KENYA

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.

October 2018

CONTENTS

LIST OF TABLES

KENYA

LIST OF FIGURES

ACKNOWLEDGEMENT

This national climate change profile, one in a series of 25 national-level assessments, is the product of the African Development Bank-led project "Enhancing the capacity of African countries to use climate information to inform decision-making and implement NDCs", sponsored by the Africa Climate Change Fund (bit.ly/AfDB-ACCF). The profiles were developed by a diverse group of experts from the University of Cape Town including the African Climate & Development Initiative (www.acdi.uct.ac.za), the Climate System Analysis Group (www.csag.uct.ac.za) and the Energy Research Centre (www.erc.uct.ac.za)) and the Cirrus Group. In addition, these profiles have benefited from the suggestions and inputs of multiple reviewers over the course of project development, and we would like to recognize and appreciate their efforts.

1. BACKGROUND

1.1. Geographic and socio-economic context

The Republic of Kenya (henceforth 'Kenya', shown below in Figure 1-1) is a country in East Africa that borders on the Indian Ocean. Kenya is one of the largest economies in Africa, ranking in the top ten for total GDP (~USD 70.5 billion). Kenya is also among the ten most populous countries on the continent with a population of ~48,000,000 people and over 60% of the country's workforce is in agriculture (est. 2017, [1]). The country has a small urban population (~26%), of which ~56% live in slums. The geography of Kenya is quite variable and as a result the country includes a diverse range of climates. The country is prone to climate-related hazards, including both floods and drought. Kenya has the second largest cumulative number of people affected by drought in Africa and the sixth largest number of people affected by floods, where these climate-related events affected ~45,000,000 and ~3,000,000, respectively, during the period 1996-present. Kenya has the 12th highest GINI coefficient in Africa (48.5), a gender inequality index of 55.2 and a human development index of 0.56, indicating a wide disparity in wellbeing, income and access to opportunity between different social and gender groups. Kenya's ND-GAIN index is 38.9. This index summarizes the country's vulnerability to climate change and other global challenges in combination with its readiness to improve resilience and shows that Kenya 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 summarised Table 1-1, below.

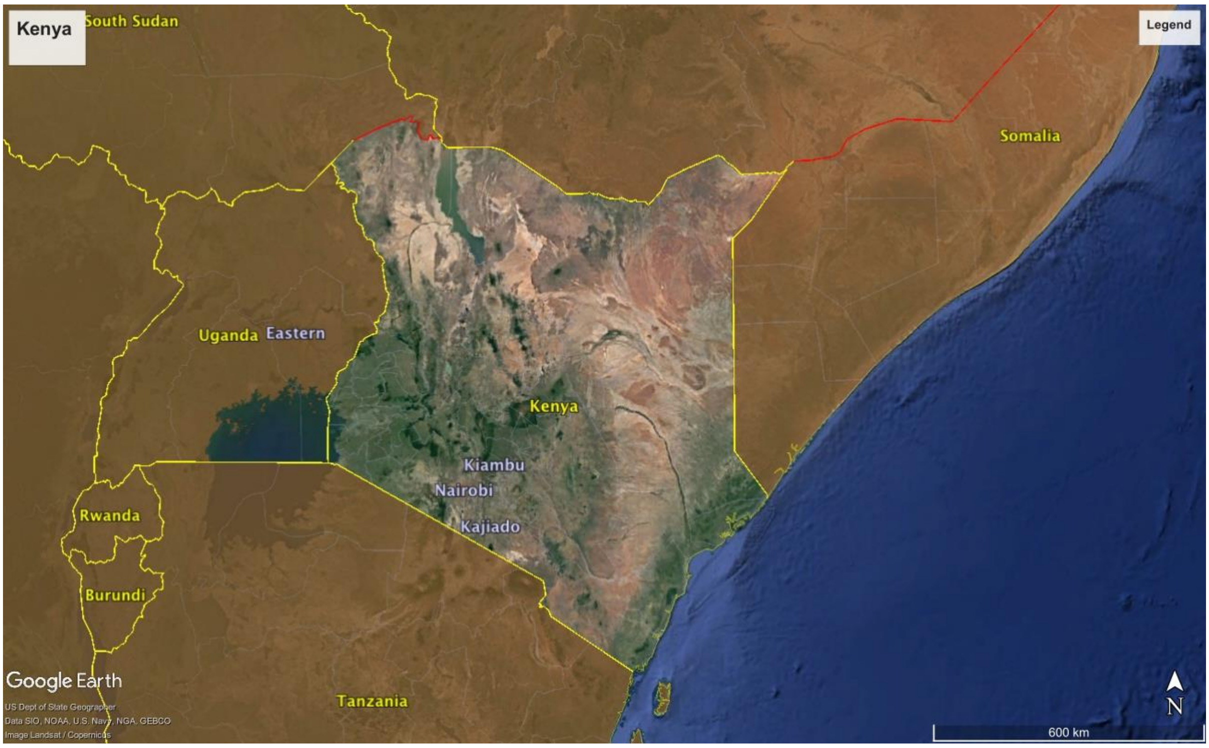


Figure 1-1: Map of Kenya

KENYA

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

VARIABLE		SCORE/TOTAL	UNIT	RANK (OUT OF 54)
Geography, Socio-Economy and Demographics				
Population[1]		48,466,928	people	7
Population growth rate[1]		2.6	% population .yr-1	24
Population density[1]		85	People/km2	18
Land area[1]		568,861	km2	23
% Urban population[1]		25.8	% population	47
% Urbanisation rate[2]		4.2	% population .yr-1	15
Economy: total GDP[2]		70.5	USD billions .yr-1	9
Economy: GDP by PPP[2]		153	USD billions .yr-1	9
Economy: GDP/capita[2]		1,455	billion international dollars per capita .yr-1	21
Population below the poverty line[3]		33.6	% below USD 1.90 per day	28
Gender Inequality Index[4]		55.2		24
GINI co-efficient[3]		48.5		12
HDI[5]		0.56		18
Access to electricity[6]		36.0	% population	29
Summary indicators of climate change vulnerability				
Workforce in agriculture[7]		61.1	% workforce	16
Population undernourished[8]		21.2	% population	17
Number of people affected by drought[9]		45,104,600	people	2
Number of people affected by flood events[9]		3,173,922	people	6
Population living within 100 km of coast[10]		3,134,170	people	20
Population living in informal settlements[6]		56.0	% urban population	24
Incidence of malaria[8]		166	cases per 1000 population at risk	24
ND-Gain Vulnerability Index[11]	Total	38.9		28
	Readiness	0.31		37
	Vulnerability	0.53		32

2. CLIMATE AND WEATHER

Kenya's climate ranges from arid tropical on the coast to semi-arid to arid in the east and north of the country, to temperate in the highlands and rift valley. Most of the country experiences two rainfall seasons with long rains in April-May and short rains in October-November. Areas to the west experience rains essentially throughout the year, while the Omo River headwaters are characterized by a single rainy season centred on June. The equatorial position of Kenya causes relatively little seasonal variation in air temperatures, with a warmer period in Oct-May, and a cooler period in Jun-Sep. There are also several mountains and mountain chains in Kenya that are characterized by microclimates which differ from the regional climate, the differences caused by topography.

Kenya can be divided into 5 climatic regions based on annual total rainfall as well as variations in the seasonal cycle of rainfall[1]. These zones are illustrated in Figures 2-1 and 2-2, below, and summary descriptions can be found in Table 2-1 below.

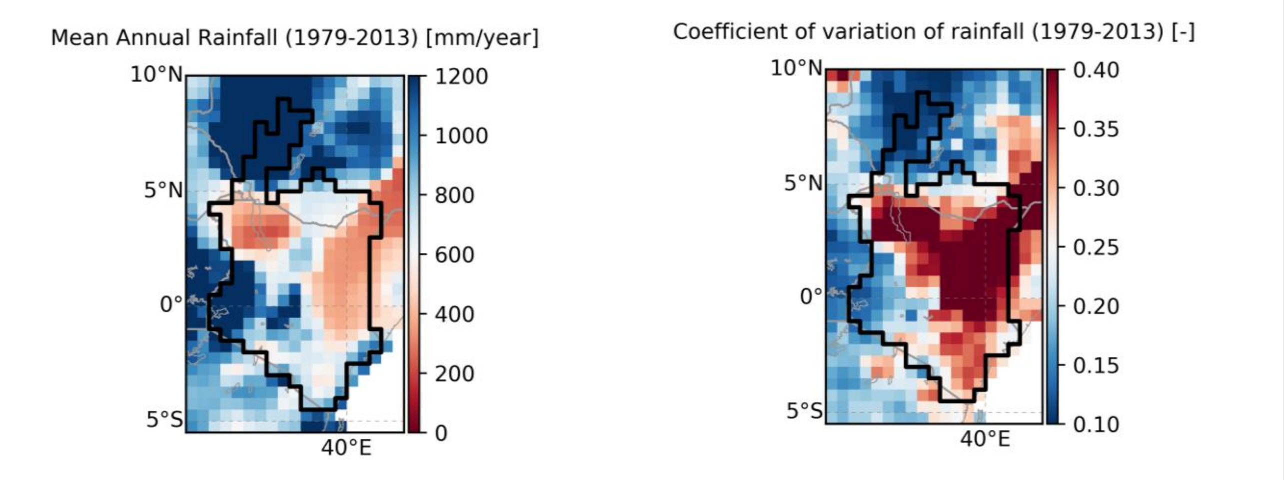
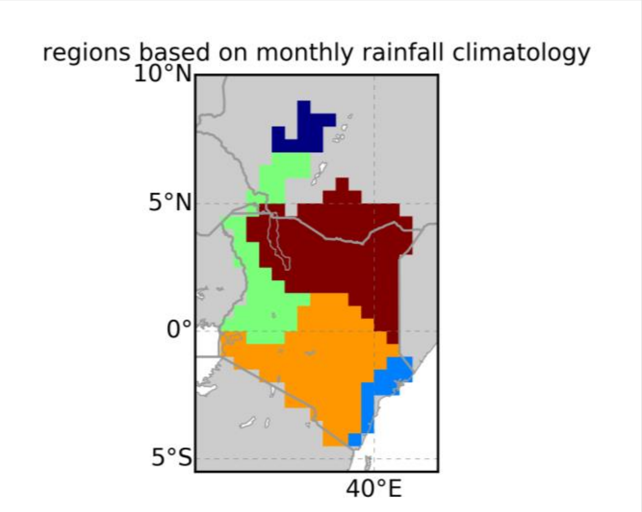


Figure 2-1: Main characteristics (magnitude and variability) of rainfall in Kenya and its region



[1] *The Kenya Meteorological Department provide regional forecasts for six geographic regions (www.meteo.go.ke)*

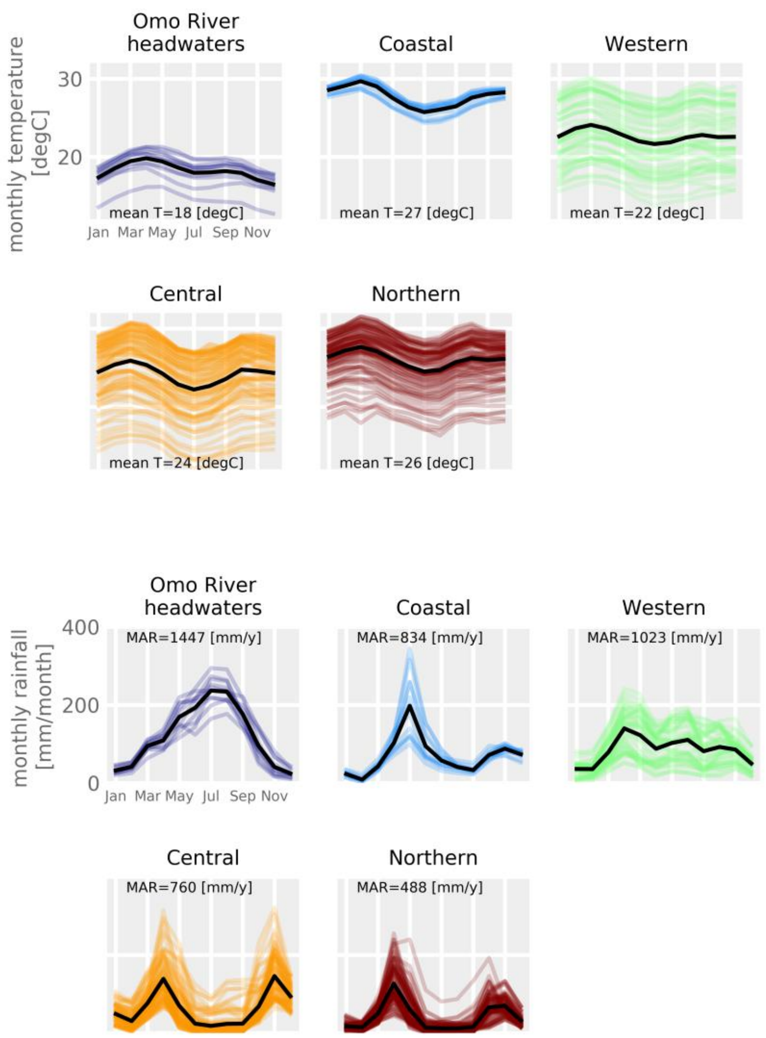


Figure 2-2: Rainfall regions of Kenya based on similarity of standardised rainfall climatology, and their rainfall and temperature climatologies

Table 2-1: Main rainfall regions of Kenya

COASTAL	Region with mean annual total rainfall of 830 mm/year and daily mean temperature of 27° C. Rainfall occurs primarily in two seasons, the long rains from April – June where values peak at 200 mm/year during May, and the short rains in October – December where values reach 80 mm/month. The interannual variability of rainfall is moderate to high especially over the southern coast and spatial differences are far larger during the long rains vs. the short rains. Daily mean temperature is high throughout the year with very little seasonal or spatial variations.
CENTRAL	Region with mean annual total rainfall of 860 mm/year and daily mean temperature of 24° C. Very clear spatial differences are evident in rainfall across the region with the far west receiving the highest values, and lowest interannual variability, and the north-east the lowest rainfall and highest interannual variability. Rainfall occurs primarily in two relatively even seasons. The first from March – May and the second October – December where values peak at around 150 mm/month in both seasons. Strong spatial differences are evident in the daily mean temperature and are generally larger than the seasonal differences

NORTHERN	Region with mean annual total rainfall of 490 mm/year and daily mean temperature of 26° C. Very clear spatial differences are evident in the magnitude of rainfall with the lower elevation areas to the east and west having lower values. Interannual variability of rainfall is high over this region. Rainfall occurs primarily in two rainy seasons, the first during March – May peaking at around 150 mm/month April and a second in October – November (80 mm/month). Strong spatial differences are evident in the daily mean temperature and are larger than the seasonal variation at any location. These differences are largely due to differences in elevation.
WESTERN	Region with mean annual total rainfall of 1020 mm/year and daily mean temperature of 22° C. Very clear spatial differences are evident in the magnitude of rainfall with the higher elevation areas to the north and south having higher values. Interannual variability of rainfall is low over the high rainfall areas and high over the low rainfall areas. Rainfall occurs during a long wet season from March to November. Strong spatial differences are evident in the daily mean temperature and are larger than the seasonal variation at any location. These differences are largely due to differences in elevation.
OMO RIVER HEADWATERS	Region with mean annual total rainfall of 1450 mm/year and daily mean temperature of 18° C. Rainfall amounts are generally high and interannual variability low over this region. Rainfall occurs in a single long rainy season (March- October) peaking at around 230 mm/month in July – August. Strong spatial differences are evident in the daily mean temperature and are larger than the seasonal variation at any location. These differences are largely due to differences in elevation.

2.1 Observed historical climate variations and climate change trends

As with many semi-arid climate regions, the majority of Kenya experiences **moderately high rainfall variability** on an inter-annual basis. On **decadal time scales** Kenya also experiences **significant variability** with some periods being relatively drier or wetter than others. This variability can be seen in the supporting evidence plots provided in the supplementary Appendix **(Figures A-1 to A-4).**

Long term trends across the five regions show consistent upward and clear trends of **increasing temperatures** over the period 1979 - 2015 with the most rapid increase observed in the Western Region and least in the Coastal Region. The majority of regions show no trend in total annual rainfall, with the exception of the Coastal Region which shows a downward trend and the Western Region which shows a strong and statistically significant upward trend. Most regions also do not show any trend in the frequency of rain events, with the exception of the Northern and Western regions. The Western Region is the only region to also show any trend in the frequency of extreme rain events (slightly upward). 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 Kenya (1979 - 2015)

REGION	MEAN T [DEG C/DECADE]	TOTAL RAINFALL [MM/DECADE]	EXTREME RAINY DAYS [DAYS/DECADE]	RAINY DAYS [DAYS/DECADE]
Coastal	+0.19	downward	not evident	not evident
Northern	+0.20	not evident	not evident	+6.1
Central	+0.27	not evident	not evident	slight upward
Western	+0.34	+58.3	slight upward	+12.8
Omo River Headwaters	+0.24	not evident	not evident	not evident

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

Projections of future climate, based on CMIP5 GCM simulations[2] under the RCP8.5 pathway[3] 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 all but the Coastal Region show a common message of **potential increased rainfall** emerging from as early as the 2020s, while the Coastal Region shows no consistent signal. All regions show no change or a potential increase in the frequency of all rainfall events and 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. Other studies have suggested that increased convective rainfall intensity (e.g. thunderstorm-related rainfall) should generally be expected in a warmer climate.

2.2.2 Projected changes in temperature from present to 2100

Projected changes in temperature are even more similar across all 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 showing projected increases of 3°C to 6°C by 2100.

2 The fifth iteration of the Couple Model Inter-comparison Project (CMIP) is a coordinate activity amongst international modeling centres 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)

3 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 Kenya 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]
Coastal	**Increasing** +1.5°C to +2.5°C by 2050s but changes evident in next decade	lack of consistent signal	**Normal to increasing** number of high intensity events, with increases up to 3-fold or even 4-fold by 2100. Increases becoming evident in 2040s.	**Normal to increasing** number of rain events, with increases up to 50% by 2100. Increases becoming evident in 2030s.
Northern	**Increasing** +1.5°C to +2.5°C by 2050s but changes evident in next decade	**Normal to increasing** rainfall, with increases up to 100% by 2100. Increases becoming evident as early as 2020s.		
Central	**Increasing** +1.5°C to +2.5°C by 2050s but changes evident in next decade	**Normal to increasing** rainfall, with increases up to 75% by 2100. Increases becoming evident as early as 2030s.		
Western	**Increasing** +1.5°C to +2.5°C by 2050s but changes evident in next decade	**Normal to increasing** rainfall, with increases up to 50% by 2100. Increases becoming evident as early as 2020s.		
Omo river	**Increasing** +1.5°C to +2.5°C by 2050s but changes evident in next decade	**Normal to increasing** rainfall, with increases up to 75% by 2100. Increases becoming evident as early as 2020s.		

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.

Officially categorised a water scarce country in 1992, increasing temperature trends is likely to increase the pressure on water resources in Kenya despite indications that rainfall trends may be normal to increasing into the future. With a large number of people already affected by droughts and floods, the possible increase in extreme rainfall events into the future is a concern. Increasing temperature and more extreme rainfall is of further concern, given that the large majority of the agricultural production takes place on small-scale rain-fed farms and given that ~half the population is dependent on income and subsistence from agricultural activities. While Kenya has a relatively small urban population, over half of the urban population lives in slums, with lack of proper access to critical services such as health care, water supply and proper housing, deeming them vulnerable to extreme temperatures and rainfall events, as well as the slower knock-on effects that climate change may have on the economy and agricultural production. Coastal areas, including the coastal tourism industry, are likely vulnerable to sea-level rise and associated stresses, while hydropower may stand to benefit from a possible increase in annual rainfall if managed appropriately.

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

SECTOR	IMPACTS
Agriculture	- Reduced yields due to water logging/damage owing to extreme rainfall - Difficulty harvesting owing to high temperatures and/or extreme rainfall - Higher irrigation demand owing to increasing temperatures - Reduced or increased yields - Change in growing regions of certain crops, which could both positively and negatively impact crop production - Incidences of Pests and diseases for crops and livestock
Fisheries	- Unknown/complex impacts owing to changing ocean temperatures, salinity and currents - Changes in breeding patterns and productivity - Changing disease incidences - Decreased water quality in inland fisheries
Water resources	- Infrastructure damage, flooding and contamination owing to extreme rainfall - Increased demand for water owing to increasing temperatures and greater evaporation - Higher losses from dams due to greater evaporation owing to increasing temperatures - Reduced quality or increased salinity of freshwater resources
Built infrastructure and human settlements	- Increased flooding & infrastructure damage owing to extreme rainfall - Increase energy demand for cooling owing to increasing temperatures - Increased coastal erosion and storm damage in coastal areas owing to increased storm surges
Human health	- Increased exposure to infections in flooded or damaged areas owing to extreme rainfall - Increased heat stress and health impacts owing to increasing temperatures - Increased transmission of some diseases (eg. Malaria) owing to higher temperatures and extreme rainfall - Reduced water quality owing to higher fresh water temperatures and extreme rainfall

KENYA

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

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

3.1 National energy production and consumption

National energy production in Kenya is split between the use of biofuels ~ (81%) and renewable energy (~19%), ~1% of which is hydroelectric (Table 3-1 below). Biofuels account for the majority (~71%) of Kenya's national energy consumption. Fossil fuels oil (~22%) and coal (~2%) as well as electricity (~5%) make up the remainder of national energy consumption. The residential sector is the primary consumer of energy (~75%), which is mostly in the form of biomass for domestic energy use. The sectors of transport (~15%) and industry (~8%) are the next energy consumers. According to Kenya's NDC, 65% of electricity was generated locally using renewable energy sources (hydropower 35.9%, geothermal 25.9%, cogeneration from bagasse 1.7%, wind 1.1% and solar 0.08%) while approximately 35% was generated using fossil fuels in the form of diesel plants. 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 Kenya's energy sector, including total national energy production, primary energy supply and national energy consumption by fuel carrier and sector.

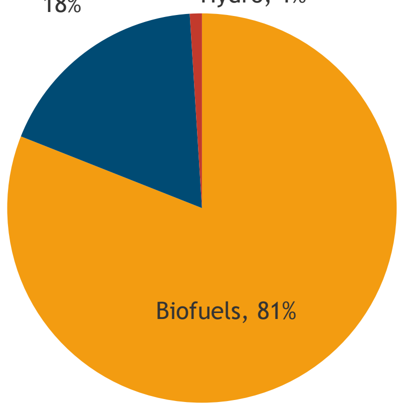


Figure 3-1: Distribution of Kenya's national energy production between major energy carriers (2014-2016)

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

NATIONAL ENERGY PRODUCTION		
Source	**Total (MTOE)[4]**	**% of total energy production**
Hydro[12]	0.04	1.5
Biofuels[12]	2.7	98.4
Non-Hydro RE[12]	2.7	100.0
Total national energy production	19.6	
Electricity[6]	Hydro	35.8
	Non-Hydro renewable	45.7
	Oil	18.5

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

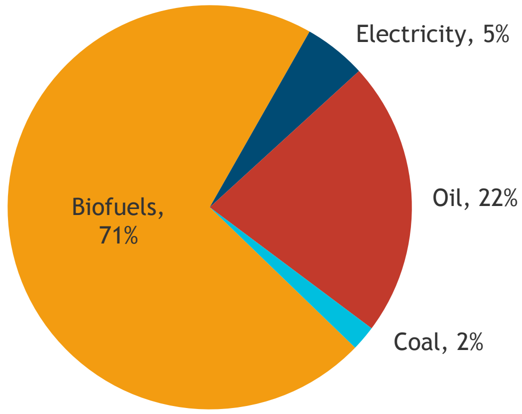


Figure 3-2: Distribution of Kenya's national energy consumption by major energy carriers

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

CONSUMPTION BY ENERGY SOURCE[12]	
Source	**Total (MTOE)**
Coal	0.3
Oil	3.2
Biofuels	10.5
Electricity	0.7
Total national energy consumption by source	14.7

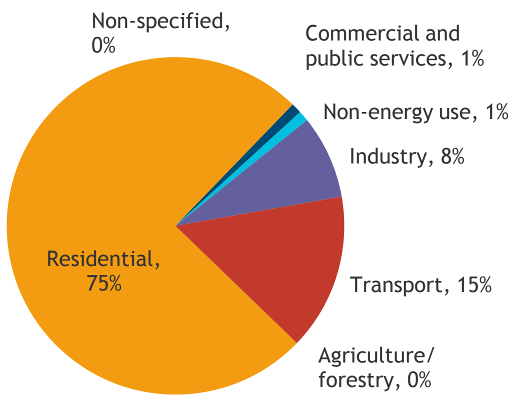


Figure 3-3: Distribution of Kenya's national energy consumption by sector (2014-2016)

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

CONSUMPTION BY SECTOR[12]	
Source	**Total (MTOE)**
Industry	1.2
Transport	2.2
Residential	11.0
Commercial and public services	0.1
Agriculture / forestry	0.0
Non-specified	0.0
Non-energy use	0.1
Total national energy consumption by sector	14.7

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

TOTAL PRIMARY ENERGY SUPPLY[12]		
Source		**Total (MTOE)**
Coal		0.3
Oil	Crude Oil	0.7
	Oil products	3.1
Hydro		0.3
Biofuels		15.8
New RE		3.5
Electricity		0.0
Total primary energy supply		23.6

3.2 National greenhouse gas emissions by source and sector

Oil is the largest contributor to Kenya's greenhouse gas (GHG) emissions from fuel combustion (~11 MT CO_2e), followed by coal (~1 MT CO_2e)[5]. The sectors that account for the largest proportion of national GHG emissions from fuel combustion are road transport (5.7 MT CO_2e), electricity and heat production (2.5 MT CO_2e) and manufacturing industries and construction (2.3 MT CO_2e) (IEA, 2013). The largest source of GHG emissions is however from agriculture (~39 MT CO_2e) (CAIT, 2013). In Kenya, the land use change and forestry sector has negative emissions, meaning that it is a net sink for GHGs (i.e. the net GHG sequestration by the sector exceeds the net emission of GHGs).

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

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

3.2.1 GHG emissions from fuel combustion, by source and sector

Table 3-5: Kenya'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		0.8
Oil		10.9
Total fuel source emissions		11.7
Electricity and heat production		2.5
Other energy industry own use*		0.1
Manufacturing industries and construction		2.3
Transport	Road	5.7
	Other	0.1
	Total	5.7
Other	Residential	0.9
	Non-residential	0.2
	Total	1.1
Total emissions (including LUCF)		11.7

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

KENYA

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

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

National GHG emissions from fuel combustion by fuel source and sector[14]		
Source / Sector		**Total emissions (MT CO_2e)**
Energy	Electricity and heat	5.7
	Manufacturing and construction	0.1
	Transport	5.7
	Other fuel combustion	
	Fugitive emissions	0.9
	Energy sub-total	0.2
Industrial processes		2.8
Agriculture		37.8
Waste		0.9
Land use change and forestry (LUCF)		-31.2
Total emissions (including LUCF)		29.0

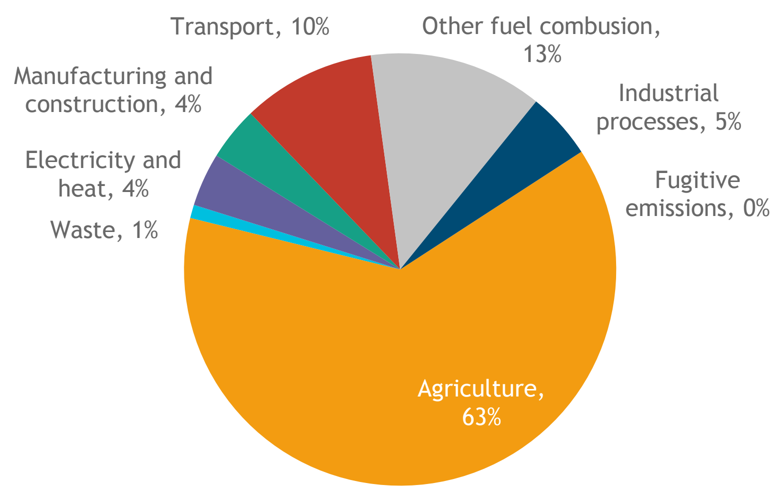


Figure 3-4: Distribution of Kenya's GHG emissions by major sectors (excluding LUCF which has negative emissions)

3.2.3 GHG emissions from agricultural practices

Table 3-7, below, summarises GHG emissions from Kenya'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 Kenya livestock production is the largest contributor to emissions. In particular, the enteric fermentation and manures left on pastures contribute ~55% and forest land use change contributes ~37% of the total emissions from this sector. Annual GHG emissions from land use change are negative and offset a large proportion of Kenya's agricultural emissions through carbon sequestration, bringing the total emissions from these sectors down to ~5.9 MT CO2e (FAO, 2014).

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

VARIABLE		ANNUAL EMISSIONS (MT CO_2E)
Annual GHG emission from agricultural practices [15]	Burning - crop residues	0.18
	Burning - savanna	0.22
	Crop residues	0.37
	Cultivation of organic soils	0.04
	Enteric fermentation	20.72
	Manure management	0.87
	Manure applied to soils	0.42
	Manure left on pasture	13.94
	Rice cultivation	0.04
	Synthetic fertilizers	0.33
	Sub-total (Agricultural practices)	37.13
Annual GHG emission from land use change [15]	Grassland	0.00
	Cropland	0.26
	Forest land	-31.53
	Burning biomass	0.03
	Sub-total (Land use change)	-31.24
Total emissions		5.9

Table 3-8, overleaf, summarises the recent historical changes in land use in Kenya 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 Kenya's forest biomass as ~625.4 million tonnes.

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

VARIABLE		TOTAL (HECTARES)	TOTAL (% OF LAND AREA)	UNIT
Total tree cover [16]	10-30% canopy cover	7,553,643.2	13.0	% of total land area
	30-50% canopy cover	1,360,171.8	2.3	
	50-100% canopy cover	1,653,574.2	2.8	
	Total	10,567,389.2	18.2	
Land use change and agricultural expansion	Historical annual rate of deforestation[17]		0.1	% of previous year
			0.3	
			0.7	
	Area of agricultural land[18]	27,991,245.1	48.2	% of total land area

4. SUMMARISED NATIONAL PRIORITIES FOR CLIMATE CHANGE ADAPTATION AND MITIGATION

Kenya's 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 Kenya's major commitments and priorities related to GHG mitigations (Table 4-2, below) as well as major priorities related to adaptation (Table 4-3, further below).

Kenya seeks to undertake an ambitious mitigation contribution towards the 2015 Agreement. Kenya therefore seeks to abate its GHG emissions by 30% by 2030 relative to the BAU scenario of 143 MTCO2e; and in line with its sustainable development agenda. This is also subject to international support in the form of finance, investment, technology development and transfer, and capacity building. "Kenya's NDC includes both mitigation and adaptation components based on her national circumstances and in line with decisions 1/CP.19 and 1/CP.20."

Kenya's contribution will be implemented with both domestic and international support. It is estimated that over USD 40 billion is required for mitigation and adaptation actions across sectors up to 2030.

Table 4-1, below, gives details on Kenya'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 Kenya'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
69.6	BAU	30 percent (conditional)	2030	CO_2, CH_4, N_2O; Energy, Transportation, Industrial Processes, Agriculture, Forestry and Other Land Use (AFOLU), Waste	Kenya does not rule out the use of international market-based mechanisms in line with agreed accounting rules.	A global land-use data approach was used, as described in the 2003 IPCC Good Practice Guidance for LULUCF.

4.1 National priorities for climate change mitigation

Kenya's major priorities for actions and investments related to climate change mitigation are summarised in Table 4-2, below, categorised according to sector. Proposed activities and investments within each sector are further categorised according to 'Technology Type', based on the categories of technologies listed by the Green Climate Fund's (GCF) impact indicators for mitigation projects (key for technology types provided below Table 4-2). These technology types and specific actions represent Kenya'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 Kenya's aim to move towards sustainability. These priorities include expansion of renewable energy and a move away from wood fuels, promotion of low-carbon transport systems, and enhancement of energy resources and efficiency in the energy sector. In the AFOLU sector, national priorities include an increase in national tree cover and promotion of climate-smart agricultural methods.

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

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE* 6
Energy	Expansion in geothermal, solar and wind energy production, other renewables and clean energy options	1
	Enhancement of energy and resource efficiency across the different sectors	1, 5
	Clean energy technologies to reduce overreliance on wood fuels	1, 4
Transport	Low carbon and efficient transportation systems	2
AFOLU	Make progress towards achieving a tree cover of at least 10% of the land area of Kenya	4
	Climate smart agriculture (CSA) in line with the National CSA Framework	4, 5
Waste Management	Sustainable waste management systems	4

[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.

4.3 National priorities for climate change adaptation

In terms of national priorities for climate change adaptation, Kenya's strategies are relatively undetailed in all priority sectors apart from institutional. In the energy, AFOLU, water, community based and health sectors the general priorities are to increase the resilience of the sectors to climate change and mainstream climate change adaptation into the sector. In the institutional sector, priorities are more specified and include climate proofing infrastructure, enhancing education, access to climate information services and access to climate change information, supporting innovation and development of technologies for climate resilient development and ensuring the resilience of ecosystems to climate variability and change. Kenya's proposed activities and investments related to adaptation are categorised according to 'Technology Type', based on the categories of technologies listed by the Green Climate Fund's (GCF) impact indicators for adaptation projects (key for technology types provided below Table 4-3).

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

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE7
Energy	Increase the resilience of current and future energy systems	1, 7
	Integrate climate change adaptation into the extractive sector	4
AFOLU	Mainstream climate change adaptation in land reforms	1, 4
	Enhance the resilience of the agriculture, livestock and fisheries value chains by promoting climate smart agriculture and livestock development	2, 4
Water	Mainstream of climate change adaptation in the water sector by implementing the National Water Master Plan (2014)	2, 5
Community based	Integrate climate change adaptation into the public sector reforms	1, 5
	Enhance the adaptive capacity of the population, urbanisation and housing sector	1, 2, 7
Institutional	Support innovation and development of appropriate technologies that promote climate resilient development	5, 6
	Enhance adaptive capacity and resilience of the informal private sector	1, 5, 7
	Climate proofing of infrastructure (energy, transport, buildings, ICT)	3
	Enhance education, training, public awareness, public participation, public access to information on climate change adaptation across public and private sectors	1, 8

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

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

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

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

4. Improved resilience of ecosystems and ecosystem services

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

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

7. Strengthened adaptive capacity and reduced exposure to climate risks

8. Strengthened awareness of climate threats and risk reduction processes

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE8
Institutional (cont)	Enhance climate information services	5, 6, 8
	Enhance the resilience of ecosystems to climate variability and change	4, 7
	Mainstream climate change adaptation into county integrated development plans and implement the Ending Drought Emergencies Strategy	1, 2, 5
Health	Strengthen integration of climate change adaptation into the health sector	2, 7

[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

Additional resources:

Kenya Ministry of Environment and Forestry: http://www.environment.go.ke

Kenya Climate Change Action Plan: www.kccap.info

Kenya Meteorological Department: http://www.meteo.go.ke

Kenya Meteorological Society: http://www.kms.or.ke

University of Nairobi, Science Faculty: http://ksc.uonbi.ac.ke/

University of Nairobi, Department of Meteorology: http://meteorology.uonbi.ac.ke/

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 Kenya. 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 five climate regions across Kenya. 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 Northern region has very high inter-annual (250mm in some years to 900mm in other years) and moderate decadal variability (400mm in some decades to 550mm in other decades). Long term trends are not statistically significant and could be as little as 0.75mm over the 30 year period.

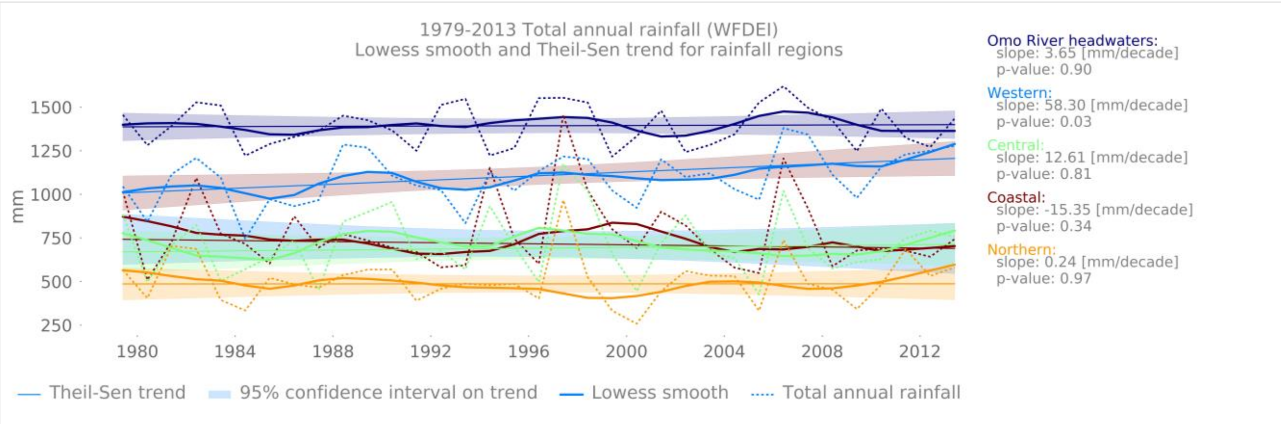


Figure A-1: Long term trends and variability in total annual rainfall regions

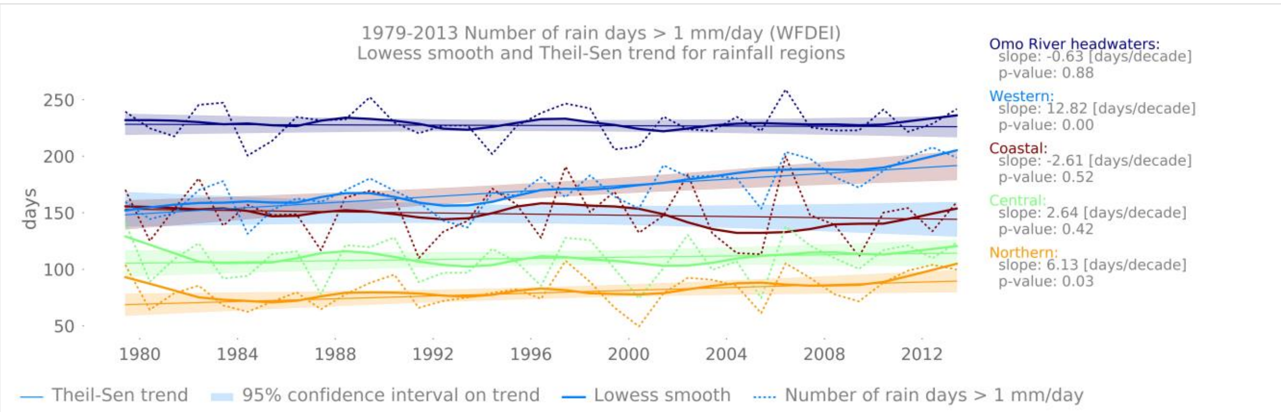


Figure A-2: Long term trends and variability in frequency of rainfall events (number of rain days) for rainfall regions

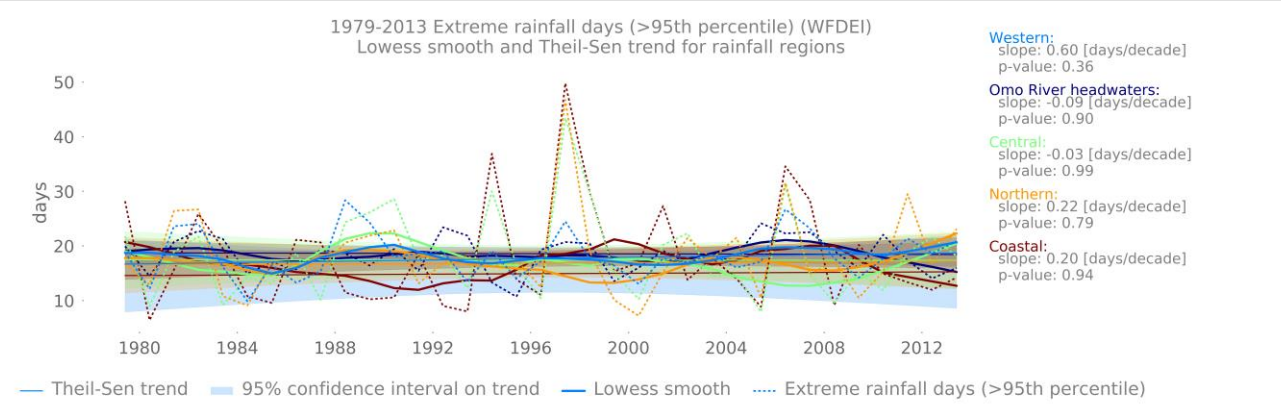


Figure A-3: Long term trends and variability in number of very heavy rainfall days (greater than 95th percentile) for rainfall regions

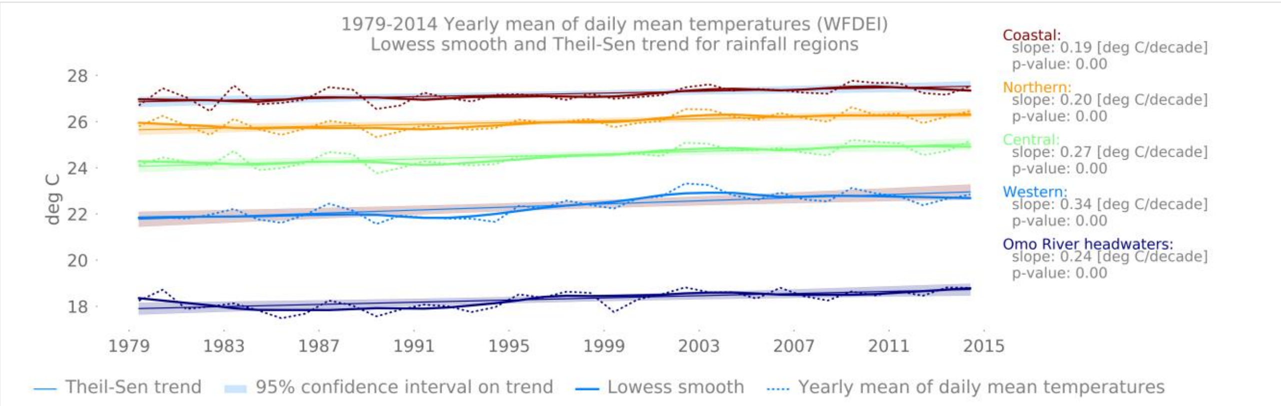


Figure A-4: Long term trends and variability in daily mean air temperatures for rainfall regions

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.

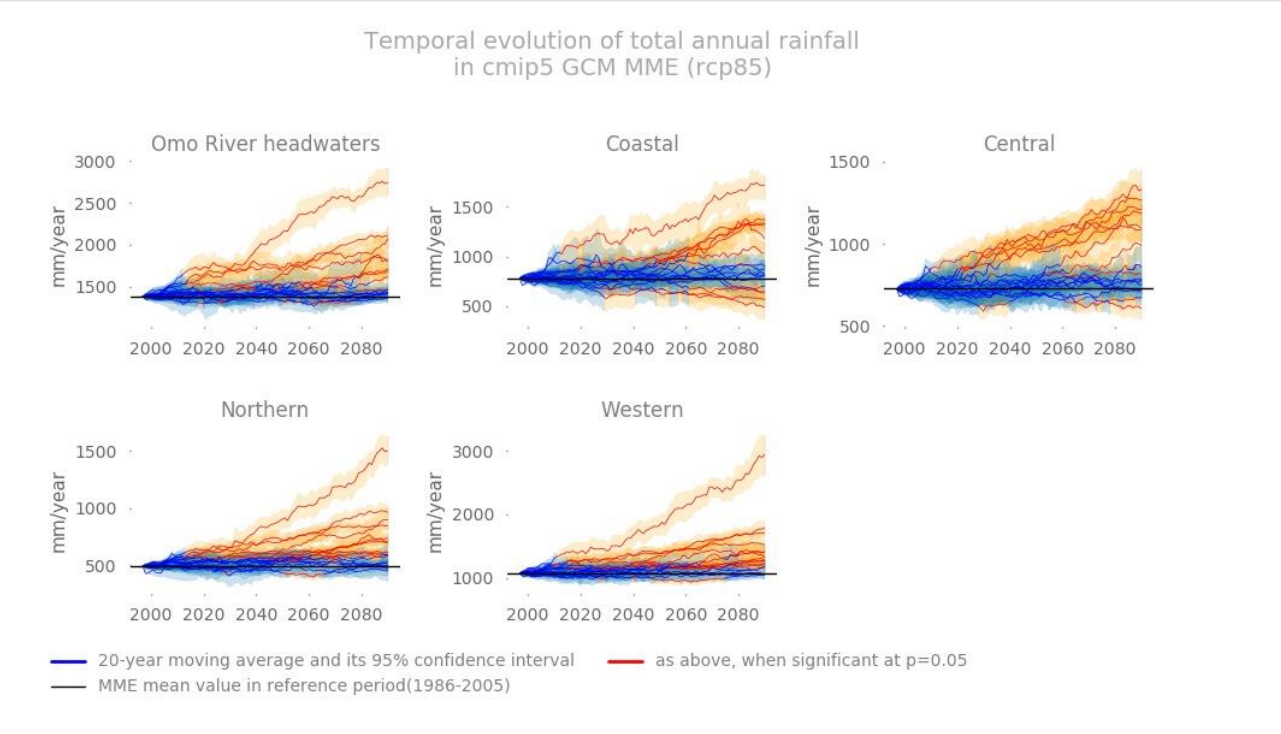


Figure A-5: Projected changes and emergence of changes in total annual rainfall

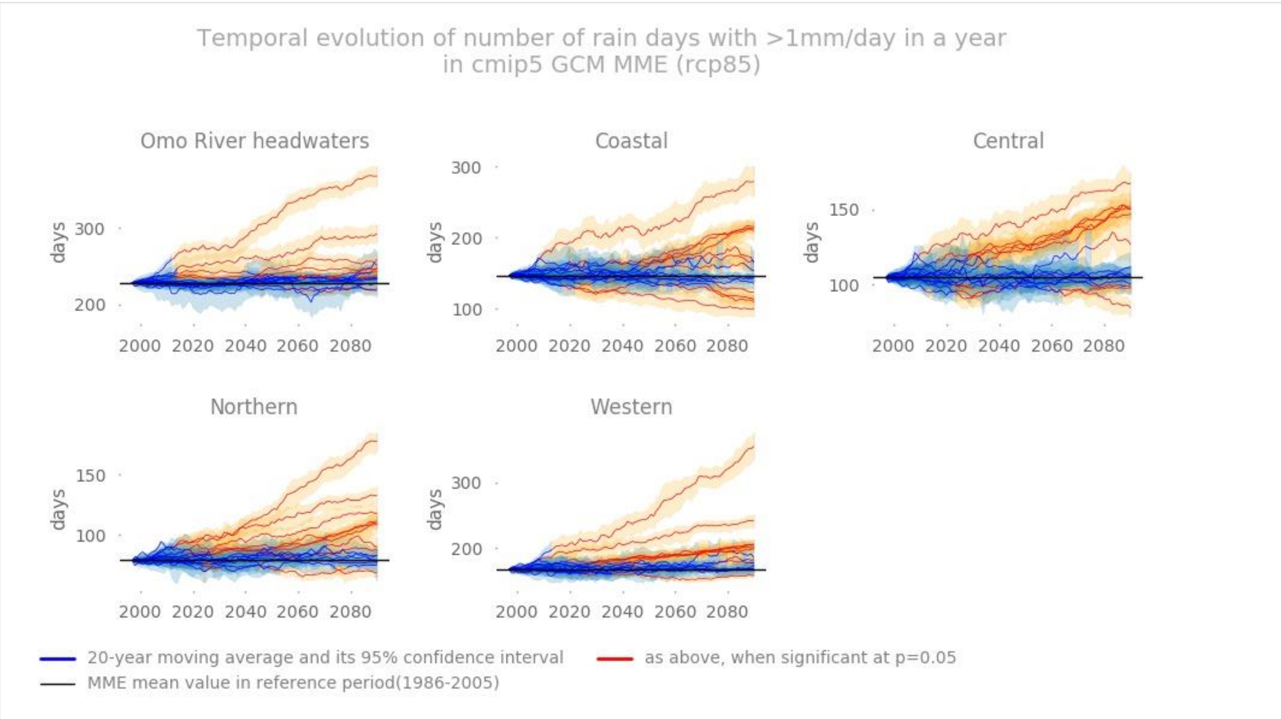


Figure A-6: Projected changes and emergence of changes in number of rain days per year

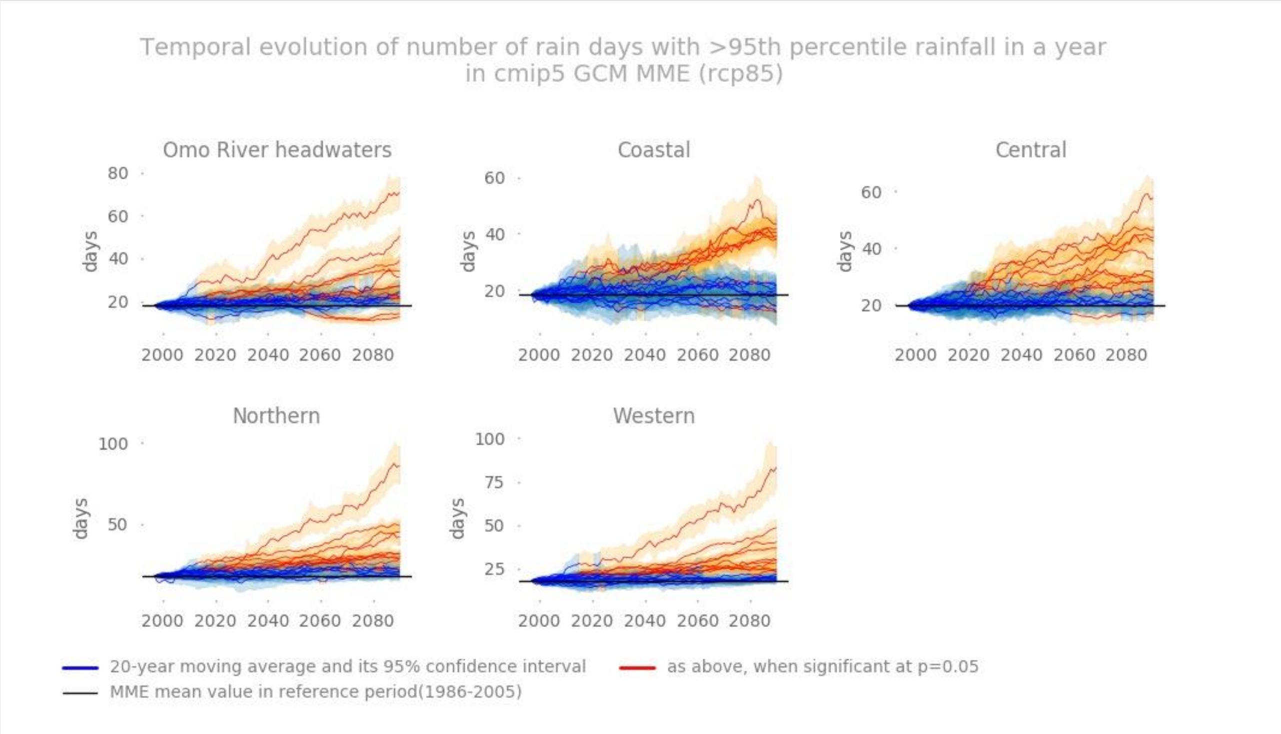


Figure A-7: Projected changes and emergence of changes in number of very heavy rainfall days (greater than 95th percentile) per year

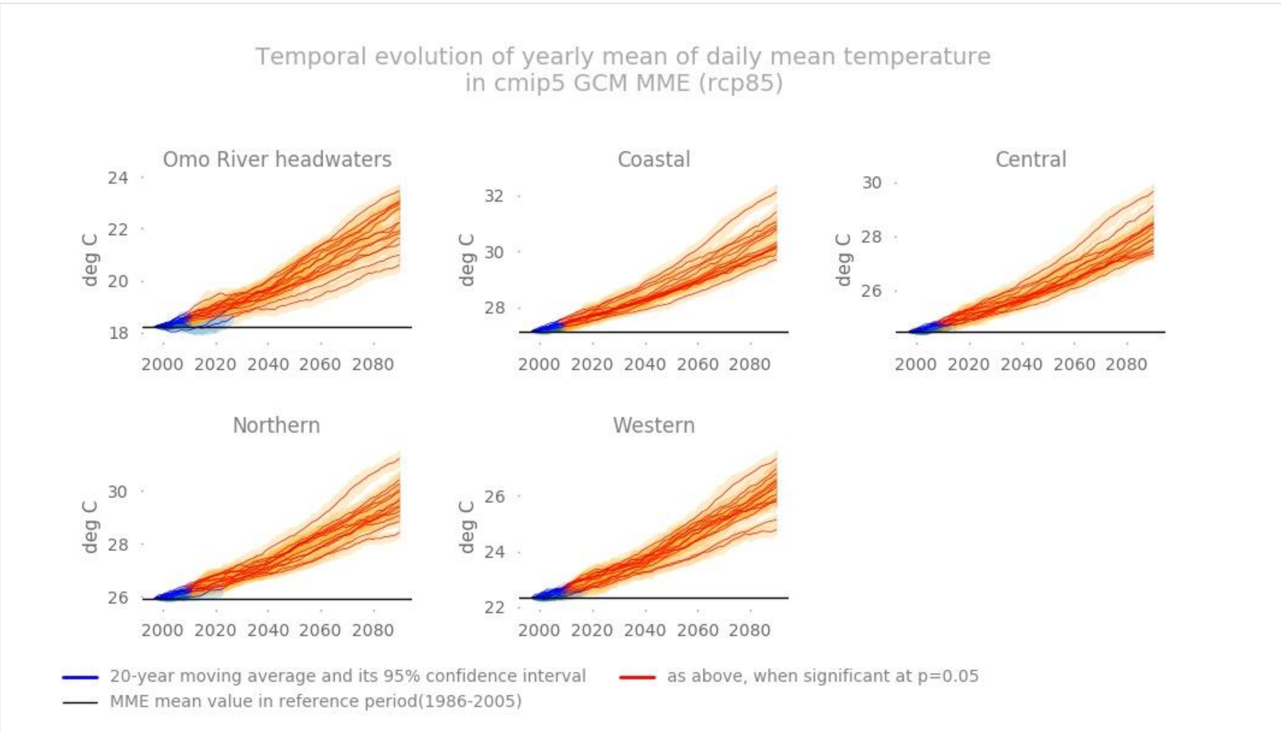


Figure A-8: Projected changes and emergence of changes in annual mean daily mean temperatures

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