MOROCCO

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.

Morocco 2018

MOROCCO

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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

Morocco (shown below in Figure 1-1) is a sovereign country located in the Maghreb region of North Africa. The country has a rugged, mountainous landscape with vast deserts and a lengthy coastline along the Atlantic and Mediterranean Oceans. Morocco has a Mediterranean climate and the country ranges from having forests in the northern regions to deserts in the south. Morocco has a population of ~35,200,000 people and a slow population growth rate of ~1.2% p/a. More than half the population is urban (~59%), of which a low percentage live in slums (~13%) relative to other African countries. Morocco is the 5th wealthiest African country in terms of total GDP. Consequently only a small percentage of Morocco's population live below the poverty line of USD 1.9 per day (~3.1%).

Morocco has the 11th highest human development index in Africa (0.65) and a large percentage of the population have access to electricity (~91.6%). The country's GINI coefficient is 40.7 and the gender inequality index is 52.5 indicating a disparity in wellbeing, income and access to opportunity between different social and gender groups. The ND-GAIN index for Morocco is 52.6, the 5th highest in Africa. This index summarizes the country's vulnerability to climate change and other global challenges in combination with its readiness to improve resilience. Morocco's score indicates that climate change-related hazards exist, however the country is relatively well positioned to adapt. Key socio-economic and demographic indicators are further presented and summarised in Table 1-1, below.

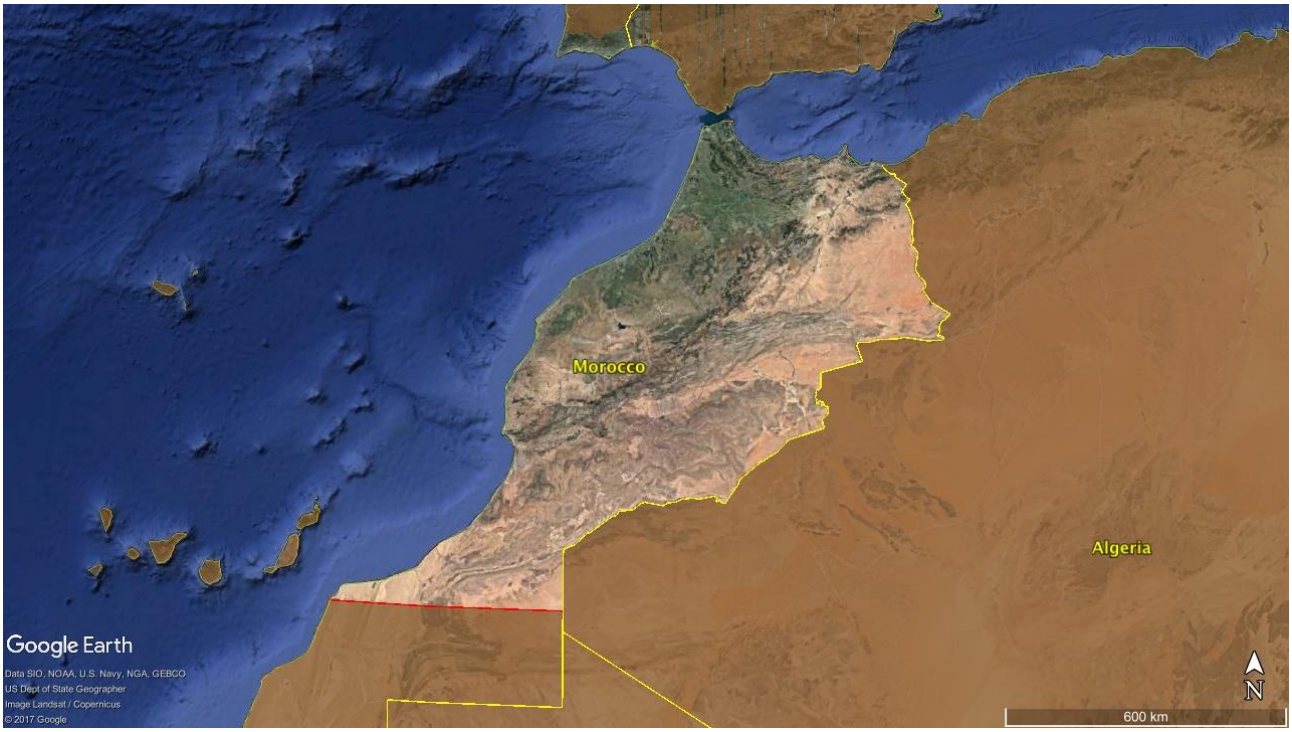


Figure 1-1: Map of Morocco

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

VARIABLE		SCORE/TOTAL	UNIT	RANK (OUT OF 54)
Geography, Socio-Economy and Demographics				
Population[1]		35,241,418	people	11
Population growth rate[1]		1.2	% population .yr-1	50
Population density[1]		79	People/km2	20
Land area[1]		446,094	km^2	25
% Urban population[1]		59.2	% population	11
% Urbanisation rate[2]		2.2	% population $.yr^{-1}$	45
Economy: total GDP[2]		101.4	USD billions $.yr^{-1}$	5
Economy: GDP by PPP[2]		281	billion international dollars $.yr^{-1}$	5
Economy: GDP/capita[2]		2,832	USD per capita/yr	13
Population below the poverty line[3]		3.1	% below USD 1.90 per day	45
Gender Inequality Index[4]		52.5		29
GINI co-efficient[3]		40.7		33
HDI[5]		0.65		11
Access to electricity[6]		91.6	% population	7
Summary indicators of climate change vulnerability				
Workforce in agriculture[6]		37.2	% workforce	26
Population undernourished[7]		5.0	% population	36
Number of people affected by drought[8]		275,000	people	29
Number of people affected by flood events[8]		194,896	people	30
Population living within 100 km of coast[9]		21,356,029	people	4
Population living in informal settlements [5]		13.1	% urban population	45
ND-Gain Vulnerability Index[10]	Total	52.6		5
	Readiness	0.45		9
	Vulnerability	0.39		51

2. CLIMATE AND WEATHER

Morocco's climate is Mediterranean in the north and arid in the interior and to the south. Rainfall is highest over the northern parts, and especially over Tangier-Tetouan-Al Hoceima prefecture, but very dry along the Algeria border and over Western Sahara. Maximum rainfall generally occurs during boreal winter with a distinct dry season during summer.

The water region or river catchments of Morocco and Western Sahara show clear climate variation. Therefore three sub-regions are distinguished here, namely the 'warm Mediterranean', 'cool Mediterranean' and the large 'Arid Interior' region. The Morocco regions are illustrated in **Figures 2-1** and **2-2**, below, and summary descriptions can be found in **Table 2-1** below.

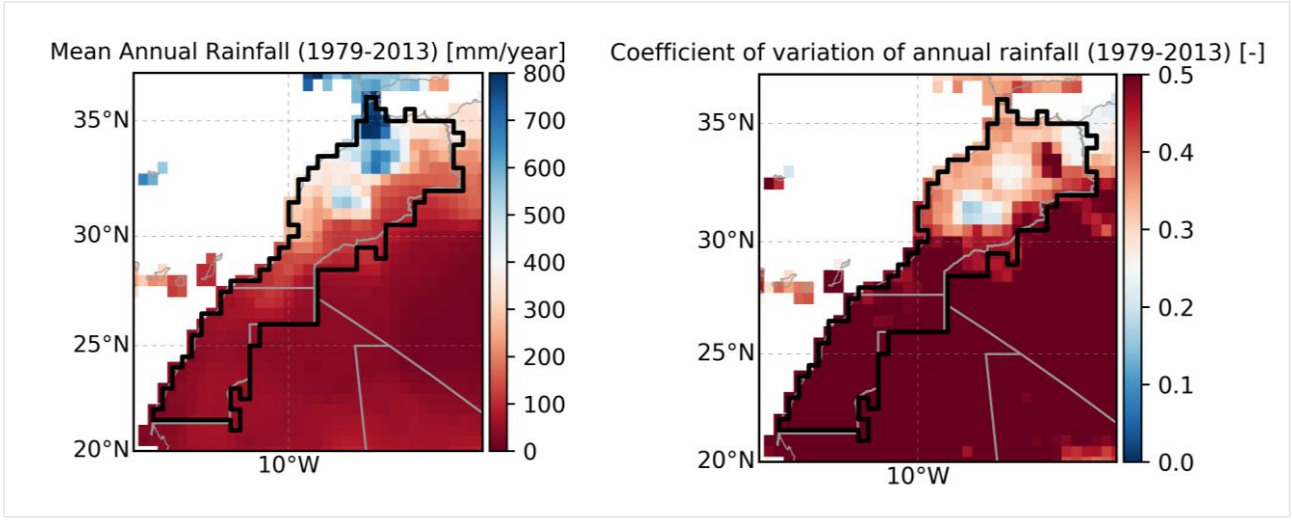
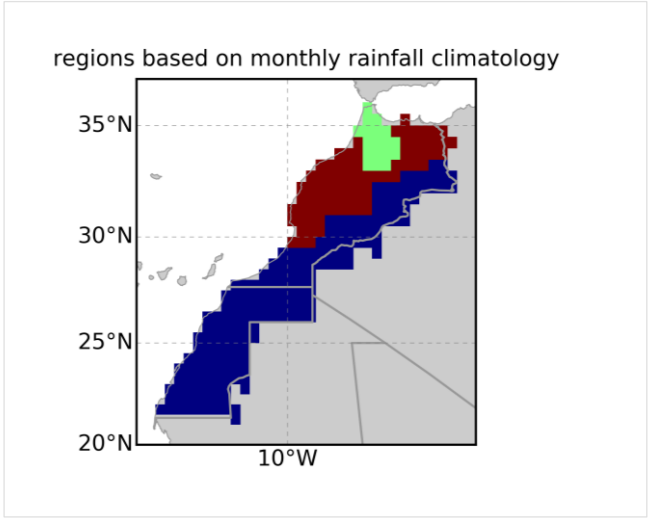


Figure 2-1: Main characteristics (magnitude and variability) of rainfall in Morocco and its region



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

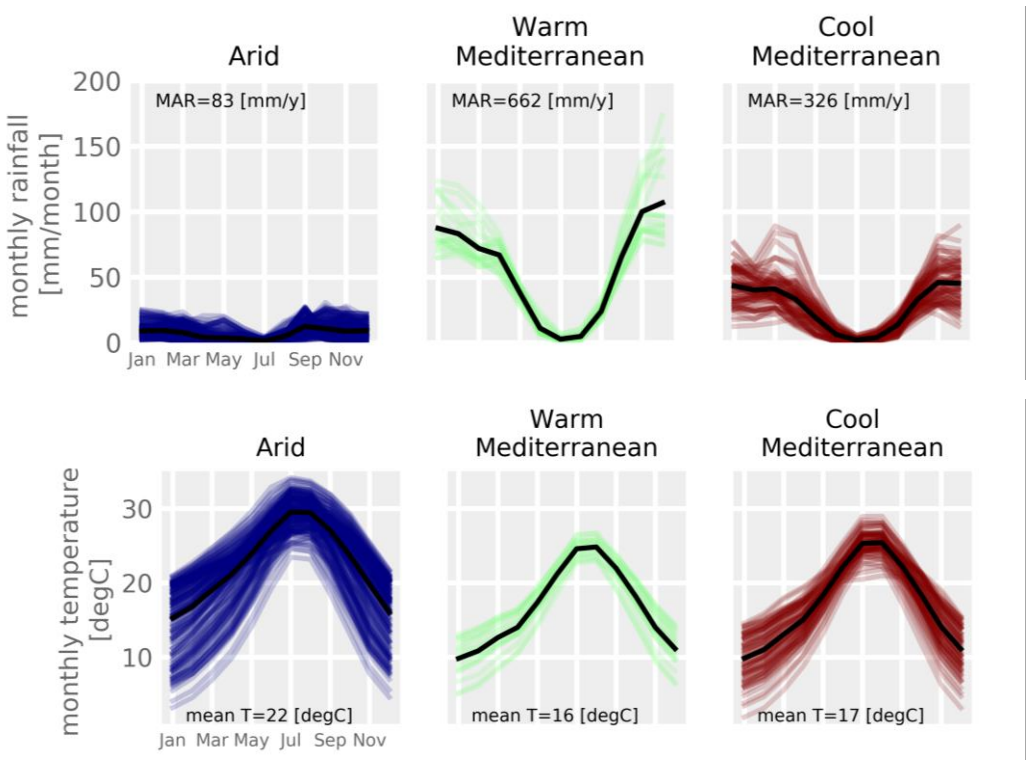


Figure 1-2: Rainfall regions of Morocco based on similarity of standardised rainfall climatology, and their rainfall and temperature climatologies

Table 2-1: Main characteristics of rainfall of Morocco regions

WARM MEDITERRANEAN	A warm Mediterranean climate with mean annual total rainfall of 660 mm/year which experiences moderate rainfall variability from year to year. Rainfall occurs during boreal winter from November to April peaking at just over 100 mm/month during December, though the range varies spatially from 70 to 170 mm/month. A short dry season occurs during summer from June to August. Daily mean temperature averages 16° C and there is a clear seasonal cycle of roughly 15° C between boreal summer and winter.
COOL MEDITERRANEAN	A cool Mediterranean climate with mean annual total rainfall of 330 mm/year which experiences moderate rainfall variability from year to year and relatively strong spatial differences. Rainfall occurs during boreal winter peaking just below 50 mm/month from November to March with a dry summer season from June – August. Daily mean temperature averages 17° C and there is a clear seasonal cycle of roughly 16° C between boreal summer and winter.
ARID	An arid climate with mean annual total rainfall of only 80 mm/year which experiences high rainfall variability from year to year especially over the southern half of the region. Rainfall values are generally low (less than 20mm/month) throughout the year, though even drier during July. Daily mean temperature averages 22° C and there is a clear seasonal cycle of roughly 15° C between boreal summer and winter.

2.1 Observed historical climate variations and climate change trends

The majority of Morocco experiences high rainfall variability on an inter-annual basis, with the exception of the northern parts where the variability is more moderate. On decadal time scales Morocco also experiences little variability. 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 region show increasing temperatures over the period 1979 – 2015, all of which are statistically significant. Stronger warming has occurred over the Cool Mediterranean and especially over the Arid region with weaker warming over the Warm Mediterranean region. Long term trends in total annual rainfall are generally upward, but not statistically significant. Trends in the frequency of rainfall events and extreme rain events are either not evident or are positive, but not statistically significant. Long term trends and variability in the Morocco 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 Morocco (1979 - 2015)

REGION	MEAN T [DEG C/DECADE]	TOTAL RAINFALL [MM/DECADE]	EXTREME RAINY DAYS [DAYS/DECADE]	RAINY DAYS [DAYS/DECADE]
Warm Mediterranean	+0.17	+30.1	+1.2	none evident
Cool Mediterranean	+0.26	+15.1	+0.9	Slight upward
Arid	+0.35	upward	upward	+1.2

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

Projected changes in main attributes of climate for the Morocco 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 Morocco regions show clear patterns of **potential decreasing rainfall** emerging from about the 2040s. That pattern appears to be consistent across the CMIP5 model ensemble. Relative magnitudes of potential decreased rainfall equates to 40% to 45% from the baseline normal. The **decreases in rainfall** seem to be strongly associated with **decreases in the rainfall events rather than in the frequency of high intensity rainy days**. It must be noted that these results are derived from GCM projections which may not accurately represent changes in extreme rainfall dynamics.

2.2.2 Projected changes in temperature from present to 2100

Air temperature is projected to be about 1 to 3°C warmer in the Morocco regions by the 2050s. By 2100 the range of projected temperatures is greater with increases of 3°C to 7°C.

Table 2-3: Summary of projected climate changes across regions of Morocco 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]
Warm Mediterranean	**Increasing** +1°C to +3°C by 2050s but changes evident in next decades	**Decreasing,** ranging from no change to a decreasing by 2050, but generally decreasing by up to 45% by 2100	**Normal to decreasing,** ranging from no change to clear decreasing frequency of up to 60% by 2100	**Decreasing,** ranging from no change to a decreasing by 2050, but generally decreasing by up to 50% by 2100
Cool Mediterranean	**Increasing** +1.5°C to +3°C by 2050s but changes evident in next decades	**Decreasing,** ranging from no change to a decreasing by 2050, but generally decreasing by up to 40% by 2100	**Normal to decreasing,** ranging from no change to clear decreasing frequency of up to 40% by 2100	**Decreasing,** ranging from no change to a decreasing by 2050, but generally decreasing by up to 50% by 2100
Arid	**Increasing** +1.5°C to +2.5°C by 2050s but changes evident in next decades	**Normal to decreasing,** ranging from no change to clear decreasing frequency of up to 40% by 2100	No consistent signal in projections	**Decreasing,** ranging from no change to a decreasing by 2050, but generally decreasing by up to 50% by 2100

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 largely urban Morocco, characterised by its lengthy coastline, vast deserts and rugged mountainous interior, increasing temperatures and indications of decreasing annual rainfall into the future is of great concern given that water resources are already characterised by both spatial and temporal scarcity and irregularity. Morocco's ill-developed irrigated agriculture system is the country's main water user, and the tension between increased demand in response to increasing temperatures and possible decrease in supply will hold implications for the economy and for the third of the population that the sector employs. Service sectors and industries are further key to the Moroccan economy, with tourism being an important and growing sector which could be prone to impacts of increasing temperatures and, in coastal areas, sea-level rise and associated stresses. The big proportion of the population living in coastal areas, around one third is of further concern, with coastal human settlements and associated developments and activities vulnerable to sea-level rise and associated stresses

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

SECTOR	IMPACTS
Agriculture	- Crop loss and reduced yields, especially for rainfed crops - Increased incidence of pests and diseases, particularly the Hessian fly - Shortened growing season, especially for rainfed crops - Decreased water availability for irrigated crops - Desertification and loss of agricultural and grazing land
Fisheries	- Loss of habitat and spawning grounds - Changed fish migratory patterns owing to changes in upwelling and ocean circulation patterns - Loss of livelihoods for coastal populations - Increased potential for toxic algae blooms caused by warmer Mediterranean waters - Increased ocean acidification reduces productivity of crusteans and corals
Water resources	- Increased water scarcity, especially in the south, owing to reduced stream flows and surface water availability - Shifts in seasonal water availability, owing to factors such as earlier seasonal melt - Increased demand on water resources, particularly ground water - Increased demand for irrigation water - Increased salinization of coastal aquifers
Built infrastructure and human settlements	- Damage to and destruction of coastal infrastructure owing to sea level rise and increased coastal erosion - Potentially increased damage to infrastructure due to increased inland flooding - Potentially increased migration from rural to urban areas
Human health	- Increased loss of life owing to increased flooding - Increased incidence of some vector-borne diseases, such as dengue fever - Increased potential for water-borne diseases, especially diarrhea - Increased potential for malnutrition and stunting, especially during drought

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

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

3.1 National energy production and consumption

Morocco has a relatively small capacity for energy production, where total national energy production contributes only 1.8 MTOE to a total national energy consumption of 14.6 MTOE (or, ~1/8th of total demand), and thus the country depends on imports for over 80% of national energy needs. Of the small proportion of national energy production, the majority is supplied by biofuels (~78%) for domestic cooking and heating. Other sources of national energy production are hydroelectricity (~8%), gas (~5%), non-hydro renewables (~9%), and oil (~0.3%). At present, Morocco's electricity is mainly produced from coal (~55%), followed by gas (~19%), oil (~13%) and then renewables (~12%); the total annual generation is ~2.5 MTOE of electricity. Oil, imported from Saudi Arabia, Iraq and Russia, accounts for the majority of energy consumption (~73%). Electricity (~17%), biofuels (~9%) and gas (~1%) make up the remaining proportion of energy consumption. The sectors that account for the largest proportion of energy consumption are transport (~35%), residential (~25%) and industry (~21%). These are followed by commercial and public services (~9%), agriculture (~7%) and forestry, and non-energy use (~3%). 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 Morocco's energy sector, including national electricity production, primary energy supply and national energy consumption by fuel carrier.

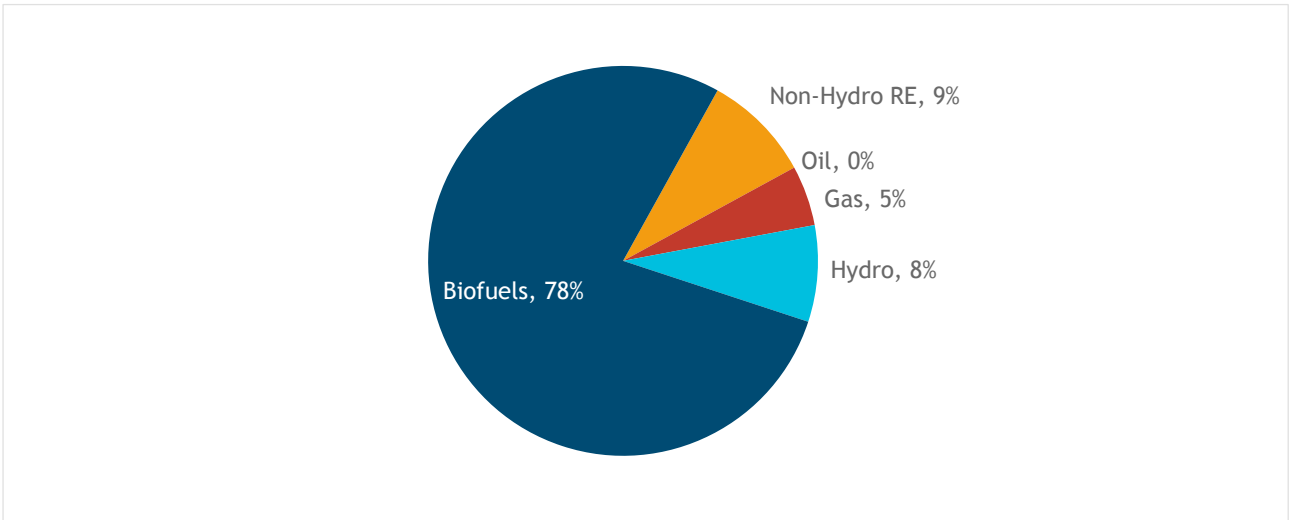


Figure 3-1: Distribution of Morocco's national energy production between major energy carriers (2014-2016)

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

NATIONAL ENERGY PRODUCTION			
Source		**Total (MTOE)[1]**	**% total energy production**
Oil [11]		0.01	0.3
Gas [11]		0.1	4.8
Hydro [11]		0.1	8.0
Biofuels [11]		1.4	77.6
Non-Hydro RE [11]		0.2	9.4
Total national energy production		**1.8**	
Electricity	Hydro		5.7
	Non-Hydro renewable		6.7
	Coal		55.0
	Oil		13.1
	Gas		19.5

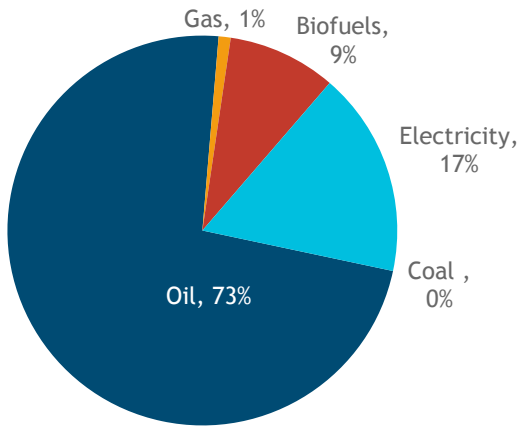


Figure 1-2: Distribution of Morocco's national energy consumption by major energy carriers

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

CONSUMPTION BY ENERGY SOURCE [11]	
Source	**Total (MTOE)**
Coal	0.02
Oil	10.6
Gas	0.1
Biofuels	1.4
Electricity	2.5
Total national energy consumption by source	14.6

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

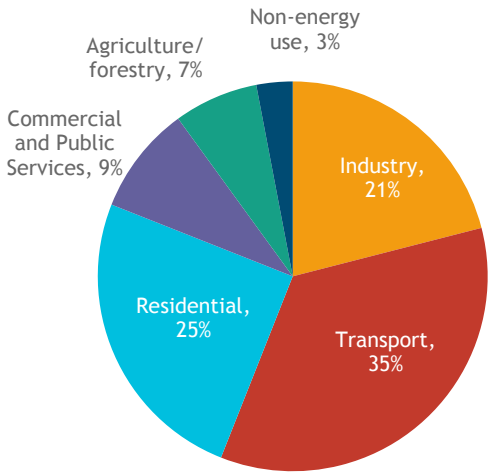


Figure 1-3: Distribution of Morocco's national energy consumption by sector (estimated for 2014-2016)

Table 3-3: Morocco's national energy consumption by sector (estimated for 2014-2016)

CONSUMPTION BY SECTOR [11]	
Sector	**Total (MTOE)**
Industry	3.1
Transport	5.0
Residential	3.7
Commercial and public services	1.3
Agriculture / forestry	1.0
Non-energy use	0.4
Total national energy consumption by sector	14.6

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

SOURCE		TOTAL (MTOE)
Coal		4.0
Oil	Crude Oil	6.6
	Oil Products	5.1
Gas		1.0
Hydro		0.1
Biofuels		1.4
New RE		0.2
Electricity		0.52
Total primary energy supply		19.0

3.2 National greenhouse gas emissions by source and sector

In Morocco, the sector that accounts for the largest proportion of national GHG emissions is the energy sector (~69%). The fuel sources that contribute to emissions are coal (~12 MT CO2e), oil (~36 MT CO2e) and gas (~2 MT CO2e). Within the energy sector, electricity and heat (~24%), and transport (~19%) contribute the most to GHG emissions. These are followed by other fuel combustion within the energy sector (~14%), as well as manufacturing and construction (~9%). Other sectors contributing to emissions are agriculture (~18%), industrial processes (~10%) and waste (~5%). Notably, the land use change sector has negative emissions (-1.5 MT CO2e), meaning that the sector is a net carbon sink.

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 Morocco'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: Morocco'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		11.8
Oil		36.2
Gas		2.3
Total fuel source emissions		50.3
Electricity and heat production		17.9
Other energy industry own use*		1.2
Manufacturing industries and construction		7.6
Transport	Road	15.1
	Other	0.03
	Total	15.1
Other	Residential	3.9
	Non-residential	4.6
	Total	8.5
Total sector emissions		50.3

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

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

Table 3-6: Morocco'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	19.1
	Manufacturing and construction	7.6
	Transport	15.1
	Other fuel combustion	10.9
	Fugitive emissions	0.9
	Energy sub-total	53.5
Industrial processes		7.7
Agriculture		14.0
Waste		3.7
Land use change and forestry (LUCF)		-1.5
Total emissions (including LUCF)		77.4

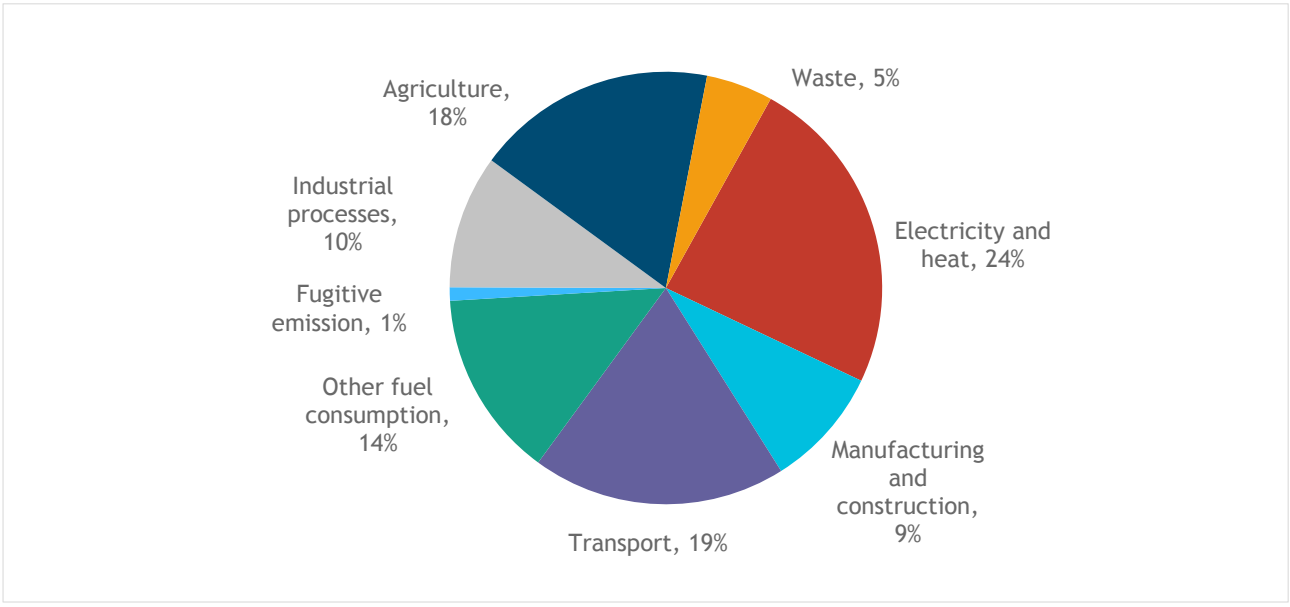


Figure 1-4: Distribution of Morocco's GHG emissions by major sectors (excluding LUCF which has negative emissions)

3.2.2 GHG emissions from agricultural practices

Table 3-7, below, summarises GHG emissions from Morocco's agriculture and land use change sectors (derived from Food and Agriculture Organisation statistics). Although there are multiple agricultural practices that contribute to GHG emissions, in the case of Morocco, the livestock production sector is by far the largest contributor. In particular, enteric fermentation and manures left on pasture contribute to over 79% of total GHG emissions from the sector. With respect to emissions and GHG sequestration from land use change and Morocco's woodlands and forests, the net GHG emission from this sector is ~ - 1.5 MT CO2e, where the negative value indicates that this sector is a net sink for GHGs (capturing more carbon than is emitted, on balance). This contribution of wooded vegetation to GHG sequestration in Morocco can be attributed to the estimated ~1 million hectares of remaining forest and woodlands (in total 1.08 million km2 or ~2.4% of total land area), of which almost half is classified as 50-100% cover forest. The majority of these wooded vegetation areas are likely to be Mediterranean Conifer and Mixed Forests growing on high elevations in the Tellien Atlas, Middle Atlas, and Rif mountain ranges.

Table 1-7: National annual greenhouse gas emissions from agricultural practices, forestry and other land use in Morocco (estimated for 2014-2016)

VARIABLE		ANNUAL EMISSIONS (MT CO_2E)
Annual GHG emission from agricultural practices [14]	Burning - crop residues	0.1
	Burning - savanna	0.0
	Crop residues	0.6
	Cultivation of organic soils	0.0
	Enteric fermentation	5.7
	Manure management	0.4
	Manure applied to soils	0.2
	Manure left on pasture	5.1
	Rice cultivation	0.0
	Synthetic fertilizers	1.5
	Sub-total (Agricultural practices)	13.6
Annual GHG emission from land use change [14]	Grassland	0.0
	Cropland	0.0
	Forest land	-1.5
	Burning biomass	0.0
	Sub-total (Land use change)	-1.5
Total emissions		12.2

Table 3-8, overleaf, summarises the recent historical changes in land use in Morocco 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. The Food and Agriculture Organisation reports the total aboveground carbon stock of Morocco's forest biomass

as ~240.6 million tonnes.

Table 1-8: Vegetation cover and land use change in Morocco (estimated for 2015)

VARIABLE		TOTAL (HECTARES)	TOTAL (% OF LAND AREA)	UNIT
Total tree cover [15]	10-30% canopy cover	461,144	1.03	% of total land area
	30-50% canopy cover	204,012	0.5	
	50-100% canopy cover	409,991	0.9	
	Total	1,075,147	2.4	
Land use change and agricultural expansion	Historical annual rate of deforestation [16] Cropland	10-30% canopy cover	0.0	% of previous year
		30-50% canopy cover	0.2	
		50-100% canopy cover	0.4	
	Area of agricultural land [17]	30,119,798	67.5	% of total land area
	Historical annual area converted to agricultural land [17]	116,103	0.4	% of previous year

4. SUMMARISED NATIONAL PRIORITIES FOR CLIMATE CHANGE ADAPTATION AND MITIGATION

Morocco'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 Morocco'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).

Morocco's commitment is to reduce its GHG emissions by 32% by 2030 compared to business as usual projected emissions. This commitment is contingent upon gaining access to new sources of finance and enhanced support, compared to that received over the past years, within the context of a new legally-binding agreement under the auspices of the UNFCCC. This target translates into a cumulative reduction of 401 Mt CO2eq over the period 2020-2030. Meeting this target will require an overall investment in the order of USD 45 billion, of which USD 35 billion is conditional upon international support through new climate finance mechanisms, such as the Green Climate Fund." Morocco's mitigation target is divided into a conditional and unconditional target: The unconditional target is a 13% reduction in GHG emissions by 2030 compared to a business as usual (BAU) scenario, while the conditional target is an additional 19% reduction achievable under certain conditions, which would bring the total GHG reduction to 32% below BAU emission levels by 2030. Note: Morocco reserves the right to revise said BAU scenario on the basis of new analysis by 2020.

Table 4-1, below, gives details on Morocco'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 Morocco'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
72.51	BAU	13 percent (unconditional); 32 percent (conditional)	2030	CO2, CH4, N2O; Energy, industrial, agriculture, LULUCF and waste	Does not exclude possibility of using market mechanisms to meet its NDC	Land-use included; accounting methodology not specified

4.1 National priorities for climate change mitigation

Morocco'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 Morocco'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.

Morocco's NDC identifies national priorities for mitigation of GHG emissions for the sectors of Energy, AFOLU and Waste. The mitigation priorities identified for Morocco's energy sector include reduced energy consumption, increased efficiency of generation and ambitious targets to increase the share of renewable energy in electricity production to 50% by 2025. In the AFOLU sector priorities are inter alia to promote and protect natural areas and resources and sustainable management, implement afforestation, and to finalise land demarcation and registry. In the waste sector, priorities are inter alia to improve household waste management and collection, establish landfills or recycling plants for household waste, close or rehabilitate illegal landfills and to train and raise awareness on waste issues.

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

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE[2]
Energy	Reaching over 50% of installed electricity production capacity from renewable sources by 2025	1, 6
	Reducing energy consumption by 15% by 2030	1
	Substantially reduce fossil fuel subsidies	1
	Substantially increase use of natural gas, through infrastructure projects allowing liquified natural gas imports	1
	Provide 42% of the installed electrical power from renewable sources	1, 6
	Reduce energy consumption in buildings, industry and transport by 12% by 2020 and 15% by 2030	2, 3, 7
AFOLU	Take into account the agricultural sector in all its sociological and territorial components by incorporating human development objectives as a key requirement	4, 5
	Improve the promotion of natural resources and their sustainable management	4, 5, 9
	Develop forestry and surrounding areas	4, 5, 9
	Finalize land demarcation and registry	4, 5
	Complete the suckering, renewal or afforestation of approximately 50, 000 hectares per year primarily focusing on natural species	4, 9
	Rehabilitate ecosystems and protect and promote natural areas as well as endangered species as resources	4, 9

[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.

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE
Waste	Mainstream household waste management master plans and standardize them for all regions and provinces	3, 5
	Improve the collection of household waste to achieve an urban collection rate of 90% by 2020 and 100% by 2030	3, 5
	Establish landfill and recycling centres for household waste for in all urban areas by 2020	3
	Rehabilitate or close all illegal landfills by 2020	3, 5
	Develop chains of 'sorting-recycling-recovery' with sorting pilot projects to achieve a 20% recycling rate by 2020	3, 5
	Train and raise awareness of stakeholders on waste issues	3, 5
	Reach an overall urban sewerage connection rate of 75% by 2016, 80% by 2020 and 100% by 2030	3, 5

4.2 National priorities for climate change adaptation

Morocco's major priorities for actions and investments related to climate change adaptation are summarised in Table 4-3, below, categorised according to sector. Morocco'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 Morocco'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.

Detailed adaptation actions and priorities for Morocco are identified for the AFOLU and Water sectors in addition to priorities focused on institutional-level actions. In the AFOLU sector, priorities involve ecosystem adaptation, restoration of ecosystems, reconstitution of forests, and conversion of grain crops to fruit plantations. Water sector priorities are detailed and involve better management of water systems and resources as well as construction of new dams and the implementation of desalination, among others. Priorities with institutional-level actions are to better understand current and future climate risks, to protect the population through risk-prevention management, to protect climate sensitive production systems, and to preserve ancestral good practices.

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

PRIORITY SECTOR	SECTOR-SPECIFIC ACTION	TECHNOLOGY TYPE[3]
Waste	Protection of natural heritage, biodiversity, forestry, and fishery resources, through an ecosystem-based adaptation approach	1, 4
	Restoring ecosystems and strengthening their resilience, to combat soil erosion and prevent flooding	1, 4
	Reconstitution of forests on 20, 000 ha	4, 5
	Conversion of nearly one million hectares of grain crops to fruit plantations that are likely to protect agricultural areas from all forms of erosion, especially water erosion	1, 2
Water	Improve integrated and appropriate water resources management and preservation methods	2, 4
	Substitution of water withdrawal (85 million m3/year) from over exploited aquifers by withdrawals from surface water	2, 4
	Increase the current area under drip irrigation from 154, 000 ha at present to 555, 000 ha	2, 4
	Desalination of 285 million m3/year of drinking water supply to several cities and centres	1, 2
	Reuse 325 million m3/year of treated wastewater	1, 2
	Construction of 38 new dams and development of an inventory and the treatment of all sites vulnerable to flooding	3, 6
	Connection to the sewerage system and wastewater treatment to reach 100 % of urban areas	1, 2, 3

[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 TYPE[4]
Institutional	Observation and research system to better understand current and future climate risks	3, 5, 6
	Protection of populations through risk-prevention management approach, particularly in the most vulnerable areas (coastal zones, mountainous areas, regions with a high propensity for desertification and oases)	1, 4
	Protection of climate-sensitive production systems, such as agriculture and tourism, as well as high-risk infrastructures	3, 4
	Preserve ancestral good practices in highly vulnerable sectors, such as water and agriculture	2, 7

[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

5. ASSUMPTIONS, GAPS IN INFORMATION AND DATA, DISCLAIMERS

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

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

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

Full references are provided as a supplementary appendix.

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

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

6. APPENDIX 1

1.a Supporting evidence

The climate projections detailed in Chapter 2 (above) are supported by rigorous analysis of observed and model projections data. More details of this analysis and supporting figures can be found below.

1.b Historical trends and variability analysis

The analysis of historical trends and variability of key climate variables is presented below. This analysis uses the WATCH Climate Forcing dataset which has been selected as the most broadly representative of station observations across Morocco. 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 three climate regions across Morocco. 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 Warm Mediterranean region has very high inter-annual (500mm in some years to 1300mm in other years) and moderate decadal variability (550mm in some decades to 750mm in other decades). Long term trends are not statistically significant but could be around 90mm over the 30 year period.

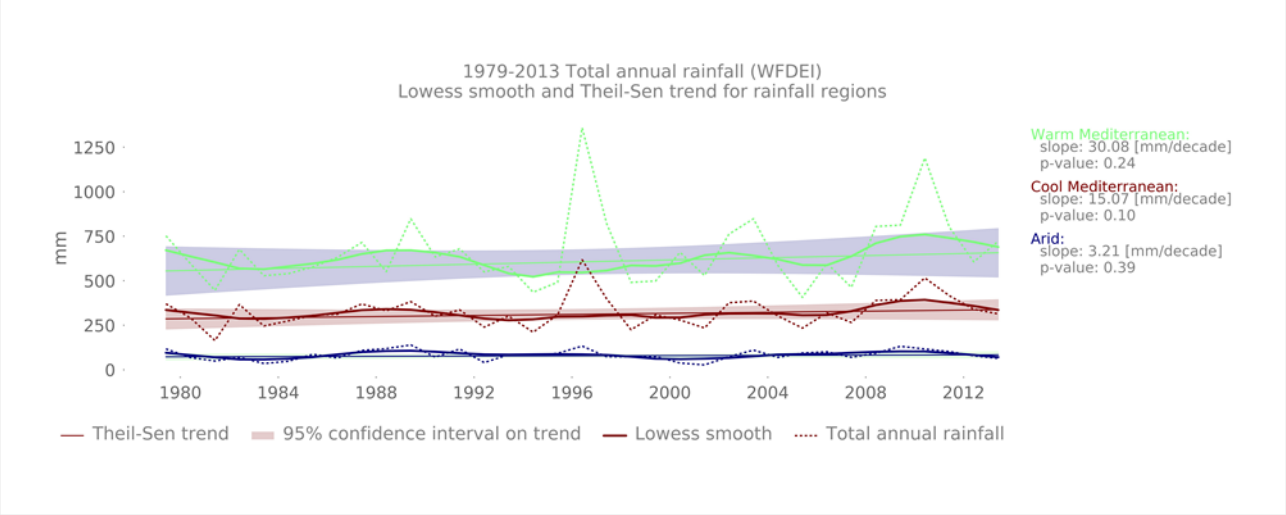


Figure A-1: Long term trends and variability in total annual rainfall for rainfall regions

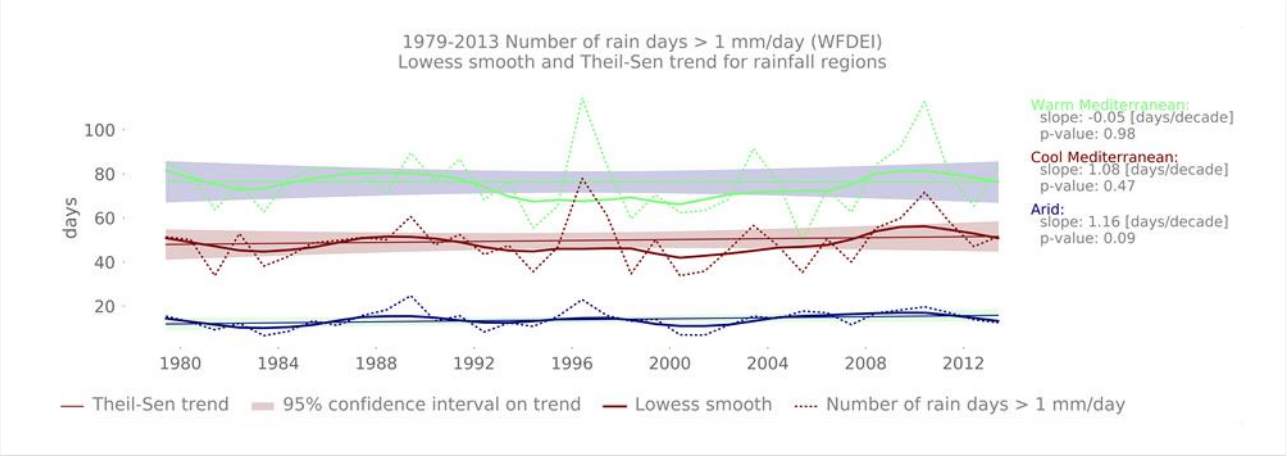


Figure A-2: Long term trends and variability in frequency of rainfall events for rainfall regions

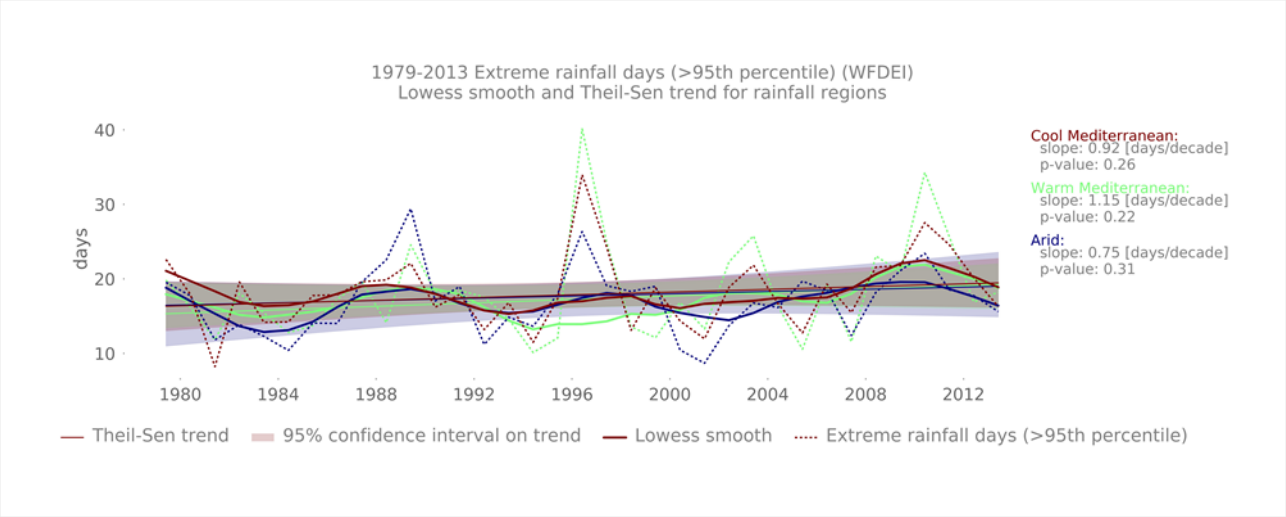


Figure A-3: Long term trends and variability in extreme rainfall events for rainfall regions

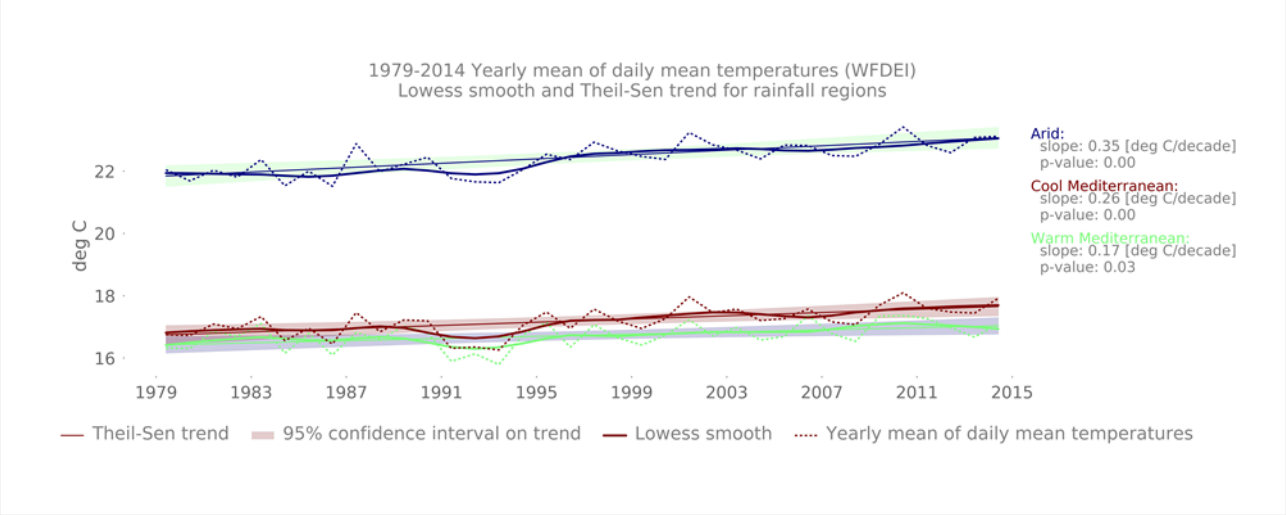


Figure A-4: Long term trends and variability in daily mean air temperatures for rainfall regions

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.

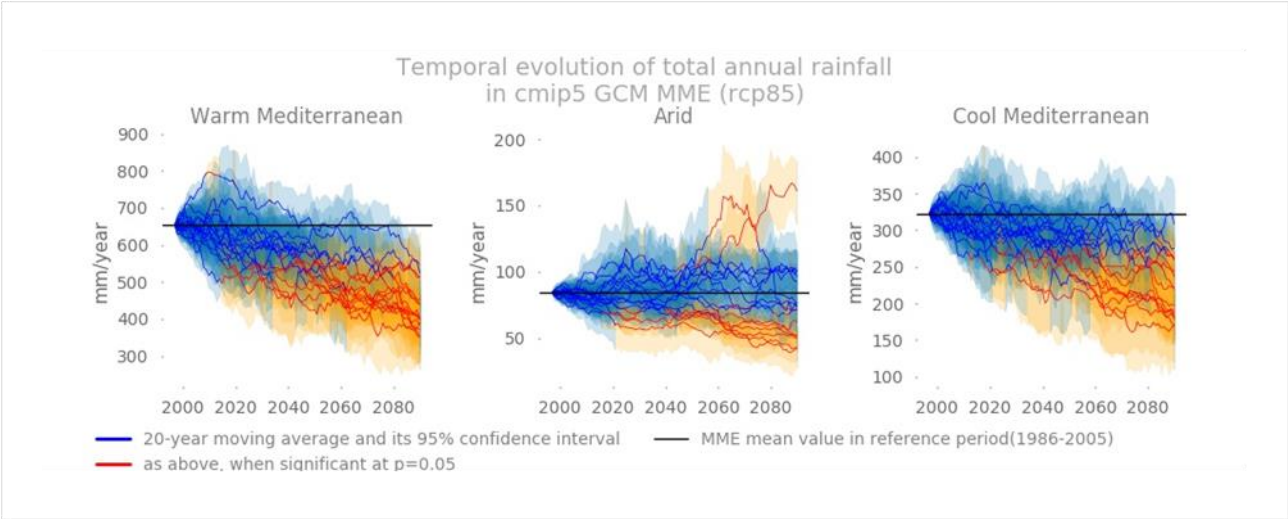


Figure A-5: Projected changes and emergence of changes in total annual rainfall

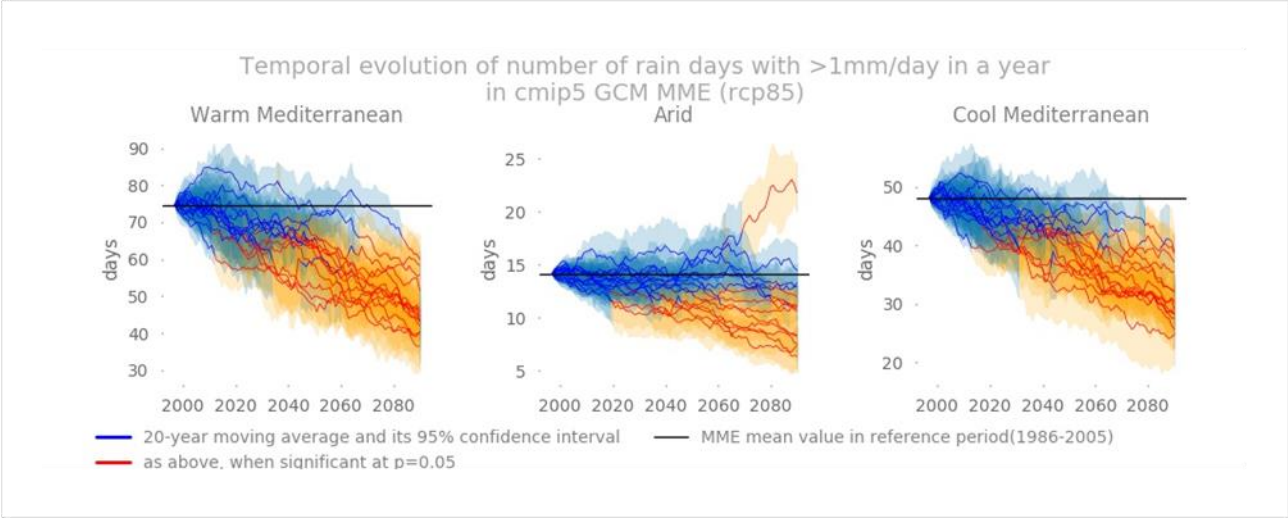


Figure A-6: Projected changes and emergence of changes in number of rain days per year

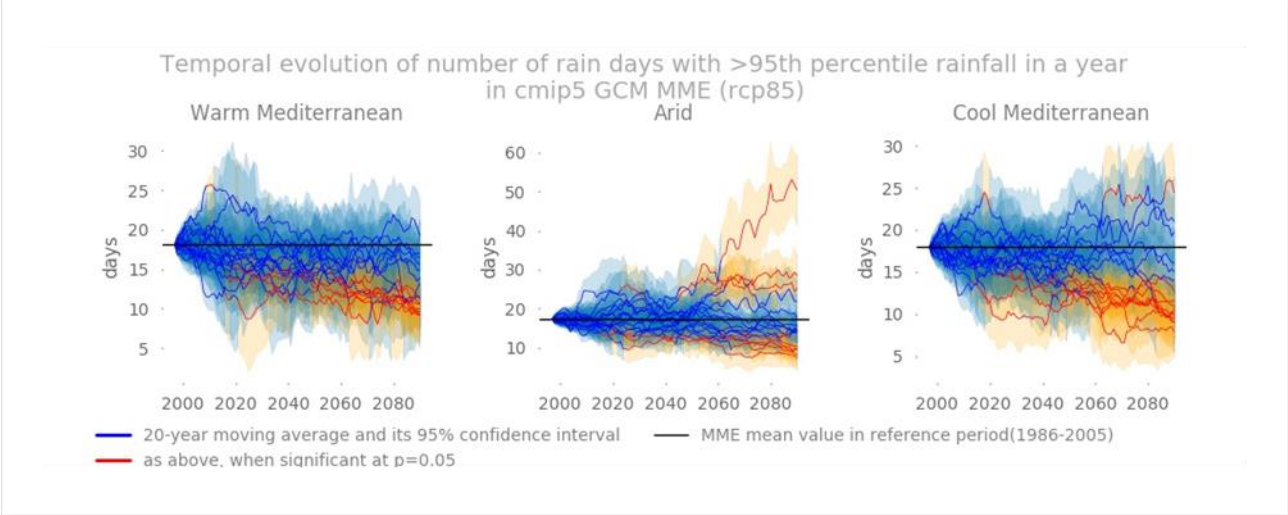


Figure A-7: Projected changes and emergence of changes in number of very heavy rainfall days (greater than 95th percentile)

per year

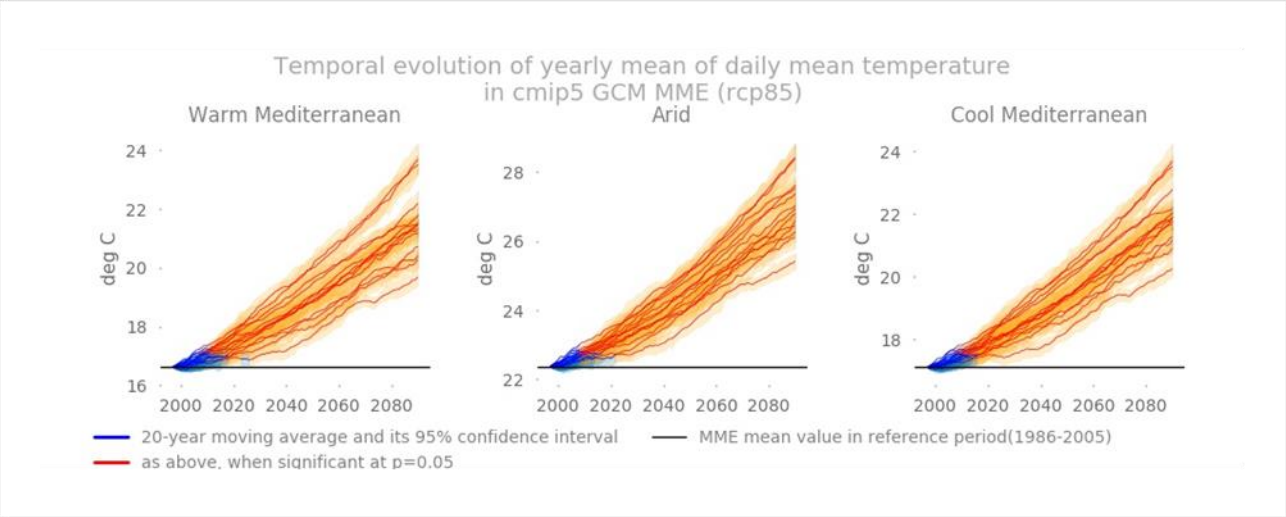


Figure A-8: Projected changes and emergence of changes in annual mean daily mean temperatures

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