



MOROCCO Climate Fact Sheet

Morocco Climate Fact Sheet

I- GENERAL CLIMATE OVERVIEW

Morocco's climate varies significantly across the country's northern to southern areas. Both temperature and rainfall are strongly influenced by the Atlantic Ocean to the west, the Mediterranean Sea to the north, and the Sahara Desert to the south and southeast (WB CCKP, 2021).

Mean annual temperature for Morocco is 18.05°C, with average monthly temperatures ranging between 9.4°C (December, January) and 26°C (July, August). Temperatures in the arid and semi-arid southern and southeastern parts of the country are generally high. In the summer, temperatures along the coast range from 18°C to 28°C and can reach up to 35°C in the interior. In the winter, temperatures along the coast range from 8°C to 17°C and can drop below 0°C in the interior mountain areas (USAID, 2016).

Mean annual precipitation is 301.6 mm, with highest rainfall occurring October to April, with extremely low precipitation occurring between June to August. Most of the country's rainfall occurs between October and May. Most of Morocco, particularly along the coast, experiences a typical Mediterranean climate, with mild, wet winters and hot, dry summers. The rainy season extends from November to March, with average annual rainfall of 1,200 millimeters (mm). The south is much drier and receives approximately 100 mm of rainfall on average each year (USAID, 2016).

II- CLIMATE CHANGE TRENDS

The ND-GAIN Country Index summarizes a country's vulnerability⁽¹⁾ to climate change and other global challenges in combination with its readiness⁽²⁾ to improve resilience. Morocco's ND-GAIN Index rank is 66. It is the 132nd most vulnerable country and the 87th most ready country. The low vulnerability score and high readiness score of Morocco places it in the lower-right quadrant of the ND-GAIN Matrix, which means that adaptation challenges still exist, but Morocco is well positioned to adapt (University of Notre Dame, 2023).

¹ Vulnerability measures a country's exposure, sensitivity, and ability to adapt to the negative impact of climate change. ND-GAIN measures the overall vulnerability by considering vulnerability in six life-supporting sectors – food, water, health, ecosystem service, human habitat, and infrastructure.

² Readiness measures a country's ability to leverage investments and convert them to adaptation actions. ND-GAIN measures overall readiness by considering three components – economic readiness, governance readiness and social readiness.

From Past to Present:



- **Temperature:** Morocco has experienced considerable warming trends since the 1960s, with mean annual temperature increasing 0.9°C since the 1960s, with observed average increases of 0.2°C per decade, exceeding the global average. Increases have been most pronounced in the April, May, June and September, October, November seasons. The hot and dry April, to June season has observed the most rapid rate of temperature increases at 0.34°C per decade. The frequency of days considered as 'hot' has significantly increased across all seasons. Hot nights have increased most notably by an additional 20% per month from September to November. The frequency of cold days and nights have also decreased significantly in all seasons, primarily in June, July, August (UNDP, 2012).



- **Rainfall:** Through the past several decades, observed trends have shown more erratic rainfall and an overall decline in precipitation. Seasonal rainfall patterns have shifted to longer and more intense rain events in October and November, but with substantial reductions in rainfall during the rest of the year (USAID, 2016).

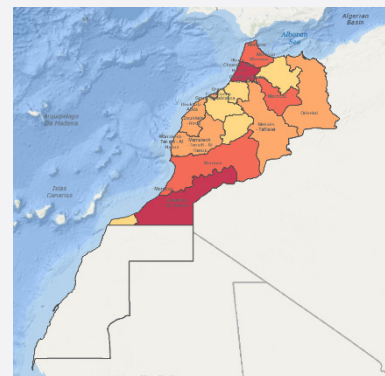
Projected:



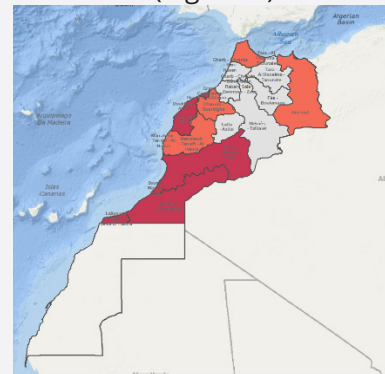
- **Temperature:** Mean annual temperature is projected to increase by 1.5°C to 3.5°C by mid-century and possibly by more than 5°C by end of the century. Warming rates are projected to be faster in the country's interior. Temperature rise are projected to increase across all emission scenarios throughout the end of the century. Under high-emission scenario(3), average temperatures are expected to increase rapidly by mid-century. The number of 'hot days' and 'nights' will also increase, with increase most significant in the July, August, September season. The number of 'cold days' and 'nights' are expected to occur on less than 4% of days and nights by end of the century (UNDP, 2012). An increase is also expected for the change in the number of very hot days where the maximum temperature is above 35°C (WB CCKP, 2021).



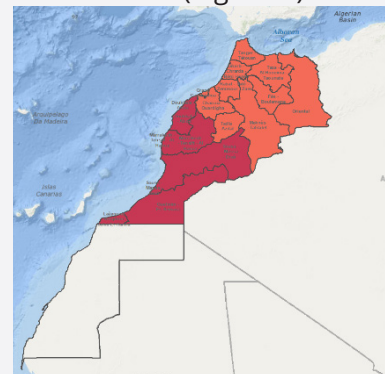
- **Rainfall:** Projections indicate significant reduction in average annual rainfall across the country from 10%–20% to as much as 30% decrease for the Saharan region by the 2090s (USAID, 2016).



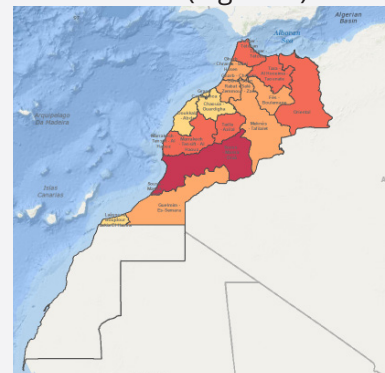
River flood (high risk)



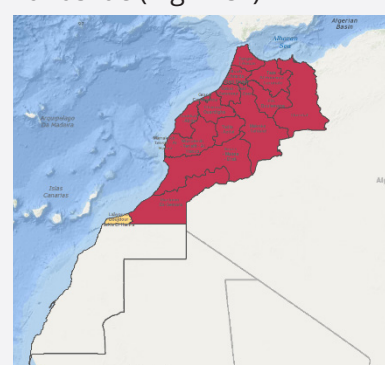
Coastal flood (high risk)



Extreme heat (high risk)



Landslide (high risk)



Wildfire (high risk)

III- CLIMATE CHANGE IMPACTS



a- Natural Hazards

One of the main impacts of the change in temperature and rainfall patterns is the occurrence of natural hazards. Figure 1 summarizes the risk level of natural hazards in Morocco. It shows that the country has a high risk of river and coastal floods, as well as landslides, extreme heat, and wildfires, that will increase due to climate change.

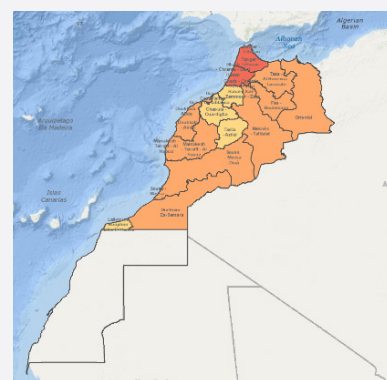
The main climate-related natural hazards that have occurred from 1900 till 2023 in Morocco are seen in table 1:

Table 1: Climate-related Natural Hazards (from 1900 till 2023) (EM-DAT, 2023)

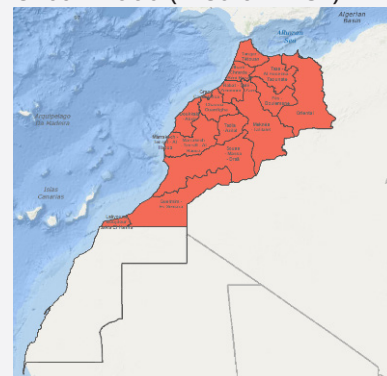
Disaster Type	Occurrence (1900-2023)
Flood	35 (of which 11 recorded riverine floods, 9 recorded flash floods)
Extreme temperature	6 (of which 5 recorded cold waves, 1 recorded heat wave)
Drought	5
Storm	4 (of which 2 recorded convective storms, 1 recorded tropical cyclone)
Landslide	2
	Total deaths: 1 796
	Total damages ('000 US\$): 2 714 676

A recent example of such disasters are the March 2021 flash floods caused by heavy rains which mainly affected the cities of Tetouan and Martil where at least 275 houses, several public buildings and roads have been damaged by floodwater (ReliefWeb, 2021).

Rising sea levels are causing high risks on the coastal zones of Morocco where 60% of the population reside and where most of the country's economic activities are located. In fact, an estimated 42% of the coastline will be at high risk of erosion and floods by 2030. Approximately 2/3 of Morocco's beaches are at risk of coastal erosion, and some of the cities that are already affected by it include Saidia and Tangier where erosion is already happening at the rate of 2 to 3 meters per year. A 0.86 m rise of sea level by 2100 could erase 99.9% of Tangier Bay's port infrastructure and 63% of the city's industrial zone. Flooding is also expected to affect the Nador Lagoon, the Moulouya River and its delta, and the coastal plains of Oued Nekkour and Oued Laou resulting in loss of habitat for



Urban flood (medium risk)



Water scarcity (medium risk)

Figure 1: Climate-Related Natural Hazards Risk Level (ThinkHazard, 2020)

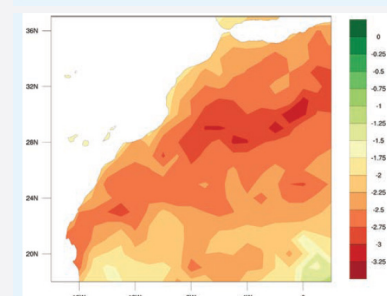
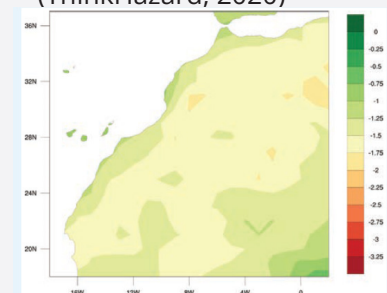


Figure 2: The Spatial Representation of SPEI for the Periods 2040-2059 (Top) and 2080-2099 (Bottom), Against the Baseline of 1986-2005 (WB CCKP, 2021)

coastal animals and marine life. Rising sea levels will in addition lead to salinization of coastal aquifers in the central and eastern Moroccan coast leading to water shortages (USAID, 2016).



b- Water

Rising temperatures are expected to reduce stream flows and overall water availability. Water shortages, particularly in the south, already started as early as 2020. The reductions in mountain snowpack will result in a shift in seasonal water availability and an increased likelihood of flooding in October and November, but with less water availability the rest of the year. This will result in increased demand for irrigation. On the other hand, increased frequency of intense rainfall events is expected to lead to an increased dependency on groundwater resources leading to overexploitation and hence insufficient recharge (USAID, 2016).

Figure 2 shows the spatial representation of the projected annual Standardized Precipitation Evapotranspiration Index (SPEI)(4) across Morocco for the periods 2040–2059 (left) and 2080–2099 (right), against the baseline of 1986–2005 under high emission scenario. Morocco will be under significant water stress, most severely occurring in the central and northern areas.



c- Agriculture and Fisheries

Agriculture is an important sector for Morocco's economy as it ensures food security as well as rural livelihoods. 87% of the country's crop total production, particularly Barley and Wheat, remains mainly rainfed and hence highly vulnerable to increased rainfall variability. Yields are also expected to reduce by 50%-70% due to rising temperatures during dry years. For example, the 2016 winter grain harvest saw harvested yields 70% lower than in 2015 due to widespread drought. Drought also promotes proliferation of the Hessian fly, increasing risk of damage to wheat yields. In addition, crop's water requirements are expected to increase by up to 12% due to hotter and drier conditions, thus increasing demand for irrigation and further stressing limited water resources (WB CCKP, 2021).

Morocco's fisheries sector produces an estimated one million tons annually, primarily sardine and mackerel. The sector is valued at \$1 billion and is a key employer for coastal and rural communities as it contributes up to 2.3 % of Morocco's GDP and directly or indirectly employs over 660,000 people. This sector sustains 3 million people and makes up 15%

4 An index which represents the measure of the given water deficit in a specific location, accounting for contributions of temperature-dependent evapotranspiration and providing insight into increasing or decreasing pressure on water resources. Negative values for SPEI represent dry conditions, with values below -2 indicating severe drought conditions, likewise positive values indicate increased wet conditions.

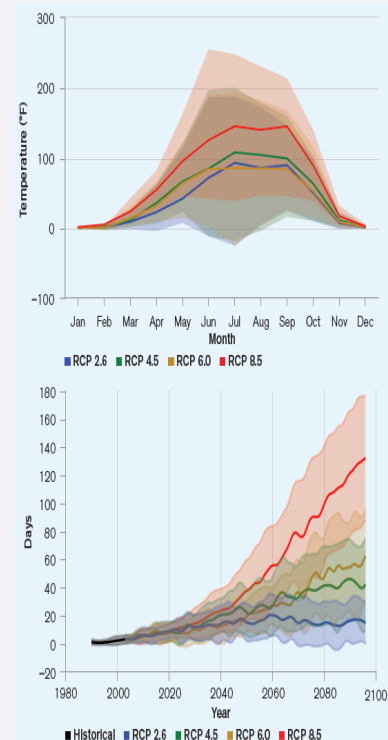


Figure 3: Projected Change in Cooling Degree Days (65°F) for the Period 2040–2059 (Reference Period, 1986–2005) (WB CCKP, 2021)

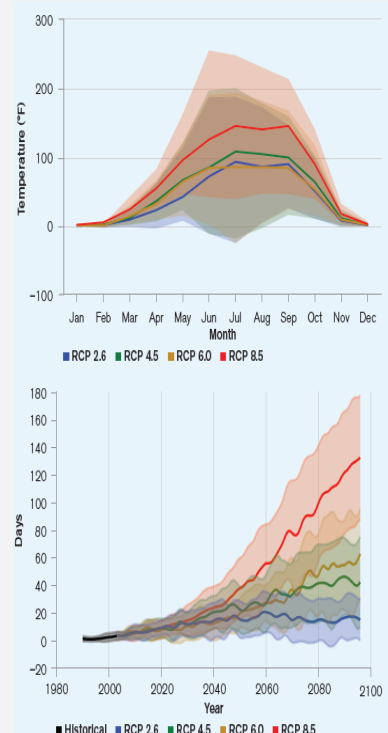


Figure 4: Projected Warm Spell Duration Index in Morocco for the Period 1986 to 2099 (Reference Period, 1986–2005) (WB CCKP, 2021)

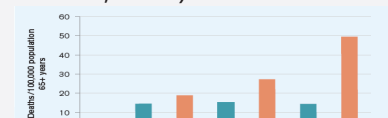


Figure 5: Heat Related Mortality in Population 65 or Over (WHO, 2015)

of total Moroccan exports, or 59% of agri-food exports. Climate change trends are expected to further aggravate issues in the fisheries sector as increased temperatures induce migration of fish species, particularly plankton, and open the way for invasive species to out-compete those upon which the industry relies. Increased sea surface temperatures may impact plankton migration habits or change the composition and hatching of marine life. It is also expected to reduce the productivity of crustaceans, corals, and echinoderms (WB CCKP, 2021).



d- Energy

Increased temperatures and seasonal changes are likely to alter demand for electricity with increased demand for peak loads during hotter summers. This will increase costs for consumers, and projected trends are also expected to increase costs of maintenance and repairing of power and energy infrastructure.

Cooling Degree Days show the relationship between daily heat and cooling demand, typically sourced through a form of active cooling or an evaporative process. The change in cooling degree days provides insight into the potential for extended seasons of power demand or periods in which power demands might increase. As seen in figure 3, seasonal increases for cooling demands are expected to increase over an extended summer period (April to October). The Warm Spell Duration Index represents the number of days in a sequence of at least six days in which the daily maximum temperature is greater than the 90th percentile of daily maximum temperature. As seen in figure 4, warm spells are expected to sharply increase in the second half of the century.

Renewable Energy: Total installed capacity from renewable energy sources in Morocco stands at 4067 MW, corresponding to 37.08% of total installed electrical capacity, with an aim of increasing renewable energies in the electricity mix to 52% by 2030. By December 2021, existing hydro resources reached 1770 MW of total installed capacity. According to the Ministry of Energy, Mines and Sustainable Development, Morocco could potentially generate 25,000 MW of wind power. At present, it has an installed capacity from wind energy of 1466 MW, the second largest volume in Africa behind South Africa. Morocco has an average solar potential of 5 kilowatt hours (kWh) per square meter per day, although this varies geographically. Total installed capacity from solar energy currently stands at 831 MW (International Trade Administration, 2022).



Morocco's population's health is vulnerable to climate change. The negative impacts of climate change on agriculture increases the chance of food insecurity and malnutrition. The country is also likely to face an increased occurrence of dengue fever, malaria, and schistosomiasis, as well as heat-related medical conditions due to increased temperatures that mainly affect the elderly, children, the chronically ill, the socially isolated, and at-risk occupational groups (WB CCKP, 2021). Under high emissions scenario, heat-related deaths in the elderly (65+ years) are projected to increase to almost 50 deaths per 100,000 by the 2080s compared to the estimated baseline of just under 5 deaths per 100,000 annually between 1961 and 1990, as shown in figure 5:

In addition, ambient air pollution was responsible for about 2,200 deaths in 2014 in Morocco. Nearly 50% of adult deaths originated in Casablanca, followed by Marrakesh and Tangier, mainly due to ischemic heart disease, stroke, and lung cancer (Croitoru & Sarraf, 2017).

IV- CLIMATE CHANGE RESPONSE: NATIONAL AND INTERNATIONAL

- ➔ Morocco has shown commitment to support its transition to sustainable development since the "Earth Summit" in Rio in 1992. Sustainable development has been integrated at the highest legislative levels, with the 2011 Constitution and the 2014 Charte Nationale de l'Environnement et du Développement Durable. Morocco was one of the first countries to develop a climate change strategy and action plan, with its National Plan Against Global Warming (PNLCRC, 2009). It has ratified several international climate agreements (Kyoto Protocol, NAMA) and is actively involved in the UNFCCC Process. The Policy on Climate Change of Morocco (PCCM, 2014) is the main policy document which supports the application of Morocco's vision in terms of climate change. It offers a coordinated approach to the different strategies and plans already initiated, as well as an operational framework until 2040. The recent submission of INDCs and the elaboration of a Green Investment Plan are supporting these commitments (Climate Expert, 2017). The different international documents submitted as part of the UNFCCC are seen in table 2:

Table 2: Timeline of UNFCCC Document Submission (ClimateWatch, 2022)

Date	Document Submitted
2001	First National Communication
2010	Second National Communication
2015	INDC
2016	First NDC
2016	Third National Communication
2021	Updated First NDC* + Fourth National Communication

* According to the most recent NDC submitted in June 2021, Morocco commits to reduce GHG emissions by 18.3% (unconditional) and 45.5% (conditional) in 2030, compared to the business-as-usual scenario.

- ➔ These instruments are complemented by a series of sectorial strategies and initiatives under the umbrella of the Ministry of Environment. Adaptation to climate change is included in most strategies, policies, action plans and programs [National Water Strategy and Plan; National Plan for the Protection against Floods; Green Morocco Plan (focusing on the Agriculture Sector); National Action Programme to Combat Desertification; National Strategy for the Planning and Development of Oases; Halieutis Plan (focusing on fishery) etc.] Moreover, in the short term, Morocco is committed to developing a National Adaptation Plan (NAP) up to 2030, to better coordinate its actions and maximize their impact in the field of Adaptation. (Climate Expert, 2017).

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