ETHIOPIA

AFRICAN DEVELOPMENT BANK

NATIONAL CLIMATE CHANGE PROFILE

PRODUCED IN COLLABORATION WITH:
African Climate & Development Initiative, University of Cape Town;
Climate Systems Analysis Group, University of Cape Town;
Energy Research Centre, University of Cape Town; Cirrus Group.

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ACKNOWLEDGEMENT

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1. BACKGROUND

1.1 Geographic and socio-economic context

The Federal Democratic Republic of Ethiopia (henceforth 'Ethiopia', shown below in Figure 1-1) is a landlocked country in the Horn of Africa. It shares borders with Eritrea to the north and northeast, Djibouti and Somalia to the east, Sudan and South Sudan to the west, and Kenya to the south. Ethiopia is the second-most populous country in Africa (~104,300,000 people). At present, the majority of Ethiopia's population is rural, however the country's urban population (currently ~19% total) is increasing at the 9th fastest rate in Africa (~4.8% p/a). As a result of the large rural population, the majority of whom are partially reliant on crop and livestock-based agriculture and ~33% of whom live below the poverty line of USD 1.90/day, the negative effects of climate-related risks have the potential to effect large numbers of people. It is estimated that the effects of drought in Ethiopia impacted about ~49,600,000 people in the country during the period 1996-2016, the largest absolute total of any African country. The country is also vulnerable to flood events with ~2,400,000 people being affected in the same period. Ethiopia has a low level of human development with an HDI of 0.45. The ND GAIN index (which summarises a country's vulnerability to climate change and other global challenges in combination with its readiness to improve resilience) score for Ethiopia is ~40, which is considered to be relatively low. The country's relatively low ND GAIN score is indicative of a relatively high vulnerability score and low readiness score, indicating that Ethiopia 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.

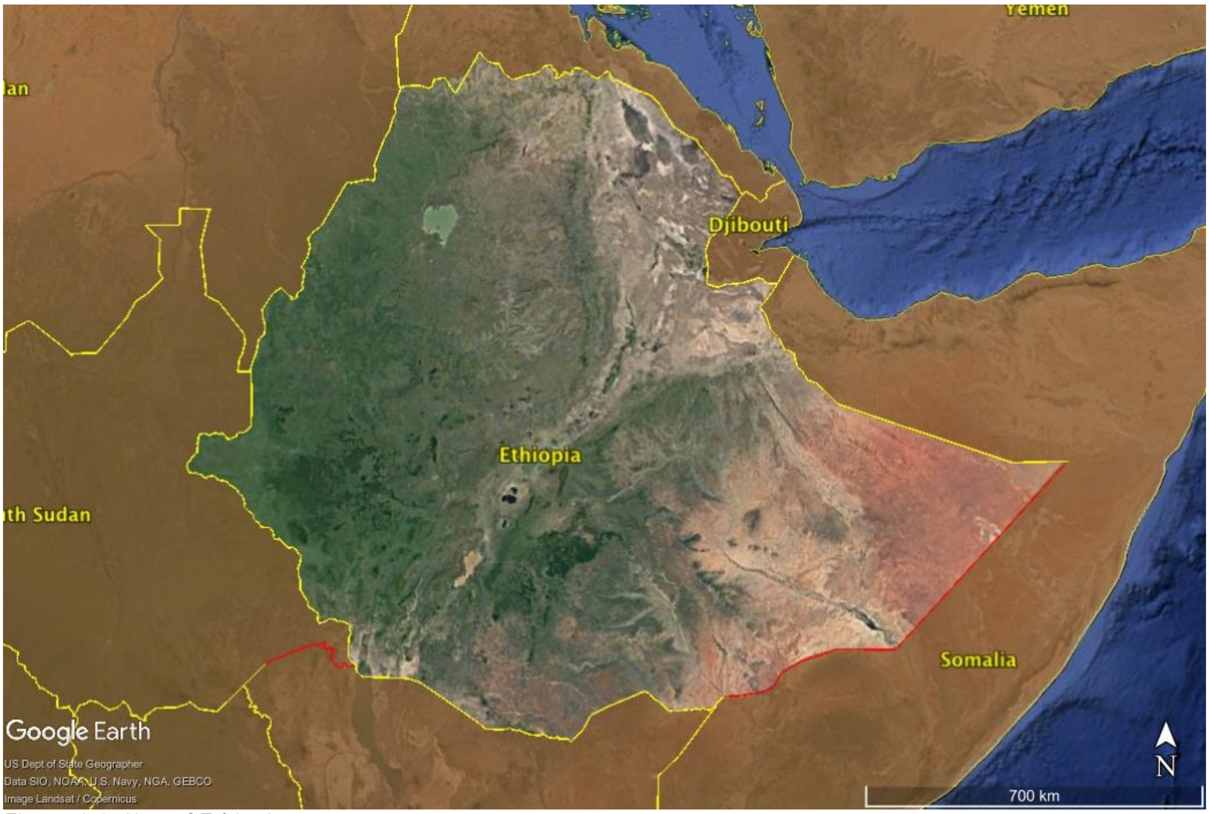


Figure 1-1: Map of Ethiopia

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

VARIABLE		SCORE/TOTAL	UNIT	RANK (IN AFRICA)
Geography, socio-economy and demographics				
Population[1]		104,344,901	people	2
Population growth rate[1]		2.5	% population. yr-1	27
Population density[1]		104	People/km2	14
Land area[1]		1,000,430	km2	11
% Urban population[1]		19.4	% population	50
% Urbanisation rate[2]		4.8	% population. yr-1	9
Economy: total GDP[2]		72.4	USD billions. yr-1	8
Economy: GDP by PPP[2]		178	billion international dollars. yr-1	8
Economy: GDP/capita[2]		707	USD per capita /yr.	32
Population below the poverty line[3]		33.5	% below USD 1.90 per day	29
Gender Inequality Index[4]		55.8		21
GINI co-efficient[3]		33.2		45
Summary indicators of climate change vulnerability				
Workforce in agriculture[6]		8.7	% workforce	39
Population undernourished[7]		32.0	% population	8
Number of people affected by drought[8]		49,691,879	people	1
Number of people affected by flood events[8]		2,425,247	people	8
Population living within 100 km of coast[9]		1,223,484	people	29
ND-Gain Vulnerability Index[9]	Total	40.0		24
	Readiness	0.34		24
	Vulnerability	0.53		30

2. CLIMATE AND WEATHER

Ethiopia's climate is strongly determined by elevation, being hot and dry in the lowlands and cooler and wetter up on the highlands. The seasonality of rainfall varies across the country having two short seasons (April – May and October) over the southern and eastern parts and a single longer season (April – October) over the Central and Western Highlands.

The water region of Ethiopia falls almost exclusively within the country's borders. Climate variation within Ethiopia is high, and four sub-regions are distinguished here. The Ethiopia water region is illustrated in **Figures 2-1** and **2-2**, below, and summary descriptions can be found in **Table 2-1** below.

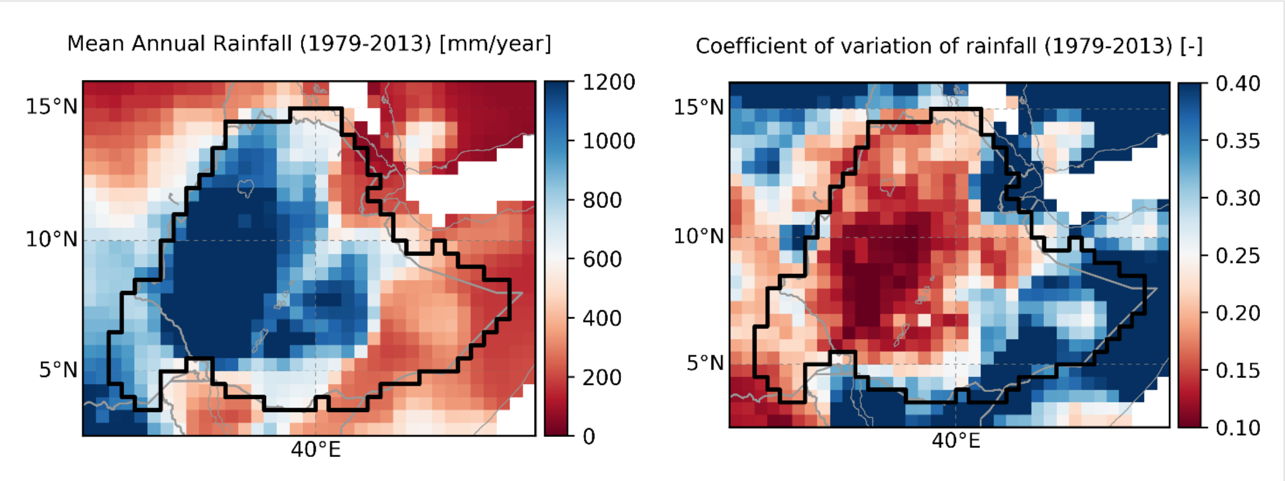
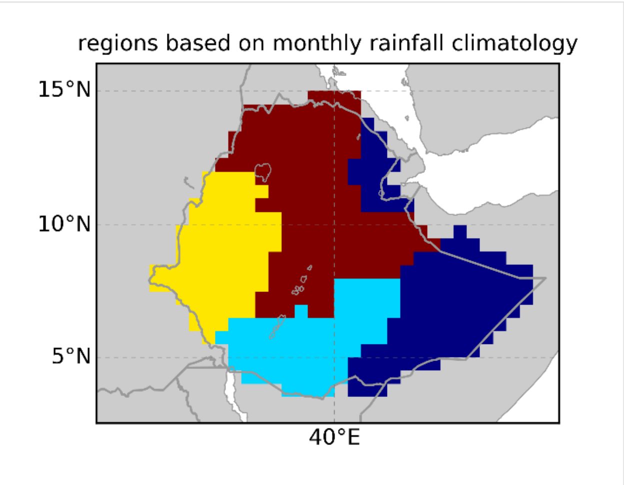


Figure 2-1: Main characteristics (magnitude and variability) of rainfall in Ethiopia and its region



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

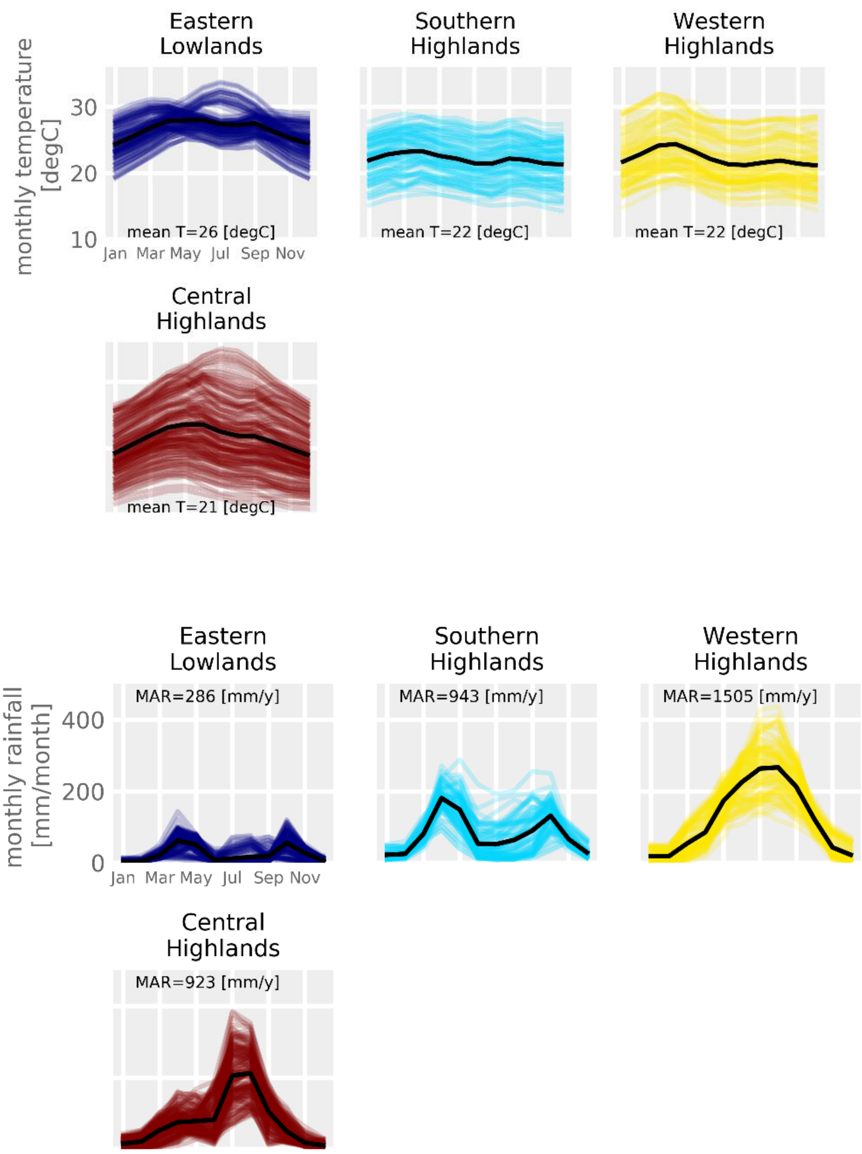


Figure 2-2: Rainfall regions of Ethiopia based on similarity of standardised rainfall climatology, and their rainfall and temperature climatologies

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

Eastern lowlands	A dry region with daily mean temperature of 26° C and mean annual rainfall reaching 290mm/year with lower values and relatively low interannual variability over the far east and south and higher values over the central parts. Rainfall peaks during April – May and in October with a dry season from December – February. Seasonal variation in daily mean temperature is around 5° C with warmest values during boreal summer and coolest values in winter for the more northern area, while the more southern area shows a bimodal seasonality with maximum temperatures around March – May and to a lesser degree in September. Clear spatial differences in temperature are evident and primarily due to elevation.
Southern Highlands	A relatively wet region with mean annual rainfall reaching 940 mm/year and daily mean temperature of 22° C. Spatial variability is evident in the magnitude of rainfall with values generally increasing with increased elevation and interannual variability decreases with this increase in rainfall. Rainfall predominantly falls during two rainy seasons; the long rains from April – May (~180 mm/month) and the short rains peaking in October (150mm/month) with a dry season from December – February. Seasonal variation in daily mean temperature is around 3° C with warmest values during early summer and coolest values in winter. Clear spatial differences in temperature are evident and primarily due to elevation.
Western Highlands	A wet region with mean annual rainfall exceeding 1500 mm/year and daily mean temperature of 22° C. Some spatial variability is evident in the magnitude of rainfall with the lower elevation areas having slightly lower values and higher interannual variability. Rainfall occurs in a single rainfall season from April – October peaking at ~270mm/month during July and August. Seasonal variation in temperature is around 4° C with warmest temperatures occurring towards the beginning of the rainy season and a secondary peak at the end. Coolest temperatures occur during winter. Clear spatial differences in temperature are evident and primarily due to elevation.
Central Highlands	A relatively wet region with mean annual rainfall of 920 mm/year and daily mean temperature of 21° C. Some spatial variability is evident in the magnitude of rainfall with the lower elevation areas having slightly lower values and higher interannual variability. Rainfall occurs in a single rainfall season from April – October sharply peaking at ~200mm/month during June and July. Seasonal variation in daily mean temperature is around 5° C with warmest values during early summer and coolest values in winter. Strong spatial differences in temperature are evident and primarily due to elevation.

2.1 Observed historical climate variations and climate change trends

The **highlands** of Ethiopia experience **relatively low rainfall variability**, while the **lowlands** experience **relatively high rainfall variability** on an inter-annual basis. On **decadal time scales** Ethiopia 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 regions show **increasing temperatures** over the period 1979 – 2015, with the strongest trends occurring over the highlands vs. the lowlands. Long term trend in total annual rainfall are relatively strong, positive and statistically **significant** over Southern and Western Highlands, while a slight, non-significant negative trend over the Central Highlands. In contrast, the Eastern Lowlands shows a statistically significant positive trend in rainfall over the last 35 years. The long-term change in total rainfall is generally positively correlated with the frequency of rainy days and extreme rainy days, however for the Southern Highlands the negative trend in annual total rainfall is associated with a negative trend in extreme rainy days, but an increase in the frequency of all rain days. Long term trends and variability in the Ethiopia region are summarized in **Table 2-2** below and illustrated further in the supplementary Appendix **(Figures A-1 to A-4).**

Table 2-2: Summary of trends in rainfall and temperature attributes in Ethiopia (1979 - 2015)

REGION	MEAN T [DEG C/DECADE]	TOTAL RAINFALL [MM/DECADE]	EXTREME RAINY DAYS [DAYS/DECADE]	RAINY DAYS [DAYS/DECADE]
Eastern Lowlands	+0.11	+27.0	+2.0	+5.4
Southern Highlands	+0.18	-39.6	-2.9	+7.3
Western Highlands	+0.22	-47.7	-1.1	slight decrease
Central Highlands	+0.21	slight decrease	slight decrease	slight decrease

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

Projected changes in main attributes of climate for the Ethiopia region are summarized in Table 2-3, below, and described in Sections 2.2.1 and 2.2.1. Additional analysis and visualisation of projections be found in **Figures A-5 to A-8** in the supplementary Appendix.

2.2.1 PROJECTED CHANGES IN PRECIPITATION FROM PRESENT TO 2100

Rainfall projections across the Ethiopia regions show a pattern of **potential increased rainfall** emerging during the second half of the century. Relative magnitudes of potential increased vary significantly between models, however rainfall could reach about 300mm/year wetter by 2100 or much higher. **The increase in rainfall** seems to be strongly associated with **increase in the frequency of rain days and high intensity rainfall events**. It must be noted that these results are derived from GCM projections which may not accurately represent changes in extreme rainfall dynamics. They are, however, consistent with the increased convective rainfall intensity (e.g. thunderstorm-related rainfall) expected in a warmer climate.

2.2.2 PROJECTED CHANGES IN TEMPERATURE FROM PRESENT TO 2100

Air temperature is projected to be between 1.5 and 2.5°C warmer in the Ethiopia region by the 2050s. By 2100 the range of projected temperatures is greater with the coastal regions showing projected increases of 2.5°C to 6°C.

Table 2-3: Summary of projected climate changes across regions of Ethiopia 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]
Eastern Lowlands Southern Highlands Western Highlands Central Highlands	**Increasing** +1.5°C to +2.5°C by 2050s but changes evident in next decades	**Normal to increasing,** with strong disagreement in the rate of increase, could become evident after 2030s	**Normal to increasing,** ranging from no change to an increase of up to 50% by 2100. Change could become evident in the 2050s	**Normal to increasing,** ranging from no change to an increase of up to 50% by 2100. Change could become evident after 2020s

2.4 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.

Landlocked in the Horn of Africa, Ethiopia's geographical location favours relatively high yet unevenly distributed rainfall. Increasing temperature trends may however increase the pressure on water resources, despite indications of normal to increasing rainfall trends into the future, with implications for the countries in the wider region to whom Ethiopian catchments are a key water source. Possible increase in extreme rainfall events is likely to further complicate access to safe drinking water, which coupled with increasing temperatures could have massive consequences in a country where half the population, around 50 million people, are prone to the impacts of drought. With an agricultural sector, which forms the backbone of the rural population and the economy at large, heavily dependent on natural rainfall, increasing temperatures and changing rainfall patterns pose a risk for both household food security and for the economy at large. One of the fastest growing economies in the world, Ethiopia has a small yet rapidly growing urban population, whose large majority resides in slums. These growing urban slum settlements could be a concern, both in terms of the impacts of disasters and the provision of safe water, sanitation and health services.

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

SECTOR	IMPACTS
Agriculture	– Crop loss and reduced yields owing to increased temperatures and changing rainfall patterns – Loss of agricultural and grazing land owing to shifting ecological zones – Altered growing cycles owing to shifts in seasonal rainfall patterns – Increased incidence of pests and diseases – Increased potential for conflict between farmers and pastoralists
Fisheries	– Shrinking of inland lakes and wetlands owing to decreased water availability – Reduced fishery productivity owing to increased water temperatures and decreased river flows
Water resources	– Increased variability in run-off, leading to increased variability in surface water availability, especially in the drier lowland areas – Increased potential for conflict over limited water resources – Reduced water storage, negatively affecting hydropower production – Increased demand on water resources, both surface and groundwater – Decreased water quality, especially during floods and droughts
Built infrastructure and human settlements	– Damage to or destruction of inland infrastructure due to extreme events, especially flooding – Increased potential for migration from rural to urban areas – Increased land degradation owing to increased prevalence of drought
Human health	– Increased prevalence of vector-borne diseases such as malaria, especially at higher altitudes – Increased prevalence of malnutrition and stunting, especially during prolonged drought – Increased potential for loss of life owing to prolonged drought – Increased risk from water-borne disease such as cholera and diarrhoea

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3. GREENHOUSE GAS EMISSIONS AND ENERGY USE

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

3.1 National energy production and consumption

In Ethiopia, the vast majority of energy production and consumption is from the domestic use of biomass fuels (~98% and 91%, respectively) (Tables 3-1 and 3-2, below). This is further reflected in the significant proportion (~92%) of total national energy which is consumed by the residential sector (Table 3-3). Other fuels which contribute to national energy consumption are oil (~7%) and coal (~1%), which are imported. After the residential sector, the next-largest energy consumers in Ethiopia include transport (~4%), industry (~3%), and commercial and public services (~1%).

Electricity production is primarily generated by hydropower (~95% of electricity production), however the amount of electricity generated accounts for only 2% of total national energy production. 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].

3.1.1 NATIONAL ENERGY PRODUCTION, PRIMARY ENERGY SUPPLY AND NATIONAL ENERGY CONSUMPTION

The tables and figures below describe Ethiopia's energy sector, including national electricity production, primary energy supply and national energy consumption by fuel carrier.

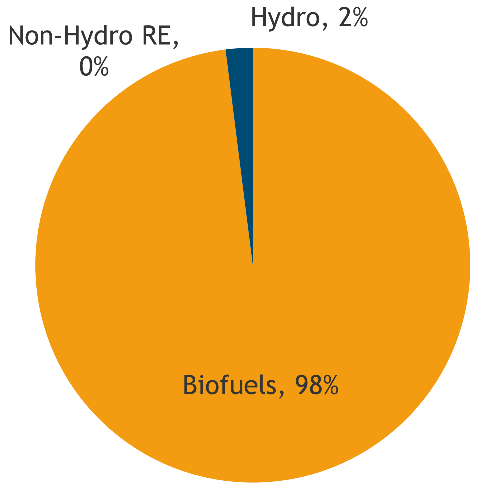

Figure 3-1: Distribution of Ethiopia's national energy production between major energy carriers (2014-2016)

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

NATIONAL ENERGY PRODUCTION		
Source	Total (MTOE)[1]	% of total energy production
Hydro[11]	0.8	1.7
Biofuels[11]	44.7	98.2
Non-Hydro RE[11]	0.1	0.1
Total national energy production	45.5	
Electricity[5]	Hydro	95.6
	Oil	4.3
	Gas	0.1

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

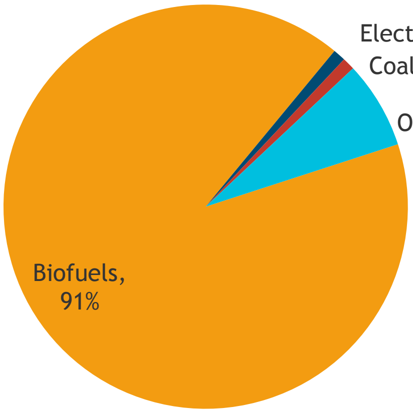

Figure 3-2: Distribution of Ethiopia's national energy consumption by major energy carriers

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

CONSUMPTION BY ENERGY SOURCE	
Source	**Total (MTOE)**
Coal	0.2
Oil	2.8
Biofuels	36.0
Electricity	0.6
Total national energy consumption by source	39.5

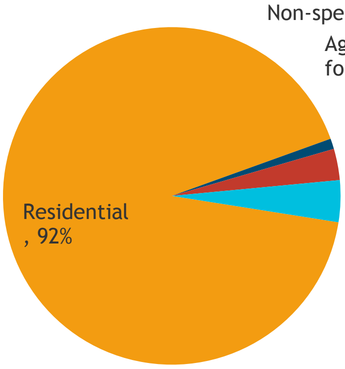

Figure 3-3: Distribution of Ethiopia's national energy consumption by sector (2014-2016)

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

CONSUMPTION BY SECTOR[11]	
Source	**Total (MTOE)**
Industry	1.1
Transport	1.4
Residential	36.1
Commercial and public services	0.5
Agriculture / forestry	0.1
Non-specified	0.1
Non-energy use	0.1
Total national energy consumption by sector	39.5

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

TOTAL PRIMARY ENERGY SUPPLY[11]	
Source	**Total (MTOE)**
Coal	0.2
Oil	2.8
Hydro	0.8
Biofuels	44.7
New RE	0.1
Electricity	-0.09
Total primary energy supply	48.4

3.2 National greenhouse gas emissions by source and sector

The sector that accounts for the largest proportion of national GHG emissions is agriculture (~91 MT CO2e, primarily the burning of biomass for fuel), followed by the energy sector (~25 MT CO2e) and land use change and forestry (~19 MT CO2e). Oil is the largest contributor to Ethiopia's greenhouse gas (GHG) emissions from fossil fuel combustion (7.8 MT CO2e), largely accounted for by road transport, manufacturing industries and construction, and the residential sectors.

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

3.2.1 GHG EMISSIONS FROM FUEL COMBUSTION, BY SOURCE AND SECTOR

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

NATIONAL GHG EMISSIONS FROM FUEL COMBUSTION BY FUEL SOURCE AND SECTOR[12]		
Source / Sector		**Total emissions (MT CO_2e)**
Coal		0.7
Oil		7.8
Gas		8.5
Total fuel source emissions		0.0
Electricity and heat production		2.9
Other energy industry own use*		3.8
Manufacturing industries and construction		0.2
Transport	4.0	15.1
	0.8	0.03
	0.8	15.1
Other	1.6	3.9
	8.5	4.6
	0.7	8.5
Total sector emissions		7.8

3.2.2 GHG EMISSIONS FROM PRIMARY ENERGY CONSUMPTION, BY SOURCE AND SECTOR

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

NATIONAL GHG EMISSIONS FROM PRIMARY ENERGY CONSUMPTION BY SOURCE AND SECTOR [13]		
Source / Sector		**Total emissions (MT CO_2e)**
Energy	Electricity and heat	0.0
	Manufacturing and construction	2.9
	Transport	4.0
	Other fuel combustion	18.5
	Fugitive emissions	25.4
	Energy sub-total	0.0
Industrial processes		2.5
Agriculture		91.6
Waste		3.9
Land use change and forestry (LUCF)		19.6
Total emissions (including LUCF)		143.0

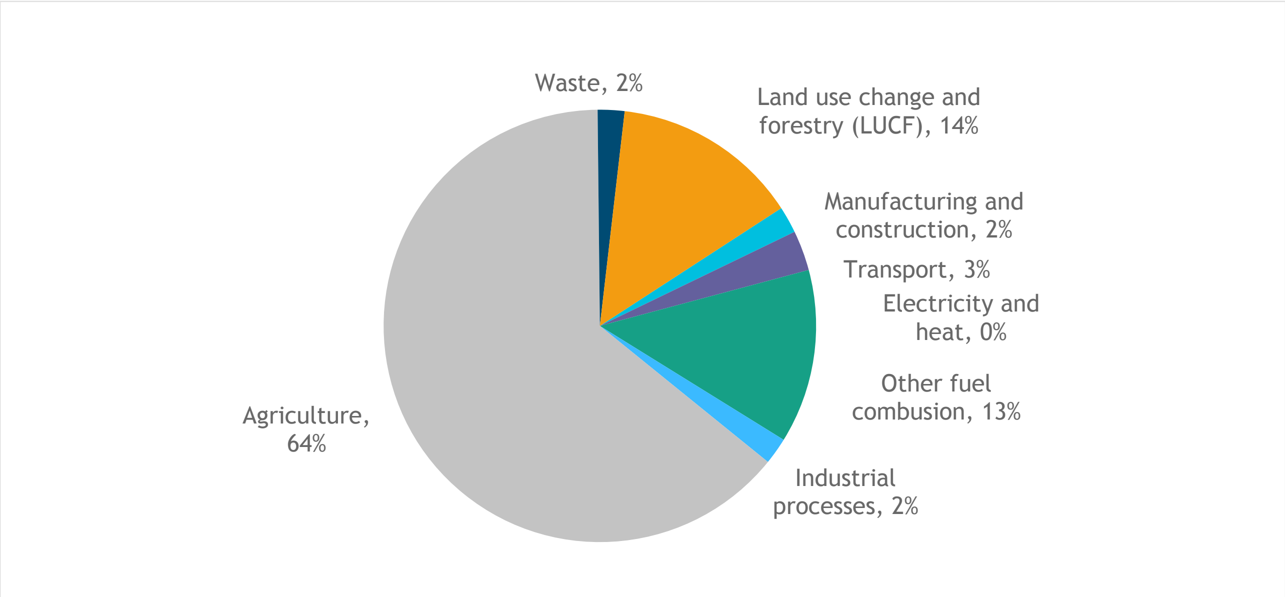

Figure 3-4: Distribution of Ethiopia's GHG emissions by major sectors

3.2.3 GHG EMISSIONS FROM AGRICULTURAL PRACTICES

Table 3-7, below, summarises GHG emissions from Ethiopia's agriculture sector (derived from Food and Agriculture Organisation statistics). Although there are multiple agricultural practices that contribute to GHG emissions, in the case of Ethiopia, the livestock production sector is by far the largest contributor. In particular, enteric fermentation and manures left on pasture contribute to over

80% of total GHG emissions from the sector.

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

VARIABLE		ANNUAL EMISSIONS (MT CO_2E)
Annual GHG emission from agricultural practices [14]	Burning - crop residues	0.2
	Burning - savanna	3.4
	Crop residues	1.3
	Cultivation of organic soils	1.4
	Enteric fermentation	50.2
	Manure management	2.0
	Manure applied to soils	0.8
	Manure left on pasture	35.2
	Rice cultivation	0.1
	Synthetic fertilizers	1.5
	Sub-total (Agricultural practices)	96.3
Annual GHG emission from land use change [14]	Grassland	0.3
	Cropland	12.1
	Forest land	2.7
	Burning biomass	8.7
	Sub-total (Land use change)	23.8
Total emissions		120.1

Table 3-8, overleaf, summarises the recent historical changes in land use in Ethiopia 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 Ethiopia's forest biomass as ~221.9 million tonnes.

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

VARIABLE		TOTAL (HECTARES)	TOTAL (% OF LAND AREA)	UNIT
Total tree cover [15]	10-30% canopy cover	18,980,213	17.19	% of total land area
	30-50% canopy cover	6,483,225	5.9	
	50-100% canopy cover	5,198,582	4.7	
	Total	**30,662,020**	27.8	
Land use change and agricultural expansion	Historical annual rate of deforestation [16] Cropland		0.0	% of previous year
			0.1	
			0.2	
	Area of agricultural land [17]	39,401,424	35.7	% of total land area
	Historical annual area converted to agricultural land [17]	773,010	2.0	% of previous year

4. SUMMARISED NATIONAL PRIORITIES FOR CLIMATE CHANGE ADAPTATION AND MITIGATION

Ethiopia's main priority actions related to climate change are described in the country's submissions to the UNFCCC through the Intended Nationally Determined Contributions (INDC) document. This document includes detailed descriptions of Ethiopia's major commitments and priorities related to GHG mitigations (Table 4-2, below) as well as major priorities related to climate change adaptation, derived from the draft National Adaptation Plan (NAP) (Table 4-3, further below).

Ethiopia intends to limit its net greenhouse gas (GHG) emissions in 2030 to 145 Mt CO_2e or lower. This would constitute a 255 $MtCO_2e$ reduction from the projected 'business-as usual' (BAU) emissions in 2030 or a 64% reduction from the BAU scenario in 2030. Ethiopia also intends to undertake adaptation initiatives to reduce the vulnerability of its population, environment and economy to the adverse effects of climate change, based on its Climate Resilient Green Economy Strategy (CRGE).

The priority actions described in Ethiopia's INDC are informed by the country's Climate Resilient Green Economy Strategy (CRGE), which is also integrated into the Second Growth and Transformation Plan (the national development plan). The total investment costs required for the full and effective implementation of the Green Economy Strategy are estimated to be at least ~USD 150 billion by 2030. The INDC notes that "future research will be conducted in order to quantify the required international financial, technological and capacity building support for the implementation of vulnerability abatement measures up to and beyond 2030".

Table 4-1, below, gives details on Ethiopia's GHG reduction targets outlined in the country's INDC, 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 Ethiopia's INDC commitments for reduction of GHG emissions

GHG EMISSIONS REPORTED IN INDC (MT CO2E/YR)	BASE LEVEL	REDUCTION TARGET	TARGET YEAR	SECTORS AND GASES	USE OF INTERNATIONAL MARKETS	LAND-USE INCLUSION / ACCOUNTING METHOD
143.87	BAU	64 percent (conditional)	2030	CO_2, CH_4, N_20; Agriculture (livestock and soil), forestry, transport, electric power, industry (including mining) and buildings (including waste and green cities)	Yes, as a seller of international credits	Land-use included; accounting methodology not specified

4.1 National priorities for climate change mitigation

Ethiopia's major priorities for actions and investments related to climate change mitigation are summarised in Table 4-2, below, categorised according to sector. Detailed actions and priorities are identified for sectors including *inter alia* energy, transport and AFOLU. 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 Ethiopia's immediate national priorities for investments in climate change mitigation and reflect recent and on-going policy-level measures to reduce GHG emissions and increase energy efficiency.

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Table 4-2: Mitigation priorities in Ethiopia's INDC

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE[2]
Energy	Expanding the electric power generation from renewable energy	1
	Leapfrogging to modern and energy efficient technologies in transport, industry and building sectors	2, 3, 6
	Identify the technical support needed to introduce new and additional policies and actions that stimulate and enable investment in limiting emission to 145Mt or lower	5
	Generation and distribution of electricity from clean and renewable sources	1
Transport	Investment in improved transportation systems (e.g. railway that utilize clean and renewable energy. These investments will be complemented by urban transition towards mixed use, impact and polycentric cities, resulting in shorter distances travelled to reduce transport/traffic related GHG emissions	2
AFOLU	Improving crop and livestock practices for greater food security and higher farmer incomes while reducing emissions	4
	Protecting and re-establishing forests for their economic and ecosystem services, while sequestering significant amounts of carbon dioxide and increasing the carbon stocks in landscapes	
	Strengthened the rural economic development through higher agricultural production, leading consequently to greater food security	
	Afforestation and land rehabilitation interventions	

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

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

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

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

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

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

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

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

8. Increased use of low-carbon transport.

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

4.2 National priorities for climate change adaptation

Ethiopia's major priorities for actions and investments related to climate change adaptation are summarised in Table 4-3, below, categorised according to sector. Detailed actions and priorities are identified for sectors including *inter alia* energy, transport, AFOLU and water, in addition to priorities focused on community- and institutional-level actions. Ethiopia's proposed activities and investments related to adaptation are further categorised according to 'Technology Type', based on the categories of technologies listed by the Green Climate Fund's (GCF) impact indicators for adaptation projects (key for technology types provided below Table 4-3). These technology types and specific actions represent Ethiopia's immediate national priorities for investments in climate change adaptation and build on recent policy-level measures to reduce vulnerability and increase capacity to respond to climate change at local and national levels.

Table 4-3: Adaptation priorities in Ethiopia's INDC

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE3
Energy	Expanding electric power generation from geothermal, wind and solar sources to minimize the adverse effects of droughts on predominantly hydroelectric energy sector	1, 7
	Building additional dams and power stations to further develop energy generation potential	3, 7
	Develop new dam sites on parallel rivers in order to maintain the baseline hydropower electricity generation capacity to levels attainable under a 'no climate change' scenario	
AFOLU	Improve and diversify economic opportunities from agroforestry and sustainable afforestation of degraded forest areas	1, 4
	Several large-scale sustainable land and natural resource programmes are ongoing, for example the Sustainable Land Management Programme and the Productive Safety Net Programme, which will contribute to building resilience to climate change	4, 5
	Increase agricultural productivity, minimize food insecurity by breeding and making available improved crop varieties, primarily from among those in Ethiopia that suit all agricultural areas	1, 2, 4
	Create biodiversity movement corridors, especially up towards higher terrain, in areas where most of the land is under cultivation	2, 3, 4

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

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

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

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

4. Improved resilience of ecosystems and ecosystem services

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

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

7. Strengthened adaptive capacity and reduced exposure to climate risks

8. Strengthened awareness of climate threats and risk reduction processes

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE4
AFOLU cont.	Enhancing ecosystem health through ecological farming, sustainable land management practices and improved livestock production practices to reverse soil erosion, restore water balance, and increase vegetation cover, including drought tolerant vegetation	1, 2, 4
	Strengthening and increasing the capacity for breeding and distributing disease resistant crop and fodder varieties to farmers and other land users in order to deal with the emergence and expansion of diseases and pests	1, 2, 5
Water	Provide water for drinking by diverting streams, digging wells and enhancing water harvesting techniques and thereby making available dependable watering points in all rural woredas (districts)	2, 3, 4
	Enhance irrigation systems through rainwater harvesting and conservation of water, including improved water use efficiency	1, 2
Community based	Enhance the adaptive capacity of ecosystems, communities and infrastructure through an ecosystem rehabilitation approach in the highlands of Ethiopia. Rehabilitation of degraded lands/forests will also increase resilience of communities, infrastructures and ecosystems to droughts and floods	1, 2, 4
Institutional	Effective early warning systems and disaster risk management policies to improve resilience to extreme weather events	4, 6, 8

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

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

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

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

4. Improved resilience of ecosystems and ecosystem services

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

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

7. Strengthened adaptive capacity and reduced exposure to climate risks

8. Strengthened awareness of climate threats and risk reduction processes

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5. ASSUMPTIONS, GAPS IN INFORMATION AND DATA, DISCLAIMERS

The observed and projected climate trends described in Section 2 'Climate and Weather' are derived from a combination of publicly-available observational data and CMIP5 climate models. Detailed information is included in Section 6. Appendix 1, including '6.1.b. Historical Trends and Variability Analysis' and '6.1.c. Climate Projections Visualisations'.

Unless stated otherwise, all statistics reported in Section 1 ('Geographic and Socio-Economic Context' and Section 3 'Climate change mitigation, greenhouse gas emissions and energy use') are derived from databases of publicly available datasets managed by international or multilateral agencies including inter alia The World Bank Group, the United Nations, World Resources Institute and International Energy Agency.

Unless stated otherwise, all energy and greenhouse gas emission figures are derived from UN Stats (2014); World Energy Council (2016); the World Resources Institute (2013), and the International Energy Agency (2016). Agriculture & forestry-related emissions are also reported from Food and Agriculture Organisation (2014-2017) and Global Forest Watch. (2015-2017). Full references are provided as a supplementary appendix.

As a result of the use of standardised methodologies and data sources across the 25 countries included in this AfDB Climate Change Profile, statistics and estimates reported herein may differ from other publicly available datasets or national estimates. Readers are advised to always check for updated publications and newly released national datasets.

This AfDB Climate Change Profile series is intended to provide a brief touch-stone reference for climate change practitioners, project managers and researchers working in African countries. The figures and estimates provided herein are intended to inform the reader of the main climate-related challenges and priorities, however these should be used to inform a process of additional research and in-country consultations. The University of Cape Town, the African Development Bank and its Boards of Directors do not guarantee the accuracy of figures and statements included in this work and accept no responsibility for any consequences of its use.

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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 Ethiopia. Long term (1979 to 2015) 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 four climate regions across Ethiopia. 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 Western Highlands region has clear inter-annual (1100mm in some years to 1900mm in other years) and moderate decadal variability (1400mm in some decades to 1600mm in other decades). Long term trends are statistically significant over three of the four regions and for the Western Highlands the change is around -150mm over the 30-year period.

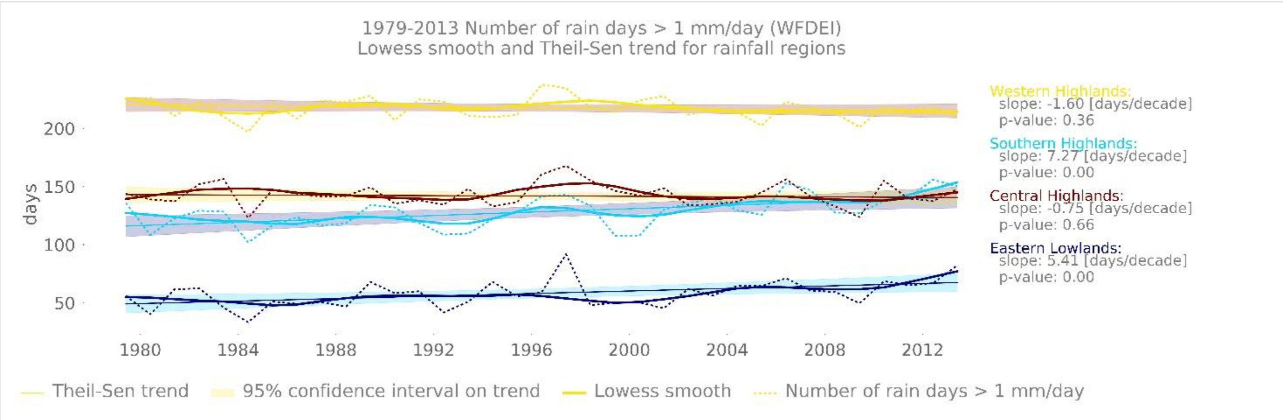

Figure A-1: Long term trends and variability in total annual rainfall for rainfall regions

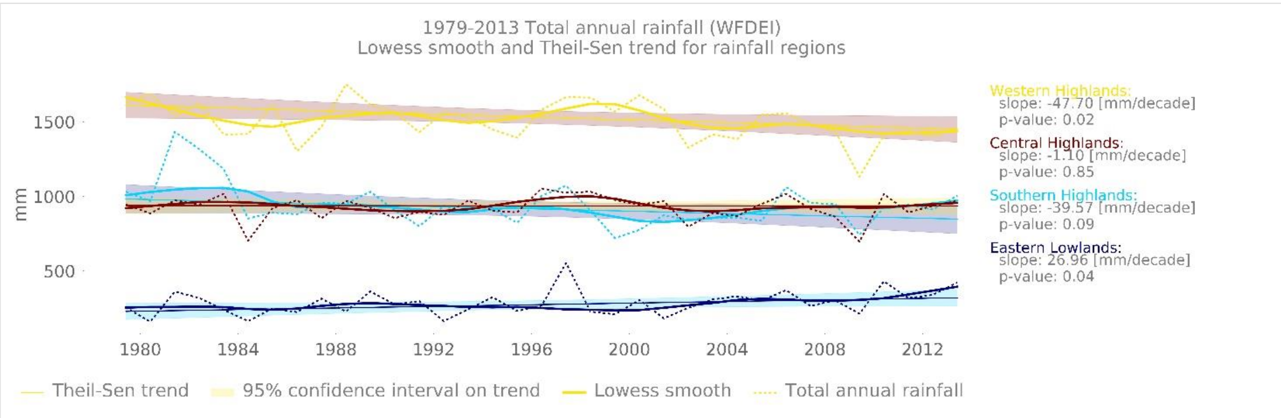

Figure A-2: Long term trends and variability in frequency of rainfall events for rainfall regions

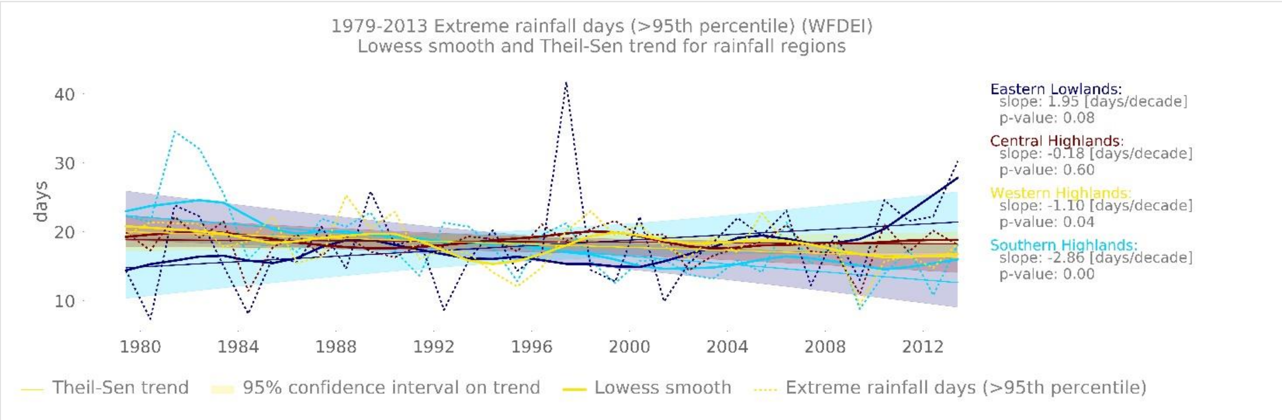

Figure A-3: Long term trends and variability in extreme rainfall events for rainfall regions

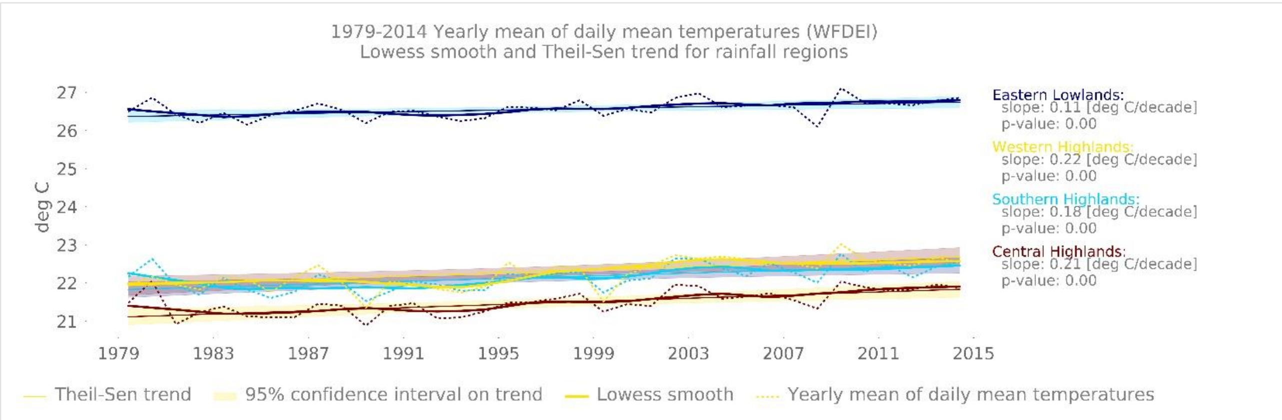

Figure A-4: Long term trends and variability in daily mean air temperatures for rainfall regions

1.c Climate projections visualizations

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

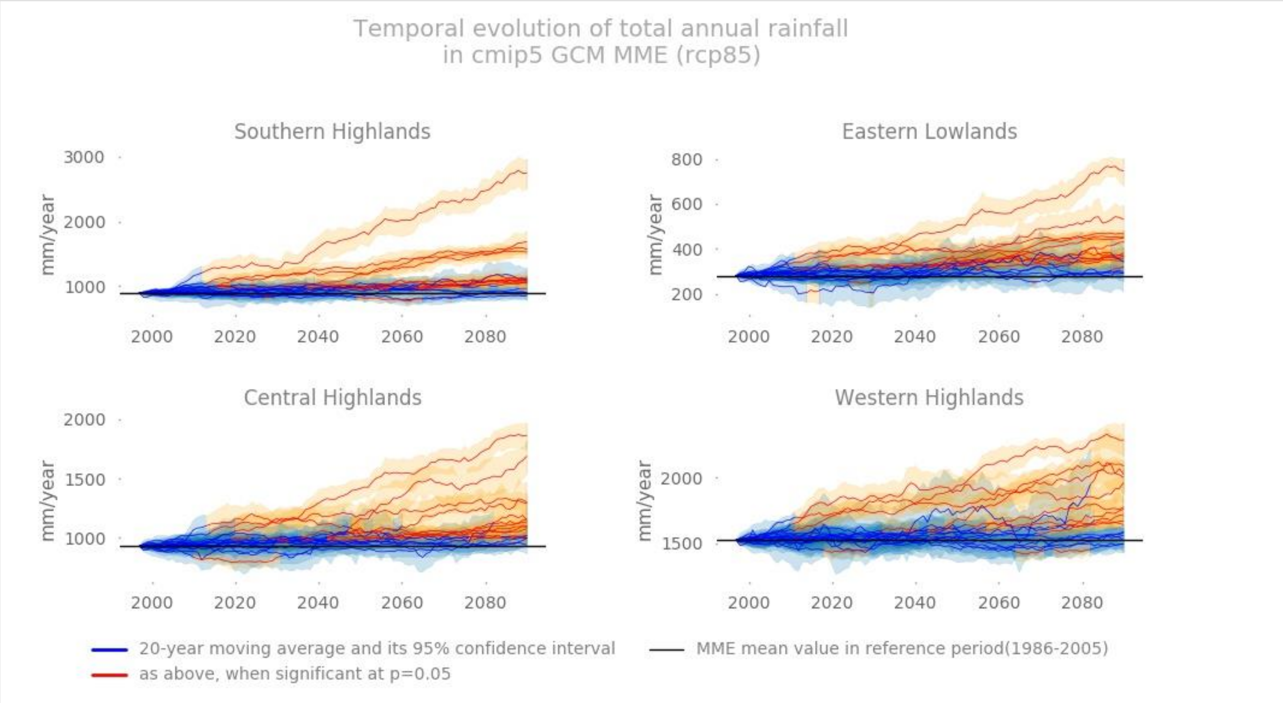

Figure A-5: Projected changes and emergence of changes in total annual rainfall

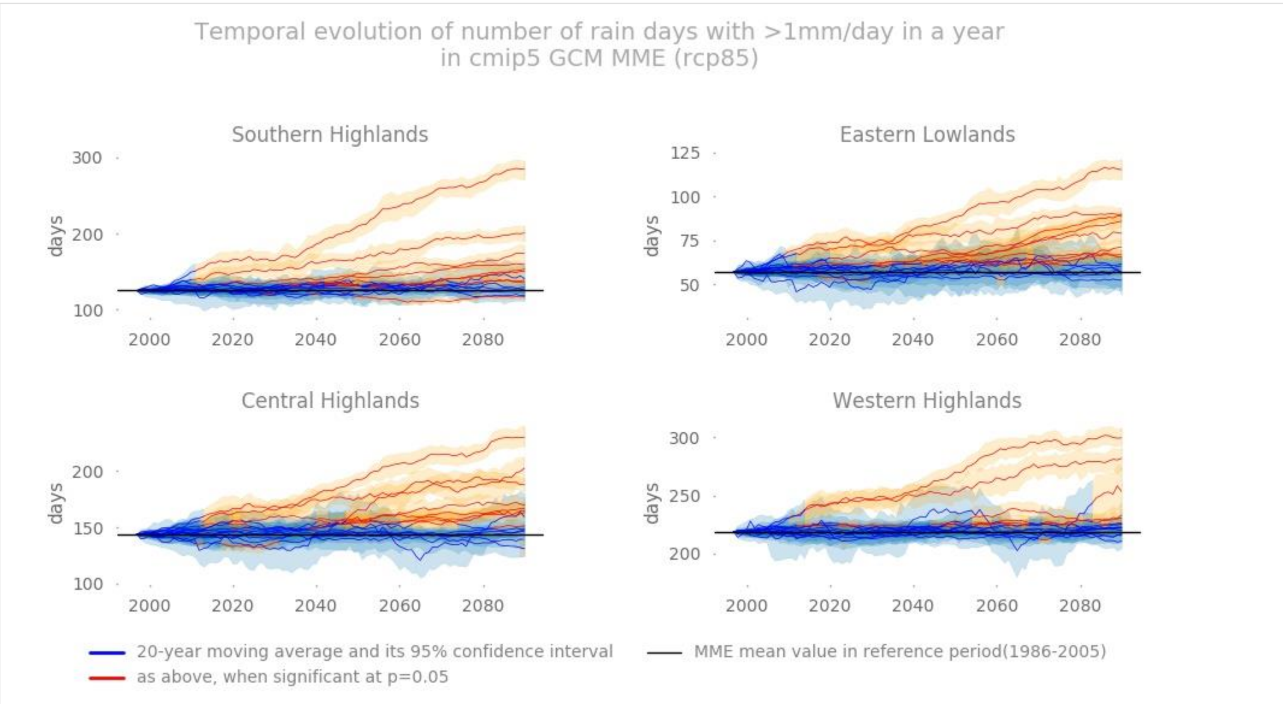

Figure A-6: Projected changes and emergence of changes in number of rain days per year

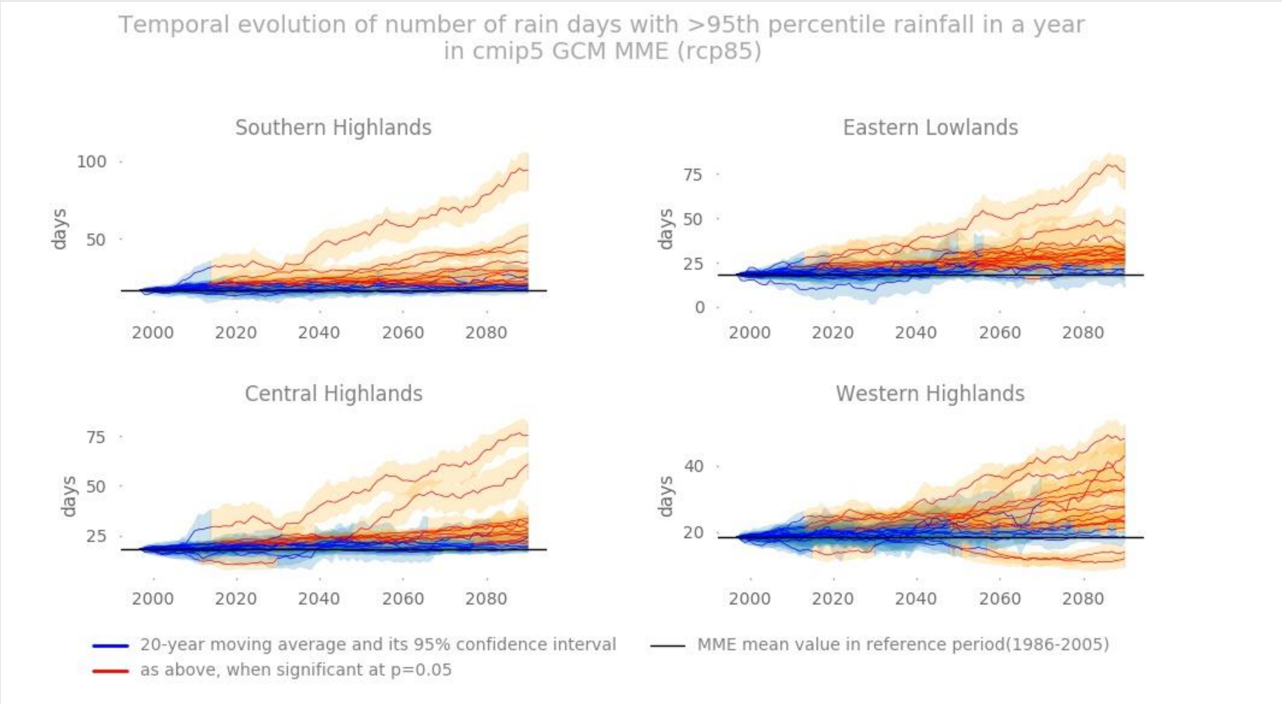

Figure A-7: Projected changes and emergence of changes in number of very heavy rainfall days (greater than 95th percentile) per year

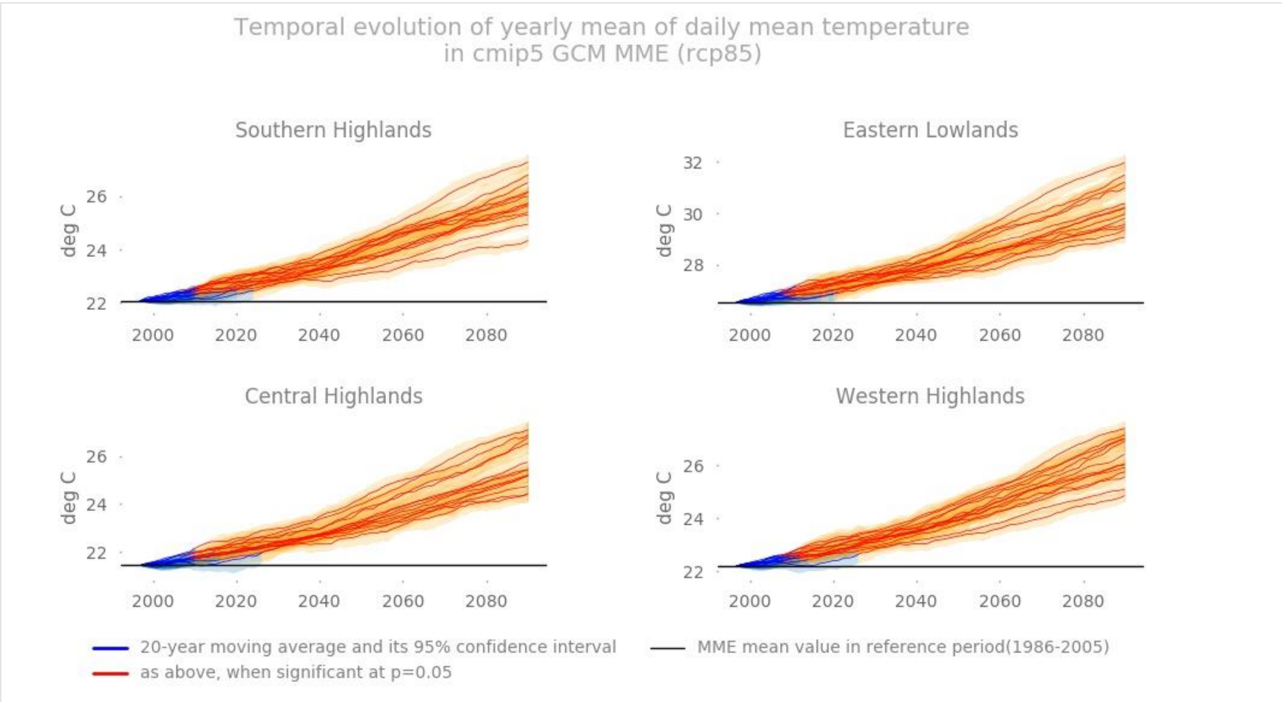

Figure A-8: Projected changes and emergence of changes in annual mean daily mean temperatures

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