

*Table 4-3: Adaptation priorities in Nigeria's NDC*

| PRIORITY SECTOR | SECTOR-SPECIFIC ACTION | TECHNOLOGY TYPE[8] |
|---|---|---|
| **Energy** | Include increased protective margins in construction and placement of energy infrastructure (i.e. higher standards and specifications) | 3 |
| | Undertake risk assessment & risk reduction measures to increase resilience of the energy sector | 7, 8 |
| | Strengthen existing energy infrastructure, in part through early efforts to identify and implement all possible 'no regrets' actions | 3, 5 |
| | Develop and diversify secure energy backup systems to ensure civil society has access to emergency energy supply | 1 |
| | Expand sustainable energy sources and decentralize transmission in order to reduce vulnerability of energy infrastructure to climate impacts | 3, 7 |
| Transport | Include increased protective margins in construction and placement of transportation and communications infrastructure (i.e. higher standards and specifications) | 3, 5 |
| | Undertake risk assessment and risk reduction measures to increase the resilience of the transportation and communication sectors | 7 |
| **AFOLU** | Adopt improved agricultural systems for both crops and livestock | 1, 2 |
| | Implement strategies for improved resource management | 2, 4, 5 |
| | Focus on agricultural impacts in the savanna zones, particularly the Sahel, the areas that are likely to be most affected by the impacts of climate change | 1, 7 |
| | Strengthen the implementation of the national Community-Based Forest Resources Management Programme | 4, 5 |
| | Support review and implementation of the National Forest Policy | 4, 5 |
| | Develop and maintain a frequent forest inventory system to facilitate monitoring of forest status; initiate a research programme on climate change topics | 5, 6 |
| | Improve management of forest reserves and enforce low impact logging practice | 4, 8 |
| **Community based** | Increase knowledge and awareness of climate change risks and opportunities | 8 |
| | Undertake and implement risk assessments and risk reduction measures | 8 |
| | Provide extension services to CSOs, communities and the private sector to help establish and restore community and private natural forests, plantations and nurseries | 1, 4, 8 |

[8] **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

Though not cited in this report, updated national estimates of GHG emissions from key economic sectors are also available from Nigeria's first Biennial Update Report to the UNFCCC (March 2018 9).

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.

9 *http://unfccc.int/files/national_reports/non-annex_i_parties/biennial_update_reports/application/pdf/nigeria_bur1_final_(2).pdf*

# 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 Nigeria. 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 five climate regions across Nigeria. 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 Humid South region has very high inter-annual (1450mm in some years to 2000mm in other years) and moderate decadal variability (1600mm in some decades to 1800mm in other decades). Long term trends are not statistically significant and is only around -3mm over the 30-year period.

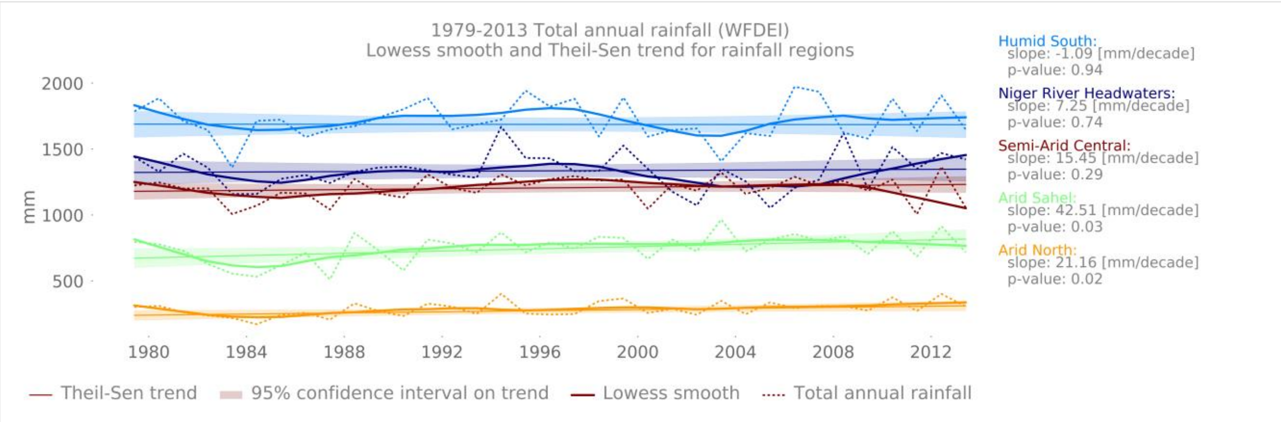



*Figure A-1: Long term trends and variability in total annual rainfall for rainfall regions*

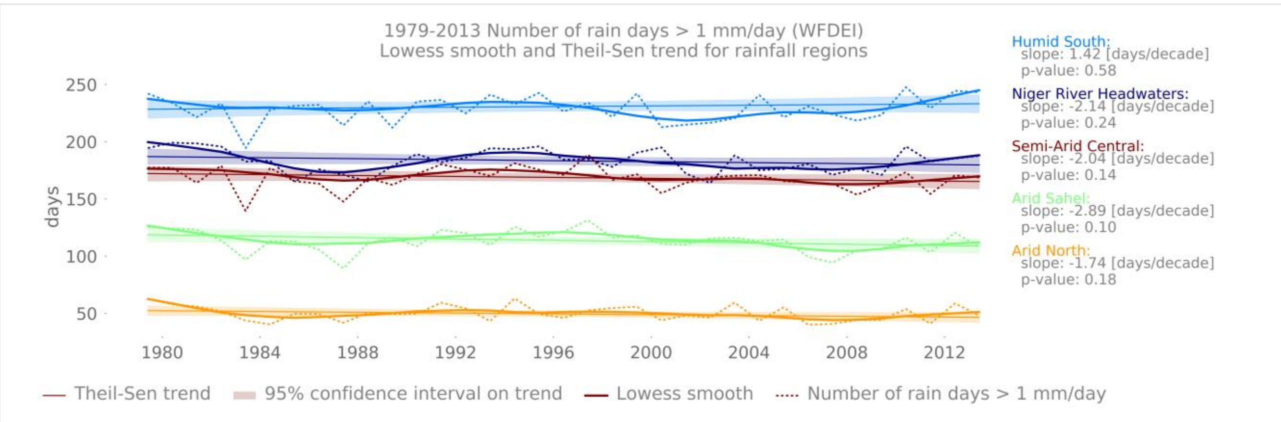



*Figure A-2: Long term trends and variability in frequency of rainfall events for rainfall regions*

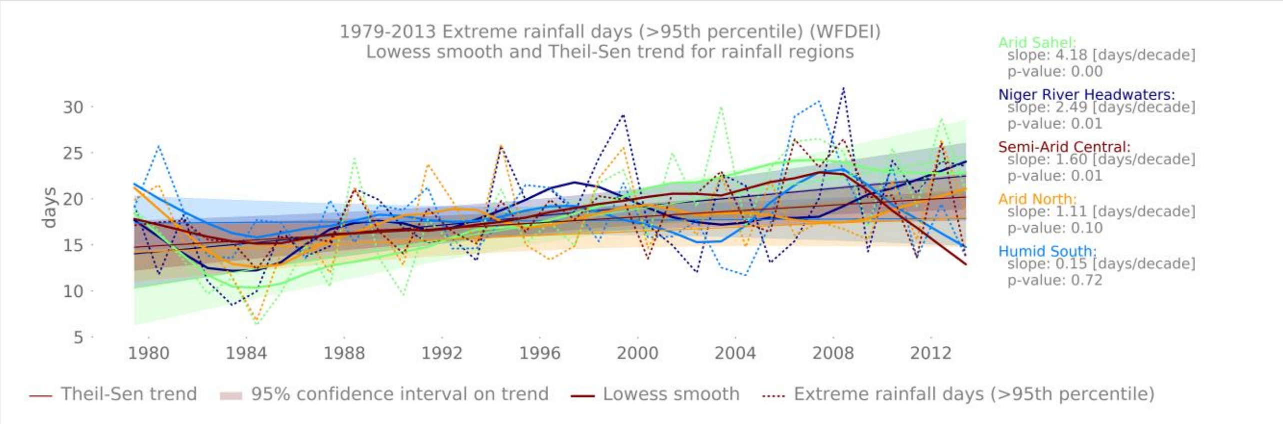



*Figure A-3: Long term trends and variability in extreme rainfall events for rainfall regions*

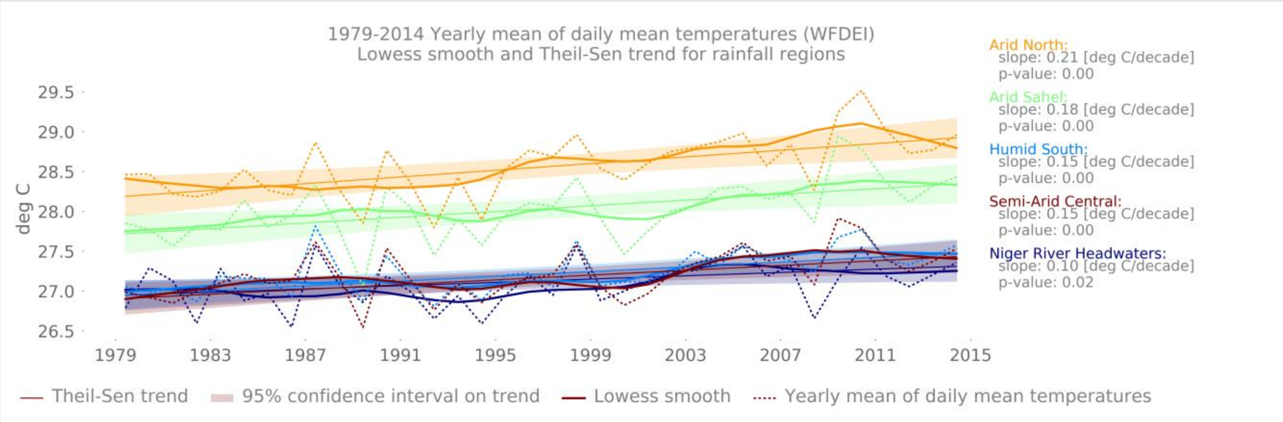



*Figure A-4: Long term trends and variability in daily mean air temperatures for rainfall regions*

## 1.c Climate projections visualizations

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

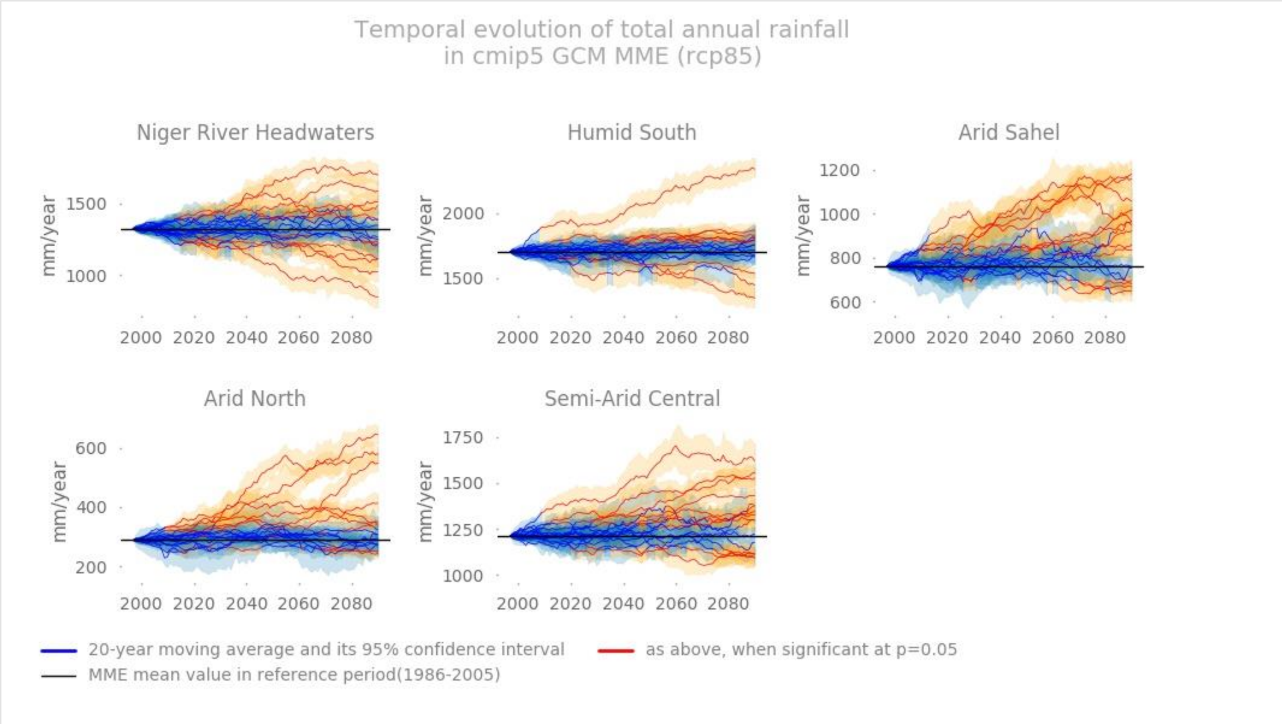



*Figure A-5: Projected changes and emergence of changes in total annual rainfall*

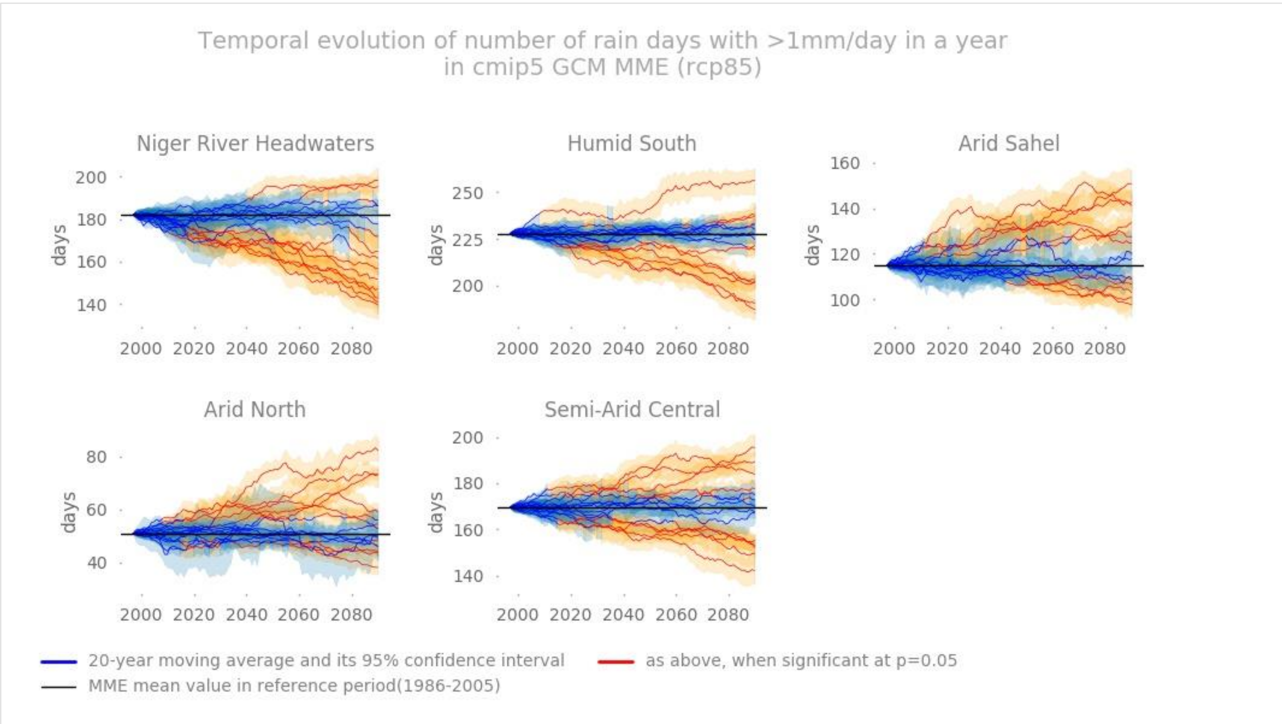



*Figure A-6: Projected changes and emergence of changes in number of rain days per year*

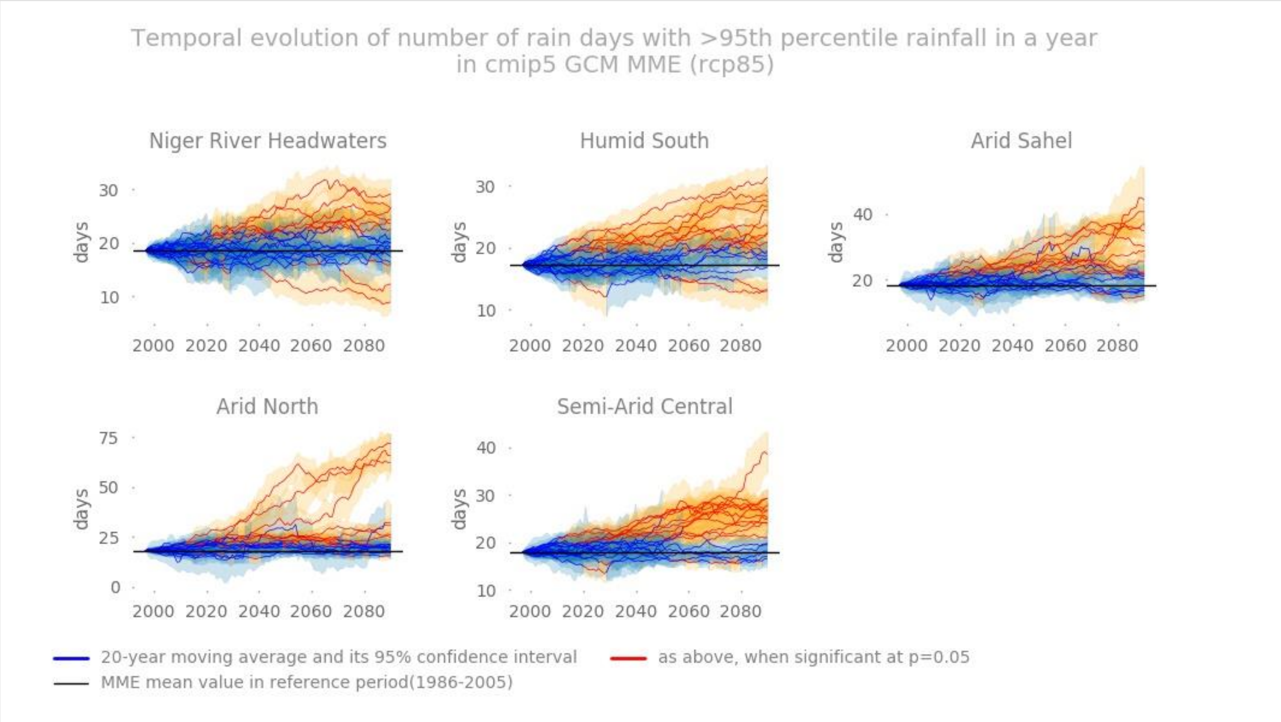



*Figure A-7: Projected changes and emergence of changes in number of very heavy rainfall days (greater than 95$^{th}$ percentile) per year*

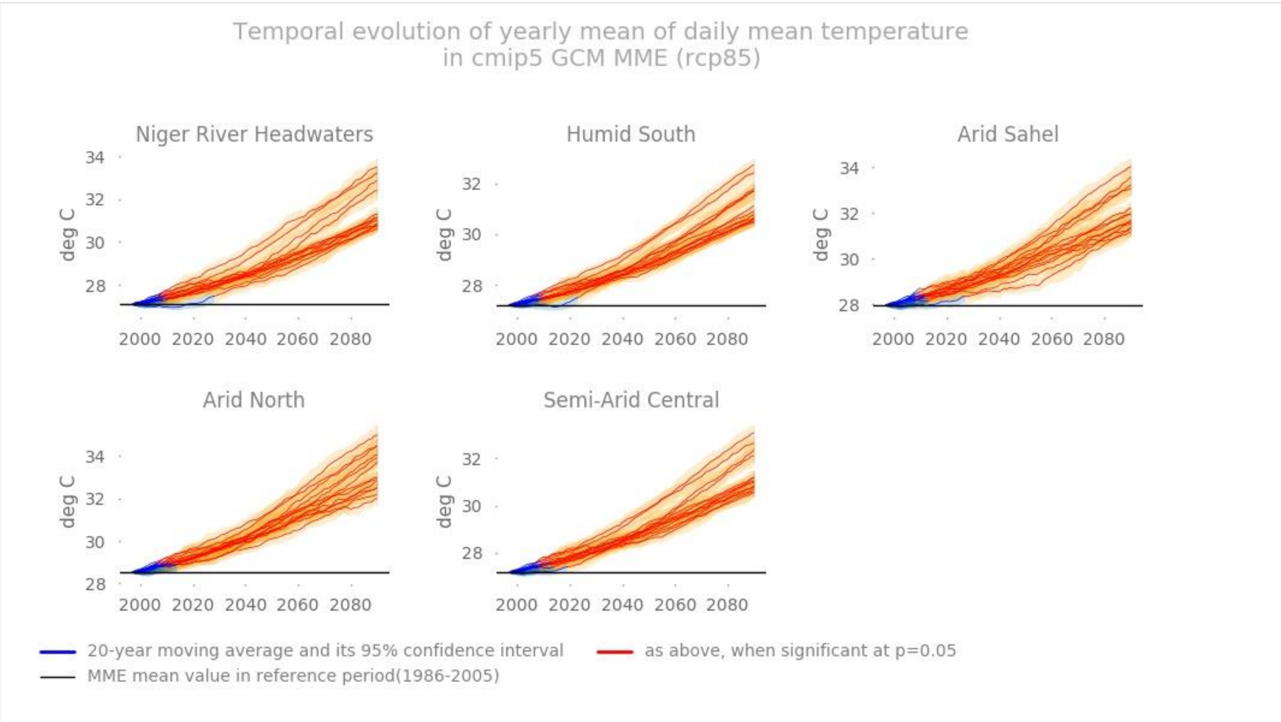



*Figure A-8: Projected changes and emergence of changes in annual mean daily mean temperatures*

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