CLIMATE RISK COUNTRY PROFILE

TUNISIA

WORLD BANK GROUP

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This profile is part of a series of Climate Risk Country Profiles developed by the World Bank Group (WBG). The country profile synthesizes most relevant data and information on climate change, disaster risk reduction, and adaptation actions and policies at the country level. The country profile series are designed as a quick reference source for development practitioners to better integrate climate resilience in development planning and policy making. This effort is managed and led by Veronique Morin (Senior Climate Change Specialist, WBG) and Ana E. Bucher (Senior Climate Change Specialist, WBG).

The Tunisia profile was written by MacKenzie Dove (Senior Climate Change Consultant, WBG). Additional support was provided by Jason Johnston (Operations Analyst, WBG) and Yunziyi Lang (Climate Change Analyst, WBG).

Climate and climate-related information is largely drawn from the Climate Change Knowledge Portal (CCKP), a WBG online platform with available global climate data and analysis based on the latest Intergovernmental Panel on Climate Change (IPCC) reports and datasets. The team is grateful for all comments and suggestions received from the sector, regional, and country development specialists, as well as climate research scientists and institutions for their advice and guidance on use of climate related datasets.

CONTENTS

FOREWORD

Climate change is a major risk to good development outcomes, and the World Bank Group is committed to playing an important role in helping countries integrate climate action into their core development agendas. The World Bank Group is committed to supporting client countries to invest in and build a low-carbon, climate-resilient future, helping them to be better prepared to adapt to current and future climate impacts.

The World Bank Group is investing in incorporating and systematically managing climate risks in development operations through its individual corporate commitments.

A key aspect of the World Bank Group's Action Plan on Adaptation and Resilience (2019) is to help countries shift from addressing adaptation as an incremental cost and isolated investment to systematically incorporating climate risks and opportunities at every phase of policy planning, investment design, implementation and evaluation of development outcomes. For all International Development Association and International Bank for Reconstruction and Development operations, climate and disaster risk screening is one of the mandatory corporate climate commitments. This is supported by the Bank Group's Climate and Disaster Risk Screening Tool which enables all Bank staff to assess short- and long-term climate and disaster risks in operations and national or sectoral planning processes. This screening tool draws up-to-date and relevant information from the World Bank's Climate Change Knowledge Portal, a comprehensive online 'one-stop shop' for global, regional, and country data related to climate change and development.

Recognizing the value of consistent, easy-to-use technical resources for client countries as well as to support respective internal climate risk assessment and adaptation planning processes, the World Bank Group's Climate Change Group has developed this content. Standardizing and pooling expertise facilitates the World Bank Group in conducting initial assessments of climate risks and opportunities across sectors within a country, within institutional portfolios across regions, and acts as a global resource for development practitioners.

For developing countries, the climate risk profiles are intended to serve as public goods to facilitate upstream country diagnostics, policy dialogue, and strategic planning by providing comprehensive overviews of trends and projected changes in key climate parameters, sector-specific implications, relevant policies and programs, adaptation priorities and opportunities for further actions.

It is my hope that these efforts will spur deepening of long-term risk management in developing countries and our engagement in supporting climate change adaptation planning at operational levels.

Bernice Van Bronkhorst
Global Director
Climate Change Group (CCG)
The World Bank Group (WBG)

COUNTRY OVERVIEW

Tunisia is located within northern Africa along the southern shore of the Mediterranean Sea, between the eastern and western Mediterranean basins. It shares land borders with Algeria to the west and Libya to the southeast. The country has a total area of 164,000 square kilometers (km^2) and over 1,300 km of coastline along its eastern and northern borders. The country is divided in two large geographical areas, separated by successive low points occupied by the Chotts El Gharsa, Djerid and Fedjej, aligned from west to east. The northern area is diagonally crossed by the Tunisian Ridge, a mountain chain comprising the Tell Atlas and the Saharan Atlas Mountains. Northwest regions in the country are marked by high plains and a rugged landscape. The southeastern regions are dominated by a low and hilly landscape, which extends to the coast. The center-west regions, which extend south of the Tunisian Ridge are dominated by highlands bordering low and scattered mountain peaks and are occupied by steppes. Southern areas consist of the Saharan desert whose eastern border is represented by the Matmata and Dahar chains.[1]

Tunisia is a lower-middle income country and while the country has achieved important progress on its political transition towards democratic systems and more open governance structures, economic progress has not kept pace. The country remains constrained by political fragmentation and the lack of consensus on key economic reforms. Additionally, recent ongoing conflict in neighboring Libya has further hindered economic recovery and added to social disaffection and unemployment, especially among youth. Tunisia is one of the few countries in the world where a higher level of education decreases employability, in particular for women.[2] Tunisia has a population of 11.7 million people (2019) with an annual population growth rate of 1.1% (2018),[3] and is projected to reach 12.7 million people by 2030 and 13.8 million people by 2050. An estimated 69% of the current population resides in urban areas, which is expected to reach 80% in 2050. The country has a Gross Domestic Product (GDP) of $38.7 billion (2019), and has experienced relatively volatile growth rates over the past decade, with a current annual growth rate of 1.0% in 2019 (**Table 1**).[4]

TABLE 1. Data snapshot: Key development indicators

Indicator	2018
Life expectancy at birth, total (years)	76.5
Population density (people per sq. km land area)	74.4
% of Population with access to electricity	99.8%
GDP per capita (current US$)	$3,438.80

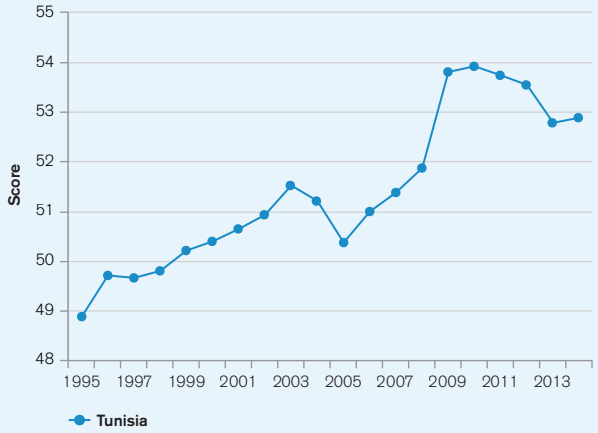
The ND-GAIN Index[5] ranks 181 countries using a score which calculates a country's vulnerability to climate change and other global challenges as well as their readiness to improve resilience. This Index aims to help businesses and the public sector better identify vulnerability and readiness in order to better prioritize investment for more efficient responses to global challenges. Due to a combination of political, geographic, and social factors, Tunisia is recognized

[1] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf
[2] World Bank (2019). Tunisia Overview. URL: https://www.worldbank.org/en/country/tunisia/overview
[3] World Bank Open Data, Data Retrieved December 2019. Data Bank: World Development Indicators, Tunisia. URL: https://databank.worldbank.org/source/world-development-indicators
[4] World Bank Open Data, Data Retrieved December 2019. Data Bank: Population Estimates and Projections, Tunisia. URL: https://databank.worldbank.org/source/population-estimates-and-projections
[5] University of Notre Dame (2020). Notre Dame Global Adaptation Initiative. URL: https://gain.nd.edu/our-work/country-index/

as vulnerable to climate change impacts, ranked 64th out of 181 countries in the 2019 ND-GAIN Index. The more vulnerable a country is the lower their score, while the more ready a country is to improve its resilience the higher it will be. Norway has the highest score and is ranked 1st. **Figure 1** is a time-series plot of the ND-GAIN Index showing Tunisia's progress.

Tunisia is considered highly vulnerable to climate change and is expected to experience adverse impacts from increased temperatures, increased aridity, reduced precipitation, and rising sea levels. Socio-economic and environmental implications will particularly affect water resources, the agricultural and livestock, ecosystems, coastal zones, health, and tourism sectors.[6]

FIGURE 1. ND-GAIN Index for Tunisia



Tunisia submitted its Nationally-Determined Contribution (NDC) to the UNFCCC in 2016 and its Third National Communication (NC3) in 2019, in support of the country's efforts to achieve its economic development goals, strengthen its approach to environmental sustainability and increase its adaptive capacity to climate change. The country is particularly vulnerable in regards to water security, agriculture and livestock health, as well as to adverse conditions for health, human settlements, and the country's energy sector. Tunisia's NDC is consistent with the country's overall goals of increasing its development, reducing its vulnerability and achieving long-term sustainable, economic development. Key focus is on the sustainability of the environment, water resources, energy, agriculture sectors and costal zones.[7]

Green, Inclusive and Resilient Recovery

The coronavirus disease (COVID-19) pandemic has led to unprecedented adverse social and economic impacts. Further, the pandemic has demonstrated the compounding impacts of adding yet another shock on top of the multiple challenges that vulnerable populations already face in day-to-day life, with the potential to create devastating health, social, economic and environmental crises that can leave a deep, long-lasting mark. However, as governments take urgent action and lay the foundations for their financial, economic, and social recovery, they have a unique opportunity to create economies that are more sustainable, inclusive and resilient. Short and long-term recovery efforts should prioritize investments that boost jobs and economic activity; have positive impacts on human, social and natural capital; protect biodiversity and ecosystems services; boost resilience; and advance the decarbonization of economies.

[6] Republic of Tunisia (2016). Nationally Determined Contribution. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Tunisia%20First/INDC-Tunisia-English%20Version.pdf

[7] Republic of Tunisia (2016). Nationally Determined Contribution. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Tunisia%20First/INDC-Tunisia-English%20Version.pdf

Climate Baseline

Overview

While Tunisia is the smallest country in North Africa, it still comprises five climate zones. The country is largely influenced by the Atlas Mountains and Mediterranean Sea. It experiences precipitation gradients, one from north to south, which experiences decreasing precipitation, and the other west to east which experiences increasing precipitation. The Atlas Mountains are the dominant force in Tunisia's northern areas, which is characterized by a typical Mediterranean climate with hot summers (June to September) of up to 22°C and precipitation occurring in the winter (November to February), which does not exceed 500 millimeters (mm) of rainfall per year. The country's western, central and mountainous region is characterized by an arid steppe with an annual mean temperature of 18°C. In southern areas, the highest part of the mountain ridge lies between a cold arid desert (annual mean temperature is lower than 18°C and the hot arid desert zone covering the plains to the south, with annual mean precipitation rates of about 150 mm per year. A unique feature is Tunisia's eastern coastal border, downwind of the Atlas Mountains. Due to land-sea interaction with the Mediterranean Sea this region still comprises an arid steppe climate with an annual mean temperature greater than 18°C, but experiences slightly higher precipitation rates at least in the winter months. In Gabes, the annual precipitation is about 175 mm per year, near Djerba, 207 mm per year. Overall, precipitation occurs in winter months.[8] In Tunisia's southern semi-arid to arid areas, drought can be frequent, while its coastal region experiences relatively frequent flooding.[9]

Tunisia is a highly arid country and receives very little annual precipitation. The majority of rain falls along the relatively humid, coastal areas, with southern areas receiving as little as 150 mm per year. Primary challenges continue to be centered around water resource availability, changing precipitation patterns and increasing population demands. Annual average temperatures for the country range between 16°C and 20°C, with hot summers. Summer mean temperatures often exceed 25°C with max temperatures reaching 32°C. Tunisia's winters are relatively mild with average temperatures between 10°C and 14°C.[10]

[8] GERICS (2019). Climate Fact Sheet – Tunisia. URL: https://www.climate-service-center.de/products_and_publications/fact_sheets/climate_fact_sheets/index.php.en

[9] USAID (2018). Tunisia – Climate Risk Profile. URL: https://www.climatelinks.org/sites/default/files/asset/document/Tunisia_CRP.pdf

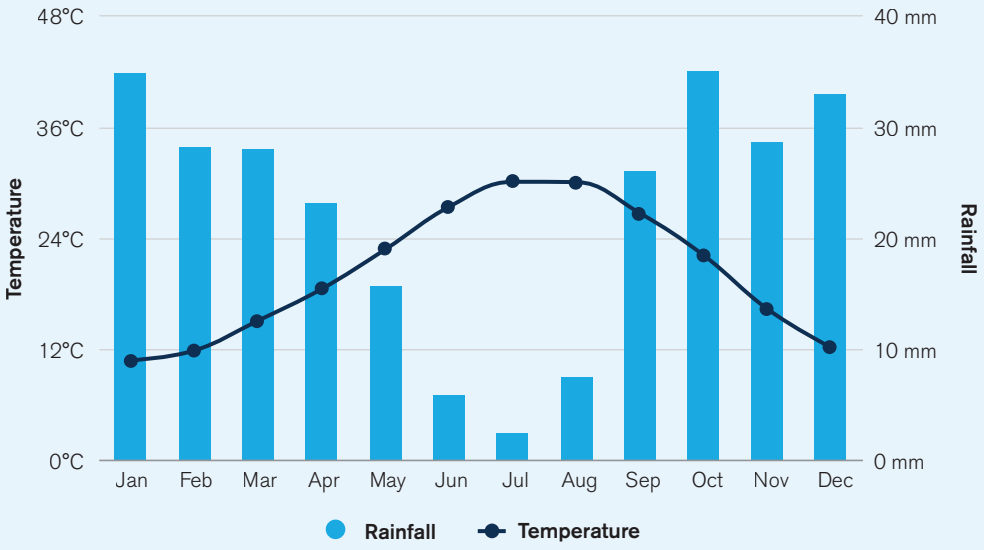
[10] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf

Analysis of data from the World Bank Group's Climate Change Knowledge Portal (CCKP) (**Table 2**) shows historical information for 1901–2019. Mean annual mean temperature for Tunisia is 19.4°C, with average monthly temperatures ranging between 28°C (June, July) and 10°C (January). Mean annual precipitation is 263.5 mm, with highest rainfall occurring September to April, with relatively very low levels of precipitation occurring nearly all year round (**Figure 2**).[11] **Figure 3** shows the spatial variation of observed average annual precipitation and temperature across Tunisia.

TABLE 2. Data snapshot: Summary statistics

Climate Variables	1901–2019
Mean Annual Temperature (°C)	19.4°C
Mean Annual Precipitation (mm)	263.5 mm
Mean Maximum Annual Temperature (°C)	25.4°C
Mean Minimum Annual Temperature (°C)	13.5°C

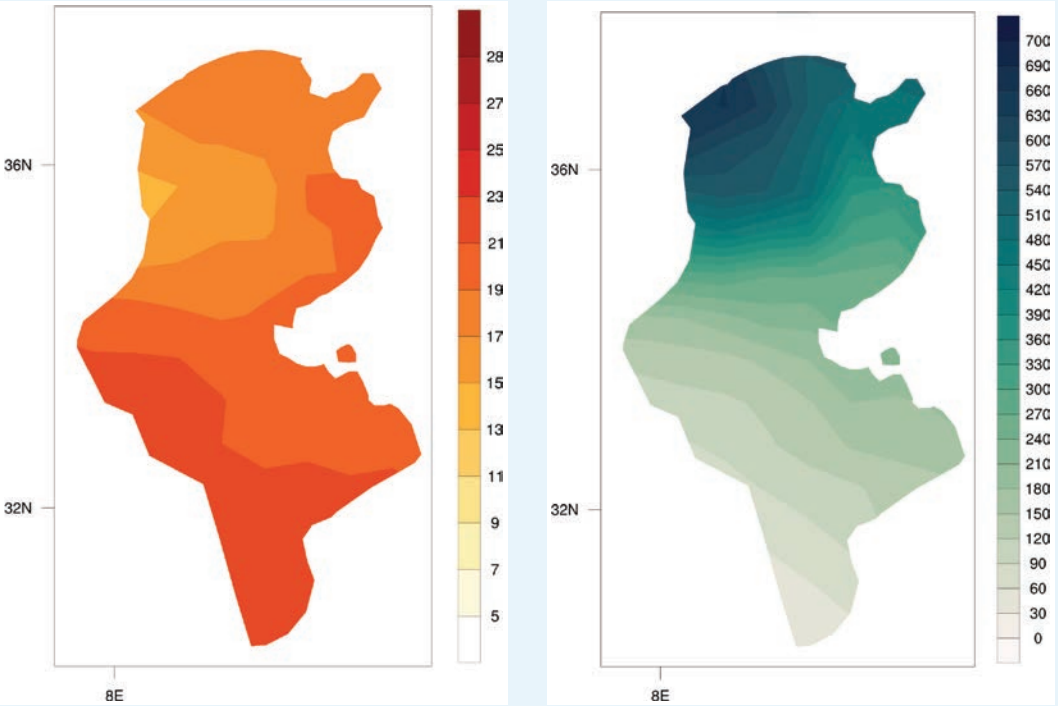
FIGURE 2. Average monthly temperature and rainfall of Tunisia for 1991–2019[12]



[11] WB Climate Change Knowledge Portal (CCKP, 2020). Tunisia. URL: https://climateknowledgeportal.worldbank.org/country/tunisia/climate-data-historical

[12] WB Climate Change Knowledge Portal (CCKP, 2020). Tunisia. URL: https://climateknowledgeportal.worldbank.org/country/tunisia/climate-data-historical

FIGURE 3. Map of average annual temperature (left); annual precipitation (right) of Tunisia, 1901–2019[13]



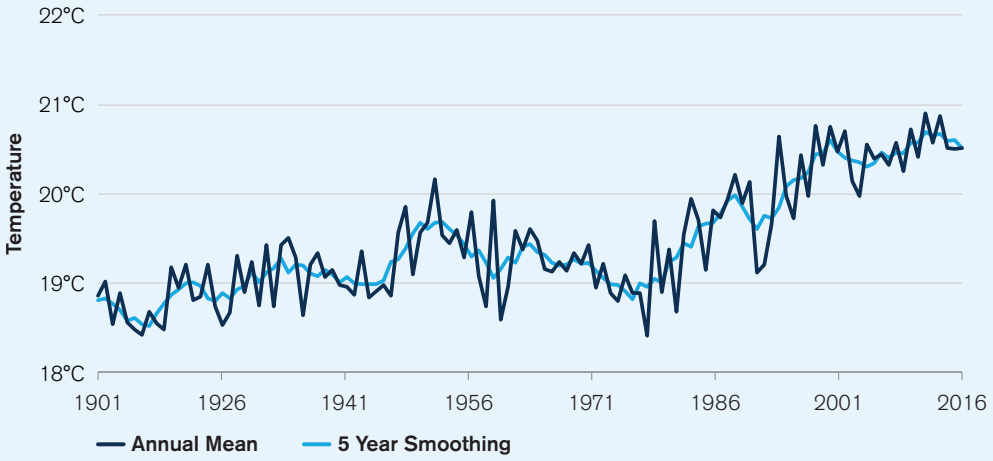
[13] WB Climate Change Knowledge Portal (CCKP, 2020). Tunisia. URL: https://climateknowledgeportal.worldbank.org/country/tunisia/climate-data-historical

Key Trends

Temperature

Tunisia has experienced a significant increase in its temperatures over the last 30 years, with temperatures increasing by 0.37°C per decade. Tunisia has observed a mean average temperature increase of 1.4°C since 1901 (**Figure 4**). In the northern areas of Tunisia, larger temperature increases were experienced, with up to 2°C temperature increase observed. Greater warming has been observed during the summer season (May to September), rather than the winter. A reduction in cool nights and increase in warm nights since 1960 have been observed.[14]

FIGURE 4. Observed temperature for Tunisia, 1901–2019[15]



Precipitation

Precipitation in Tunisia is highly variable; however, precipitation was observed to have decreased approximately 3% over the past 30 years. Tunisia has also experienced reduced water availability in some areas and increased periods of drought and dry spells. Stronger precipitation events resulting in flash flooding in recent years has also been observed.[16]

[14] GERICS (2019). Climate Fact Sheet – Tunisia. URL: https://www.climate-service-center.de/products_and_publications/fact_sheets/climate_fact_sheets/index.php.en

[15] WB Climate Change Knowledge Portal (CCKP, 2020). Tunisia URL: https://climateknowledgeportal.worldbank.org/country/tunisia/climate-data-historical

[16] GERICS (2019). Climate Fact Sheet – Tunisia. URL: https://www.climate-service-center.de/products_and_publications/fact_sheets/climate_fact_sheets/index.php.en

Climate Future

Overview

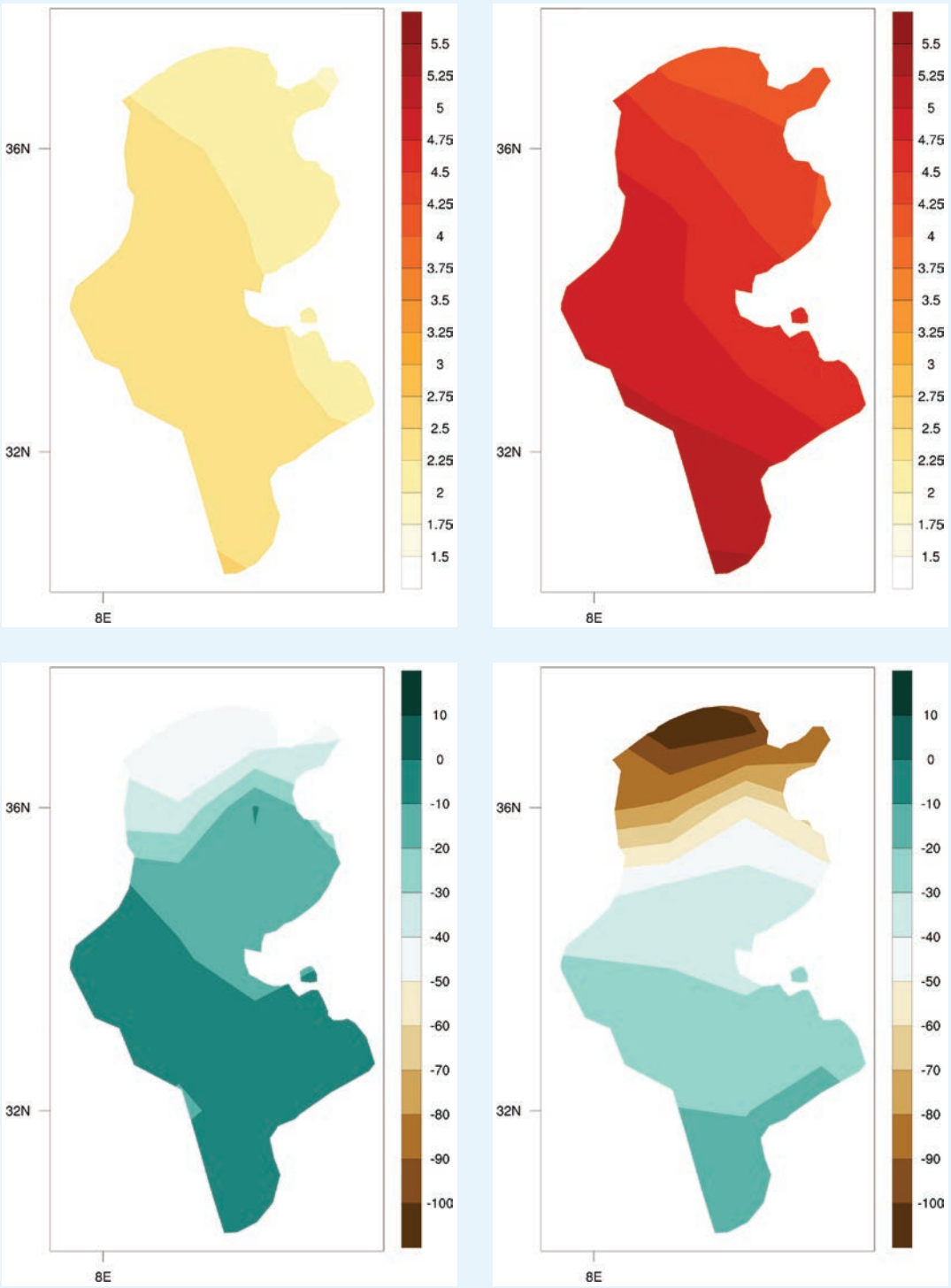
The main data source for the World Bank Group's Climate Change Knowledge Portal (CCKP) is the CMIP5 (Coupled Inter-comparison Project Phase 5) data ensemble, which builds the database for the global climate change projections presented in the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC). Four Representative Concentration Pathways (i.e. RCP2.6, RCP4.5, RCP6.0, and RCP8.5) were selected and defined by their total radiative forcing (cumulative measure of GHG emissions from all sources) pathway and level by 2100. The RCP2.6 for example represents a very strong mitigation scenario, whereas the RCP8.5 assumes business-as-usual scenario. For more information, please refer to RCP Database. For simplification, these scenarios are referred to as a low (RCP2.6); a medium (RCP4.5) and a high (RCP8.5) emission scenario in this profile. **Table 3** provides CMIP5 projections for essential climate variables under high emission scenario (RCP 8.5) over 4 different time horizons. **Figure 5** presents the multi-model (CMIP5) ensemble of 32 Global Circulation Models (GCMs) showing the projected changes in annual precipitation and temperature for the periods 2040–2059 and 2080–2099.

TABLE 3. Data snapshot: CMIP5 ensemble projection

CMIP5 Ensemble Projection	2020–2039	2040–2059	2060–2079	2080–2099
Annual Temperature Anomaly (°C)	**+0.5°C to +2.2°C** (+1.3°C)	**+1.5°C to +3.3°C** (+2.3°C)	**+2.0°C to +4.9°C** (+3.3°C)	**+3.0°C to +6.5°C** (+4.6°C)
Annual Precipitation Anomaly (mm)	**–5.9 to +5.2** (–0.5 mm)	**–7.0 to +4.9** (–1.3 mm)	**–8.8 to +4.5** (–1.6 mm)	**–9.4 to +3.7** (–3.0 mm)

Note: The table shows CMIP5 ensemble projection under RCP8.5. Bold value is the range (10th–90th Percentile) and values in parentheses show the median (or 50th Percentile).

FIGURE 5. CMIP5 ensemble projected change (32 GCMs) in annual temperature (top) and precipitation (bottom) by 2040–2059 (left) and by 2080-2099 (right), relative to 1986–2005 baseline under RCP8.5[17]



[17] WB Climate Change Knowledge Portal (CCKP, 2020). Tunisia Projected Future Climate. URL: https://climateknowledgeportal.worldbank.org/country/tunisia/climate-data-projections

Key Trends

Temperature

According to analysis from the German Climate Service Center (GERICS) of 32 Global Climate Models (GCMs), Tunisia is projected to experience mean annual temperature increases from 1.9°C to 5.3°C by the 2080s. Maximum temperatures are expected to increase by 2.3°C to as much as 6.4°C by the 2080s. This is also likely to result in longer lasting and more intense heat waves, with an increase in heat waves by up to an additional 78 days per year by the 2080s; cold nights and cold spells are also expected to significantly decline.[18]

Across all emission scenarios, temperatures will continue to increase for Tunisia throughout the end of the century. As seen in **Figure 6**, under a high-emission scenario, average temperatures will increase rapidly by mid-century. Across the seasonal cycle, temperature increases will spike from October to April with daily temperatures greater than 25°C (**Figure 7**). Increased heat and extreme heat conditions will result in significant implications for human and animal health, agriculture, water resources, and ecosystems.

FIGURE 6. Historical and projected average temperature for Tunisia from 1986 to 2099[19]

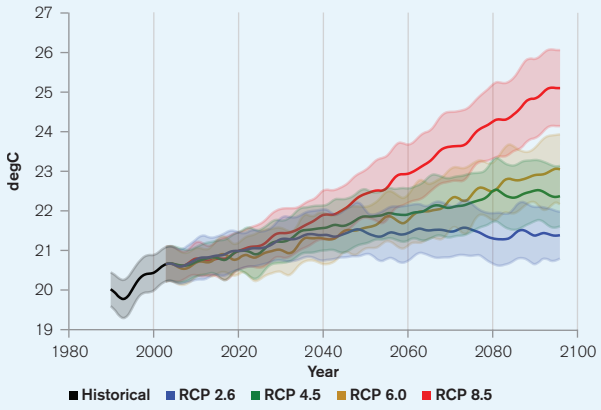
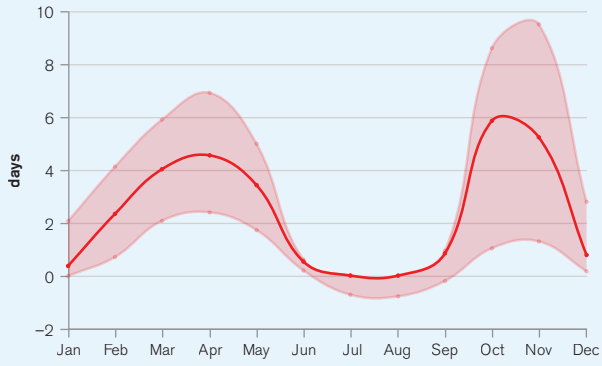


FIGURE 7. Projected change in summer days (Tmax > 25°C)[20]



[18] GERICS (2019). Climate Fact Sheet – Tunisia. URL: https://www.climate-service-center.de/products_and_publications/fact_sheets/climate_fact_sheets/index.php.en

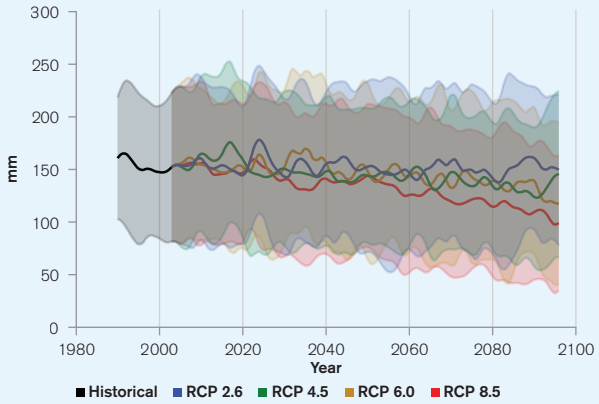
[19] WB Climate Change Knowledge Portal (CCKP, 2020). Interactive Climate Indicator Dashboard - Agriculture. Tunisia. URL https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=TUN&period=2080-2099

[20] WB Climate Change Knowledge Portal (CCKP, 2020). Interactive Climate Indicator Dashboard - Agriculture. Tunisia. URL https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=TUN&period=2080-2099

Precipitation

Rainfall trends in Tunisia are variable. Analysis from the German Climate Services Center (GERICS) indicate that the reduction in precipitation, observed over the past 30 years, is expected to continue through the end of the century, with projections indicating reduced precipitation and a trend of longer and more frequent dry spells. Additionally, an increase in the intensity of heavy rainfall events is expected under high emissions scenarios. This will also affect the water balance for the country, with the majority of projections indicating a decrease in water balance by the 2080s.[21] **Figure 8**, shows the change in the projected annualaverage precipitation for Tunisia. Water routing, storage and other management options can be highly varied depending if the precipitation input comes frequently or with long periods of aridity in between rainfall.[22] As seen below, annual average precipitation is low and is expected to decrease slightly by the of the century under a high emissions scenario of RCP8.5.

FIGURE 8. Annual average precipitation in Tunisia for 1986 to 2099[23]



CLIMATE RELATED NATURAL HAZARDS

Overview

Tunisia has a high degree of risk to natural hazards. The country experiences disasters such as flash flooding, droughts, storms, sandstorms, and earthquakes; sea-level rise also poses a significant threat to the country's coastline not only due to inundation and salinization, but also from increasingly harmful storm surge. The region has also been impacted by an increase in frequency and intensity of extreme weather events such as heavy rainfall, landslides, and flooding, as well as droughts. An increased frequency of extreme events, such as inter alia droughts, soil erosion and desertification. The country is expected to become generally hotter and drier in projected future climates and as such, Tunisia, is increasingly severely impacted by and susceptible to drought. While drought conditions are generally a common occurrence, Tunisia has experienced increasingly frequent occurrences of

[21] GERICS (2019). Climate Fact Sheet – Tunisia. URL: https://www.climate-service-center.de/products_and_publications/fact_sheets/climate_fact_sheets/index.php.en

[22] WB Climate Change Knowledge Portal (CCKP, 2020). Tunisia Water Dashboard. Data Description. URL: https://climateknowledgeportal.worldbank.org/country/tunisia/climate-sector-water

[23] WB Climate Change Knowledge Portal (CCKP, 2020). Tunisia Agriculture Dashboard. Tunisia. URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=TUN&period=2080-2099

aridity and drought in recent years.[24] Sea level rise is projected to lead to the loss of a sizable proportion of the northern and eastern coastlines due to a combination of inundation and erosion, with consequential loss of agricultural land, infrastructure, and urban areas.[25]

Data from the Emergency Event Database: EM-Dat database, presented in **Table 4**, shows the country has endured various natural hazards, including floods, landslides, epidemic diseases, and storms.

TABLE 4. Natural disasters in Tunisia, 1900–2020[26]

Natural Hazard 1900–2020	Subtype	Events Count	Total Deaths	Total Affected	Total Damage ('000 USD)
Drought	Drought	2	0	31,400	0
Earthquake	Ground Movement	1	13	0	0
Flood	Flash Flood	5	69	37,508	36,000
	Riverine Flood	4	49	180,500	242,800
Insect Infestation	Locust	2	0	0	0
Wildfire	Forest Fire	1	0	2,000	0

Key Trends

Disaster risk from increased temperatures and reduced precipitation is expected to exacerbate existing tensions for water resources between agricultural, and livestock and human needs, especially during periods of high aridity and drought. The existing quality of available water from surface water and groundwater, is also likely to be altered. Water scarcity and changing rainfall patterns are will play a significant role for the agricultural sector.[27] Increased temperatures and degraded agricultural conditions are expected to adversely impact livelihoods and economic resilience of vulnerable groups as well as increased risks of wildfires. Most of the country's population and infrastructure are concentrated along the Mediterranean coast, making the country additionally vulnerable to the impacts of sea level rise and coastal erosion, particularly inundation and saltwater intrusion. **Figure 9** presents the risk of coastal flooding and wildfires for Tunisia.[28]

[24] UNISDR (2013). Factsheet: Overview of Disaster Risk Reduction in the Arab Region. URL: https://www.unisdr.org/files/31693_drrfactsheetarabregionfinal.pdf

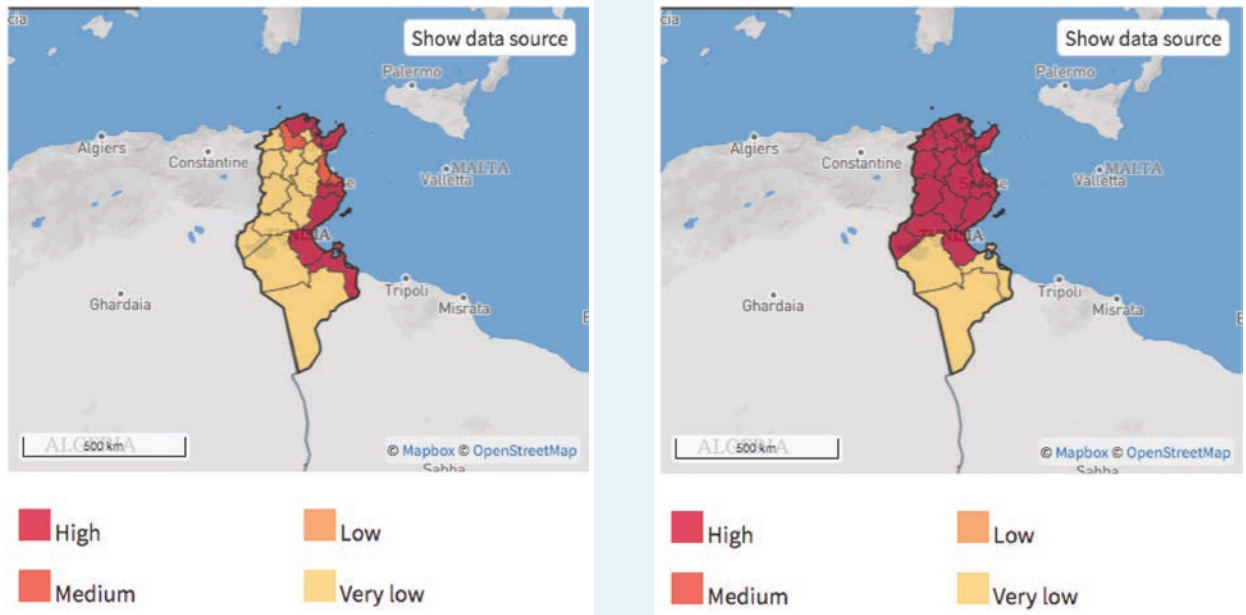
[25] Reimann, L., Vafeidis, A., Brown, S., Hinkel, J., and Tol, R. (2018). Mediterranean UNESCO World Heritage at risk from coastal flooding and erosion due to sea-level rise. Nature Communications (2018) 9:4161. DOI: 10.1038/s41467-018-06645-9. URL: https://www.nature.com/articles/s41467-018-06645-9.pdf

[26] EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir, Brussels, Belgium. URL: http://emdat.be/emdat_db/

[27] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf

[28] European Commission (2018). The Future of Climate Action in the South Mediterranean Region. Lessons Learned Since the Paris Agreement. ClimaSouth project. URL: https://op.europa.eu/en/publication-detail/-/publication/70f66617-2cbc-11e8-b5fe-01aa75ed71a1/language-en

FIGURE 9. Risk of Coastal Flood (left)[29]; Risks of Wildfires (right)[30]



Climate change is expected to increase the risk and intensity of water scarcity and drought across the country. The primary sectors affected are water, agriculture, forestry, human health, and livestock. Additionally, increased frequency of intense precipitation events will lead to a heightened risk of flooding, river bank over flow, and flash flooding. Flooding may also result in soil erosion and water logging of crops, thus decreasing yields with the potential to increase food insecurity; particularly for subsistence-scale farmers. Higher temperatures with increased aridity may also lead to livestock stress and reduced crop yields. This is likely to result in significant economic losses, damage to agricultural lands and infrastructure as well as human casualties. Furthermore, land degradation and soil erosion, exacerbated by recurrent flood and drought adversely impacts agricultural production, further affecting the livelihoods of the rural poor. Small rural farmers, are more sensitive to impacts of these types of disasters (floods, dry periods) because they have limited resources with which to influence and increase adaptive capacity.[31]

[29] ThinkHazard! (2019). Tunisia - Coastal Flooding. URL: http://thinkhazard.org/en/report/248-tunisia/CF
[30] ThinkHazard! (2019). Tunisia - Wildfire. URL: http://thinkhazard.org/en/report/248-tunisia/WF
[31] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf

Implications for DRM

The Tunisian Government is focused on further advancing the country's disaster risk management (DRM) efforts and strengthening its disaster risk reduction (DRR) capabilities. The country has been collaborating with the European Union to improve DRR capabilities across the Mediterranean by preparing Tunisia's Civil Protection program for enhanced DRM and increased international collaboration and cooperation. The Tunisian Civil Protection National Office provides senior direction and management for the country's DRM efforts. Additional ongoing priorities for the sector include, strengthening regional coordination and investment in technological innovations to address water scarcity, sea level rise and storms. Additional efforts are being placed on exploring disaster risk financing and insurance mechanisms; enhancing early warning systems; and, building the capacity and financial resources Additional investment in the strengthening of early warning systems and integrating resilience into urban infrastructure investments remains a priority.[32]

CLIMATE CHANGE IMPACTS TO KEY SECTORS

Tunisia is considered to be one of the Mediterranean countries most exposed to climate change. Primary risks, which the country is likely to confront are temperature increases, reduced precipitation, rising sea levels and escalating extreme weather phenomena (floods and droughts). These risks are likely to result in significant environmental and socio-economic vulnerability.[33] The country remains highly vulnerable to climate variability and change in the immediate as well as longer-term, particularly for the country's water, agriculture, energy, and health sectors. Impacts are already being experienced across the already highly arid country. Water scarcity and drought conditions are expected to increase risks of food insecurity and may exacerbate conflict situations over scarce resources, settlements, and population/ livestock movements. The country faces increased challenges to the agricultural sector and the resulting loss of livelihoods and increased food insecurity. These are expected to be further compounded by climate stressors, environmental degradation, impacted water resources, and sea level rise presenting significant obstacles to the country's ongoing development and poverty reduction efforts.[34]

Gender

An increasing body of research has shown that climate-related disasters have impacted human populations in many areas including agricultural production, food security, water management and public health. The level of impacts and coping strategies of populations depends heavily on their socio-economic status, socio-cultural norms, access to resources, poverty as well as gender. Research has also provided more evidence that the effects are not gender neutral, as women and children are among the highest risk groups. Key factors that account for the differences

[32] OCHA (2019). Tunisia – Humanitarian Data Exchange. URL: https://www.unocha.org/middle-east-and-north-africa-romena/tunisia
[33] Republic of Tunisia (2016). Nationally Determined Contribution. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Tunisia%20First/INDC-Tunisia-English%20Version.pdf
[34] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf

between women's and men's vulnerability to climate change risks include: gender-based differences in time use; access to assets and credit, treatment by formal institutions, which can constrain women's opportunities, limited access to policy discussions and decision making, and a lack of sex-disaggregated data for policy change.[35]

Agriculture

Overview

Tunisian agriculture is a crucial sector due to its significant contribution to the country's food security and economy. Tunisia has more than 10 million hectares (ha) of agricultural land, which represents 62% of the country's total area; 32% of which is covered by annual and permanent crops. Livestock is dominated by sheep, cattle, goats and poultry. The agriculture and agri-food sector accounts for approximately 14% of its GDP (2012). The sector provides permanent income for 470,000 farmers, contributing to the stability of the rural population, which are 35% of the country's population.[36] The country's top agricultural commodities are typical Mediterranean foods, including olive oil, dates, citrus, grain, meat, and poultry products.[37] Agriculture remains an important part of the Tunisian economy and provides significant employment opportunities. The two most important export crops are cereals and olive oil. Tunisia is one of the world's biggest producers and exporters of olive oil; it also exports dates and citrus fruits. Additionally, Tunisia remains one of the few Arab countries that still produces most of the dairy products, vegetables, fruit, and red meat consumed domestically. Since the 1980s, agricultural output has increased by approximately 40%, and exports of food have risen significantly. However, Tunisia remains a net importer of major food items, including cereals, forage crops, and processed food.[38]

Climate Change Impacts

The projected climate change impacts to food production, agricultural livelihoods and food security in Tunisia are significant national concerns. Impacts on food production and food security are linked to projected water supply constraints as well as temperature rise. Tunisia is projected to experience rising temperatures, decreasing precipitation, increasing evapotranspiration and decreasing availability of water resources. This is expected to threaten the yields of irrigated and rainfed crops in Tunisia by the end of the century and further threaten economic viability and sustainability of the agricultural sector. The area of non-irrigated orchards could be reduced by about 800,000 ha, nearly 50% of the current production area, especially in the central and the southern areas of the to be threatened by changing growing conditions. Areas of irrigated cereals are expected to decrease by 20% in the 2020s, affecting mainly the central and southern regions of Tunisia. Rainfed cereal crops could decrease by nearly 30% by the 2030s.[39]

Higher temperatures can further negatively impact crops due to an increase in weeds and diseases. Increased temperature, sea level rise, and decreased precipitation will also exacerbate existing water resources challenges

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[35] World Bank Group (2016). Gender Equality, Poverty Reduction, and Inclusive Growth. URL: https://openknowledge.worldbank.org/handle/10986/23425

[36] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf

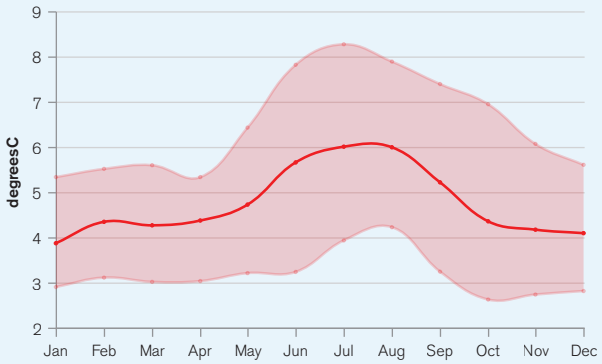
[37] USAID (2018). Tunisia – Climate Risk Profile. URL: https://www.climatelinks.org/sites/default/files/asset/document/Tunisia_CRP.pdf

[38] World Bank (2013). Economic of Climate Change in the Arab World. Case Studies from the Syrian Arab Republic, Tunisia and the Republic of Yemen. URL: http://documents.worldbank.org/curated/en/709141468304773864/pdf/Economics-of-climate-change-in-the-Arab-World.pdf

[39] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf

as currently the agriculture sector in Tunisia utilizes approximately 80% of all water resources. Floods and droughts are expected to occur more frequently in coastal, desert, and urban areas, which may result in crop losses and food insecurity. These climate risks are expected to also have a negative impact on crop yields, mainly wheat, barley, and irrigated potatoes. Dryness and impaired soil health will also negatively impact fruit and olive oil production. The projected increased heat will increase stress on crops and is also likely to change the length of the growing season. Decreased water availability is likely to reduce yields and the reduction in soil moisture may alter suitable areas for agriculture or the production of specific crops. Increased heat and water scarcity conditions are likely to increase evapotranspiration, expected to contribute to crop failures and overall yield reductions.[40] **Figure 10** shows the average daily max-temperature across the seasonal cycle. These higher temperatures have implications for impacts to soil moisture and crop growth and as seen in the graph below, summer spikes in temperature for traditional harvest seasons.

FIGURE 10. Average daily max temperature for Tunisia[41]



Adaptation Options

Recent efforts by the Tunisian Government have resulted in increased meteorological and climatic monitoring, primarily focused on extreme events which can cause significant crop damage. The country has also worked to improve its water efficiency following the adoption of its National Program on Water Savings in 1995. This has resulted in localized irrigation (drip irrigation) now applied to 46% of the total area of irrigated perimeters. Other adaptation measures implemented in the agricultural sector to reduce the water demand, particularly for conservation agriculture have been implemented at local and regional scales. Within in agricultural zones, each governorate, depending on the types of agriculture developed within its geographical area, has also planned adaptation strategies to climate change by strengthening participative debates between managers and farmers and inhabitants of rural areas. Several strategies have been recently developed to protect Tunisian ecosystems from the impacts of climate change, focusing on sensitive oasis ecosystems.[42] The government has also committed to increase the capacity building of institutions and sectors to improve understanding of climate change impacts and key adaptation measures required. The government has committed to the following specific actions, such as irrigated crops in the central regions, increasing mixed farming-livestock production in highly vulnerable regions, introducing climate monitoring and early warning systems as well as climate insurance mechanisms for agriculture and developing innovative systems for arable crops.[43]

[40] USAID (2018). Tunisia – Climate Risk Profile. URL: https://www.climatelinks.org/sites/default/files/asset/document/Tunisia_CRP.pdf
[41] WB Climate Change Knowledge Portal (CCKP, 2020). Tunisia Agriculture. Dashboard URL: https://climatedata.worldbank.org/CRMePortal/web/agriculture/crops-and-land-management?country=TUN&period=2080-2099
[42] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf
[43] Republic of Tunisia (2016). Nationally Determined Contribution. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Tunisia%20First/INDC-Tunisia-English%20Version.pdf

Water

Overview

Tunisia is a water-scarce country and substantial imbalances exist in water resource distribution between the better endowed north and the semi-arid south in regards to water balance, storage, and water distribution. Already, the country has a 90% mobilization rate of water resources through dams, whereas groundwater resources are overexploited. A network of canals and transfers exists to transport water from the North to the South.[44] The country's main, permanent watercourse is the Medjerda River, with sources in Algeria and on which Tunisia's largest dam, the Sidi Salem dam, is located. Rainwater also infiltrates the soil and contributes to the country's water reserves for rainfed agriculture, with the remaining water stored in wetlands or flowing towards the sea.[45] While the country has made significant progress in regards to its water supply, sanitation and water-related health services, significant imbalances and lack of access still remain high. Inequalities persist in regards to service availability, water quality and access, particularly across different geographies and between urban and rural populations.[46]

Climate Change Impacts

Tunisia is projected to experience decreases in average rainfall resulting in increases in the intensity and frequency of dry periods and water scarcity. Increases in temperature should reduce soil moisture, surface water, and underground water stocks. These are likely to worsen the increasing water needs, notably for human use, but more particularly for agriculture, given the increase in evapotranspiration and the decrease in soil humidity. Most of the country's groundwater comes from deep aquifers in the south, among which the largest resources are non-renewable fossil groundwater. Currently, the country is undergoing an intensive exploitation of underground resources, which provide around 81% of the water needs of the irrigated sector.[47]

Tunisia is also expected to experience a decrease in water availability, with greater decreases in water stocks experienced in the northern areas of the country where ground water is the primary source for agriculture and human consumption. The country's water resource scarcity by the 2050s is expected to be significant and is likely to result in further drying of key water sources, especially for rural communities and in central and southern areas. Coastal aquifers are also being threatened by sea level rise and increased threats from overexploitation, degradation and salinization. Water use conflicts are already occurring and are intensifying in Tunisia, especially during drought periods. Rural areas relying on springs for drinking will be the most affected, given the drying up of these springs. Women are likely to be even more vulnerable, considering that they often are responsible for water supply and hygiene in the household. The poorest people, including those living in forests and rural areas, are likely to be most affected, further intensifying the current social crises between different regions of the country.[48]

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[44] World Bank Group (2018). Water and Sanitation for All in Tunisia. URL: http://documents.worldbank.org/curated/en/633951499266691889/pdf/P153680.pdf

[45] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf

[46] World Bank Group (2018). Water and Sanitation for All in Tunisia. URL: http://documents.worldbank.org/curated/en/633951499266691889/pdf/P153680.pdf

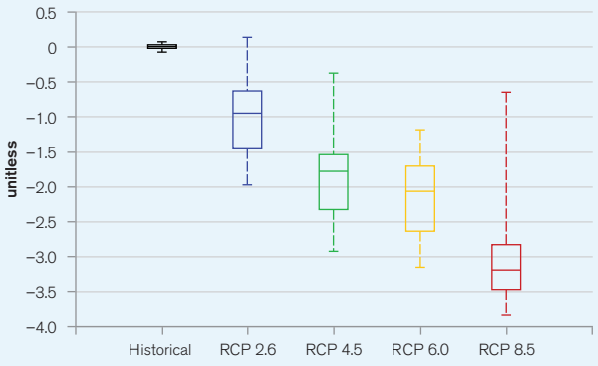
[47] Republic of Tunisia (2016). Nationally Determined Contribution. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Tunisia%20First/INDC-Tunisia-English%20Version.pdf

[48] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf

Rainfall and evaporation changes also impact degrees of surface water infiltration and recharge rates for groundwater and low-water storage capacity increases the country's dependence on unreliable rainfall patterns. Changes in rainfall and evaporation translate directly to changes in surface water infiltration and groundwater re-charge. This has the potential for further decreased reliability of unimproved groundwater sources and surface water sources during droughts or prolonged dry seasons. Increased strain on pump mechanisms can lead to breakdowns if maintenance is neglected and the potential for falling water levels in the immediate vicinity of wells or boreholes, particularly in areas of high demand. Additionally, temperature increases have the potential to result in increased soil moisture deficits even under conditions of increasing rainfall.

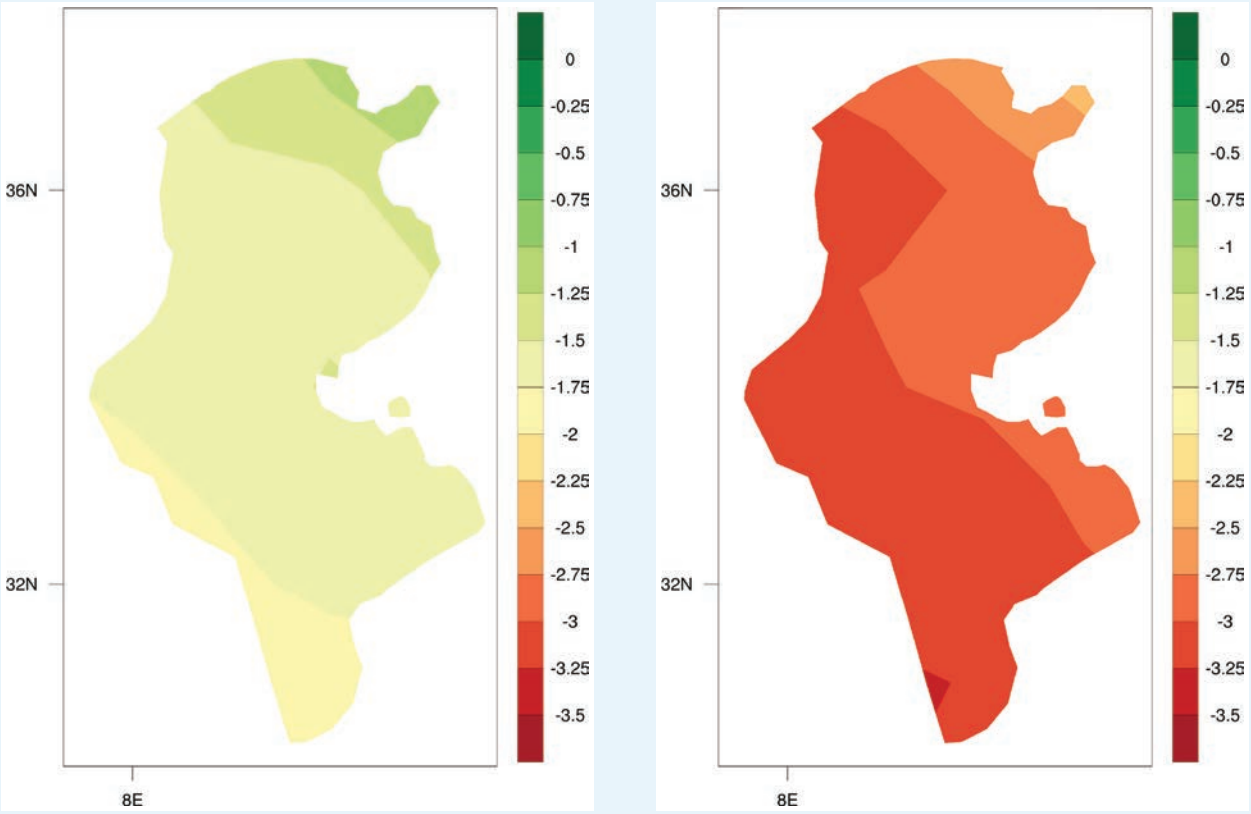
Figure 11 shows the projected annual Standardized Precipitation Evapotranspiration Index (SPEI) through the end of the century. The SPEI is an index which represents the measure of the given water deficit in a specific location, accounting for contributions of temperature-dependent evapotranspiration 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. This is an important metric in understanding for the water sector in regards to quantity and quality of supply for human consumption and agriculture use as well as for the energy sector as reductions in water availability impacts river flow and the hydropower generating capabilities. At a national scale, Tunisia is projected to experience significantly heightened dry conditions and significant drought severity, which will likely increase pressure on water resources for the country and region by mid-century and by end of the century. While Figure 10 shows nationally aggregated trends, **Figure 12** shows the spatial representation of SPEI across the country for the periods 2040–2059 and 2080–2099. As shown, the entire country will be under significant water stress, most acutely occurring in the central and northwestern areas in the 2050s and 2090s, respectively.

FIGURE 11. Annual SPEI Drought Index in Tunisia for the period, 1986 to 2099[49]



[49] WB Climate Change Knowledge Portal (CCKP, 2020). Tunisia Water Sector Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/water/land-use-/-watershed-management?country=TUN&period=2080-2099

FIGURE 12. Spatial representation of SPEI across Tunisia for the period 2040–2059 (left) and 2080–2099 (right), under RCP8.5



Adaptation Options

Various adaptation measures have already been implemented to enhance Tunisia's water usage efficiency. The Djerba desalinization plant became operational in 2018 and the Sfax, Zarrat, and Sousse desalinization plants are expected to be operational by 2020. Investments in these plants are projected to secure the drinking water supply required though 2030. The reuse of wastewater is another possibility and another ongoing adaptation effort. Additional efforts include the transference of surplus water from the extreme north to inland regions, water transference for city of Kairouan is under review and would require the expansion and connection of dams, transfer lines and additional storage facilities. Water and soil conservation have also been introduced as part of a new strategy integrating the impact of climate change on the country and to reduce water demand from key sectors such as agriculture.[50] The Tunisian Government has also committed to specific adaptation measures to transfer and reuse treated wastewater and to improve and secure the water supplies of large urban centers, especially Greater Tunis, Cap-bon, Sahel and Sfax.[51]

[50] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf

[51] Republic of Tunisia (2016). Nationally Determined Contribution. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Tunisia%20First/INDC-Tunisia-English%20Version.pdf

Energy

Overview

Tunisia's power sector is relatively well developed, and nearly the entire population enjoys access to the national electricity grid. Tunisia has a current power production capacity of 5,547 megawatts (MW) installed in 25 power plants, which produced 19,252 gigawatt hours in 2018. The State power utility, STEG, controls 91.5% of the country's installed power production capacity and produces 81% of its electricity. The remainder is produced by Tunisia's only independent power producer, Carthage Power Company. However, as a result of delays in power plant construction, the power sector does not possess excess generation capacity and is susceptible to brownouts. Peak summer electricity demand is often not met and the country's 5% annual growth in power consumption continues to add additional strain on the sector. Current power generation projects at various stages of design and development will help meet an expected doubling in electricity demand over the next 15 years. Approximately 97% of Tunisia's electricity is generated from fossil fuels, mainly natural gas. Nearly 45.5% of Tunisia's natural gas needs are met through imports (mainly from Algeria); local gas production comes from the concessions of the country's national exploration company and foreign companies' concessions. Just 3% of Tunisia's electricity is generated from renewables, including hydroelectric, solar, and wind energy.[52] Despite low economic growth, primary energy demand in Tunisia has increased steadily since the revolution, with gas demand quadrupling since 1990s' levels. While peak electricity demand increased at a high pace, the vertically integrated public electricity and gas utility has struggled to expand its installed generation capacity, which grew by only 3.6% per year between 2010 and 2018 (as opposed to 7%–8% per year in the 2000s). Additionally, customer payment discipline has declined and average gas prices have continued to increase, increasing strain on the sector.[53]

Climate Change Impacts

Increasing temperatures and the increased frequency and intensity of aridity and drought are expected to further increase energy demand. Changes in demand are likely to be through the expansion of peak-hour patterns, air conditioning intensity needs and the increased need for water desalination (used in processing and station cooling). The existing infrastructure and generation capabilities are ill-prepared to cope with the projected effects of climate change and the increased demand. Existing energy systems are at risk of system failures and increased/ expanded energy outages.[54] Additionally, the projected decrease in precipitation and change in seasonal rainfall patterns are likely to reduce hydropower generation potential as well as the potential for revenue loss due to overbuilt hydropower, which may be under supplied. Increased evaporation rates from existing water storage facilities will also increase production costs, resulting in increased prices for consumers. Increased temperatures and changing rainfall patterns may also alter the seasonal demand for energy, increasing demand during peak loads with a projected increase in net electricity usage.[55] While Tunisia has planned to increase its renewable energy consumption by up to 30% by 2030, infrastructure and investment have yet to keep pace with these goals.[56]

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[52] US Department of Commerce (2019). Tunisia – Electrical Power Systems and Renewable Energy. URL: https://www.export.gov/article?id=Tunisia-Electrical-Power-Systems-and-Renewable-Energy

[53] World Bank (2019). Energy Sector Improvement Project – Tunisia. URL: http://documents.worldbank.org/curated/en/296941561687292260/pdf/Tunisia-Energy-Sector-Improvement-Project.pdf

[54] Middle East Institute (2012). Implications of Climate Change on Energy and Security in the MENA Region. URL: https://www.mei.edu/publications/implications-climate-change-energy-and-security-mena-region

[55] World Bank (2019). Energy Sector Improvement Project – Tunisia. URL: http://documents.worldbank.org/curated/en/296941561687292260/pdf/Tunisia-Energy-Sector-Improvement-Project.pdf

[56] Chibani, A. (2018). Climate Change Mitigation in Tunisia: Challenges and Progress. EcoMENA, 26 March, 2018. URL: https://www.ecomena.org/climate-change-tunisia/

Cooling Degree Days shows 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 cooling demand (power demands) might increase. As seen in **Figure 13**, seasonal increases for cooling demands are expected to increase over an extended summer period (May 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 shown in **Figure 14**, warm spells are expected to sharply increase in the second half of the century, especially under RCP8.5.

FIGURE 13. Change in Cooling Degree Days (65°F) in Tunisia for the period 2040–2059[57]

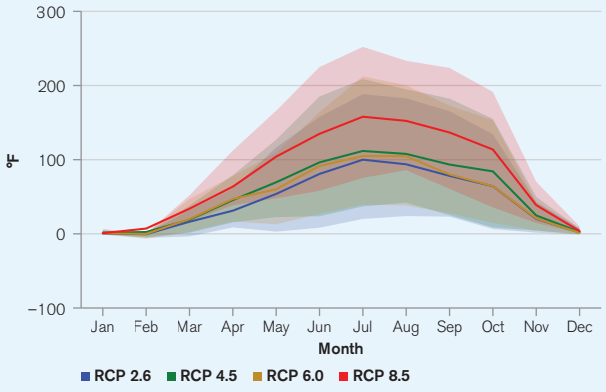
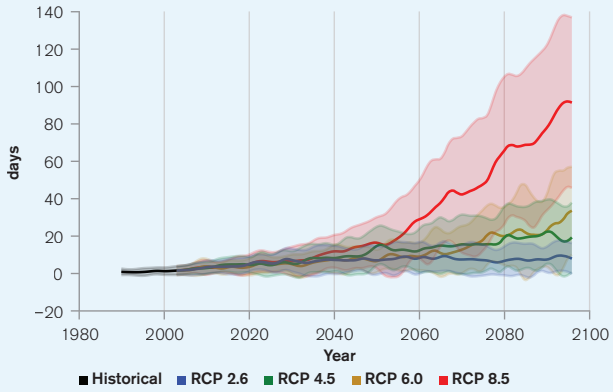


FIGURE 14. Warm Spell Duration Index in Tunisia for the period 1986 to 2099[58]



Adaptation Options

As a result of Tunisia's growing domestic energy demand, the government is working to diversify its energy supply and specifically, to increase the amount of power generated from renewable sources, particularly hydro and solar. However, electricity consumption continues to outpace generation capacity and expansion. While Tunisia was once a net exporter of oil and gas, the country has become heavily dependent upon external supply to meet energy needs. More than half of the country's natural gas, 72% of which is used for energy production, is imported form Algeria. Dependency on energy imports reached 51% in 2018; a significant strain on the country's energy security.[59]

Tunisia should continue towards the development and implementation of innovative new regulatory and finance models to increase efficiency, especially for utilities and, ultimately implement customer energy savings programs and new approaches to the delivery of electricity, including renewable energies. The government has committed to build institutional and technical capacities of different units in the energy sector in specific response to climate change issues. Increased support for research and technological development should also be implemented to enable the electricity sector to deal more effectively with climate change.[60]

[57] WB Climate Change Knowledge Portal (CCKP, 2020). Tunisia – Energy. URL: https://climateknowledgeportal.worldbank.org/country/tunisia/climate-sector-energy

[58] WB Climate Change Knowledge Portal (CCKP, 2020): Tunisia Energy Sector Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/energy/oil-gas-and-coal-mining?country=TUN&period=2080-2099

[59] World Bank (2019). Energy Sector Improvement Project – Tunisia. URL: http://documents.worldbank.org/curated/en/296941561687292260/pdf/Tunisia-Energy-Sector-Improvement-Project.pdf

[60] Middle East Institute (2012). Implications of Climate Change on Energy and Security in the MENA Region. URL: https://www.mei.edu/publications/implications-climate-change-energy-and-security-mena-region

Health

Overview

More than 90% of Tunisians are covered through the country's health insurance schemes or free medical assistance programs, which are provided for vulnerable populations; public health facilities provide preventive services free of charge, regardless of income.[61] Tunisia has experienced rising living standards over the past decades due to the successes of national health programs such as the reduction of infant mortality (from 51.4% in 1985 to 16.3% in 2014). As of 2015, the state budget allocated 5.6% towards health efforts (1.9% of GDP). Overall, Tunisians benefit from an extensive offer of care but challenges remain such as strong regional inequalities and a growing demand of healthcare due to an aging population. Finally, the presence of doctors in rural areas remains scarce, causing difficulties to access health care facilities in some areas.[62] Health challenges continue to disproportionately affect the rural poor and have the potential to impact the country's economic prosperity more broadly over the long-term. The system remains fragmented, particularly for rural and poor areas and as such, the centralized nature of the national system has often resulted in lack of responsiveness to unique local needs or geographical disparities.[63]

Climate Change Impacts

For Tunisia, the projected increase in heat waves, dust storms, coastal flooding, and extreme weather events are likely to have a significant impact on the health of the population, with the urban poor particularly at risk. Given the projection of higher temperatures, a resurgence of vector borne diseases such as malaria, leishmaniasis, dengue, and West Nile fever are expected. Changes in rainfall patterns as well as temperatures may change the geographical distribution of insect vectors of these diseases, such as mosquitoes or sandflies.[64]

The rise in temperature is likely to exacerbate respiratory diseases, and water-borne diseases may spread due to degradation of the quality of water resources. The current deterioration of water quality and related health risks are caused by a lack of water sterilization. Access to drinking water, sanitation and hygiene may become more difficult, resulting in new break outs of pathogenic microorganisms and potential bacteriological contamination. Vector borne diseases and water contamination are expected to affect rural areas in particular, mainly in the center and north-west part of Tunisia, where access to drinking water and sanitation is already limited.[65] The increase of heat waves and heat islands could strongly increase respiratory diseases. Increase in the CO_2 content of the atmosphere, degrading the air quality, would also contribute to increased risks of heart attacks, strokes and respiratory infections. People living in urban areas should be more affected because of greater pollution by fine particles and higher CO_2

[61] WHO (2013). Tunisia: Health Systems Profile – key health system indicators. URL: http://applications.emro.who.int/docs/Country_profile_2013_EN_15402.pdf

[62] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf

[63] WHO (2013). Tunisia: Health Systems Profile – key health system indicators. URL: http://applications.emro.who.int/docs/Country_profile_2013_EN_15402.pdf

[64] WHO (2015). Climate and Health County Profile – Tunisia. URL: https://apps.who.int/iris/bitstream/handle/10665/246121/WHO-FWC-PHE-EPE-15.46-eng.pdf?sequence=1

[65] Republic of Tunisia (2016). Nationally Determined Contribution. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Tunisia%20First/INDC-Tunisia-English%20Version.pdf

content in the air. The increase in droughts and floods is likely to also destabilize the agricultural sector, which could have a significant impact on food security in the country, causing an increase in malnutrition.[66]

Increasing temperatures are of increasing concern for Tunisia. For the country, the annual distribution of days with a high-heat index provides insight into the health hazard of heat. **Figure 15** shows the expected Number of Days with a Heat Index >35°C for the 2090s; showing a sharp increase by mid-century and continuing to sharply increase by end of the century, under a high-emission scenario. It also shows night temperatures (>20°C), which are expected to rapidly increase in a high-emission scenario. Increased health threats can be projected and monitored through the frequency of tropical nights. Tropical Nights (**Figure 16**) represents the projected increase in tropical nights for different emission scenarios to demonstrate the difference in expected numbers of tropical nights.

FIGURE 15. Days with a Heat Index >35°C[67]

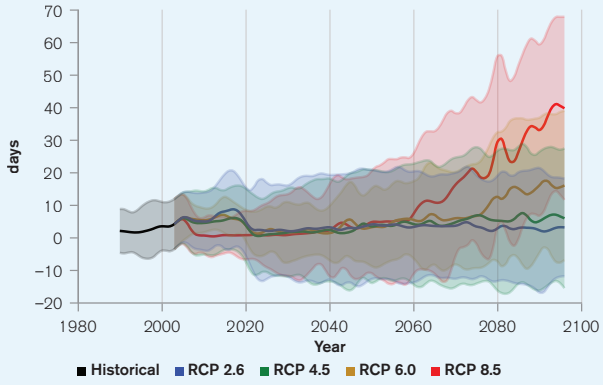
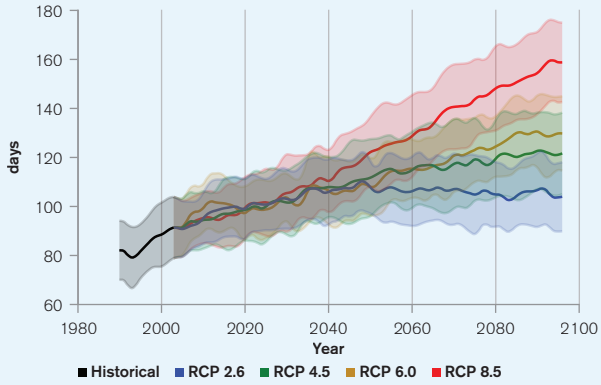


FIGURE 16. Number of Tropical Nights (Tmin >20°C)[68]



Adaptation Options

Tunisia's Ministry of Health is responsible for vector disease fight and control, and has cooperated with the country's National Meteorological Institute to establish early warning systems for climate related health risks. An early warning system focused on new and emerging diseases was set up in 2008, in coordination with the National Observatory for New and Emerging Diseases. Furthermore, the health sector is focused on increasing and strengthening its health surveillance and risk mapping, that focus on health-related adverse conditions and a strengthened knowledge management and communication network for information sharing. The country is also working to expand its health system, including the expansion of district health offices, surveillance systems and vaccination for children.[69] Tunisia has also focused on communication and health education to encourage healthy behaviors and has committed to raising community awareness about climate change induced risks and adaptation options.[70]

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[66] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf

[67] WB Climate Change Knowledge Portal (CCKP, 2020). Tunisia Health Sector Dashboard. URL: https://climatedata.worldbank.org/CRMePortal/web/health/systems-and-service?country=TUN&period=2080-2099

[68] WB Climate Change Knowledge Portal (CCKP, 2020). Tunisia Health Sector. URL: https://climateknowledgeportal.worldbank.org/country/tunisia/climate-sector-health

[69] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf

[70] Republic of Tunisia (2016). Nationally Determined Contribution. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Tunisia%20First/INDC-Tunisia-English%20Version.pdf

Coastal Zones and Sea Level Rise

Overview

Tunisia has a coastline of 2,290 km, which is comprised of 1,280 km of continental coastline, 450 km of island coastline and 560 km of lagoons. The three main types of fishing found in Tunisia's coastal areas are trawling, lamp fishing, and inshore fishing. The main marine production area is located in Sousse, Monastir and Nabeul. The production of continental aquaculture, is mainly located in Béja. Tunisia's coastal zone also plays a vital role in the country's development and economic prosperity. The diverse coastal environment powers more than 80% of the country's economic activities, houses 90% of its tourism infrastructure, and is the site of a major share of the nation's irrigated agriculture.[71]

Climate Change Impacts

Tunisian coasts are at highl risk from sea level rise (SLR), coastal erosion and storm surges and a significant retreat of the coastline is expected by the end of the century. More than 3,000 ha of urban areas are considered vulnerable and threatened by submersion due to SLR, and more than half of these potentially submersible lands are residential urban areas located mainly in the city of Tunis and in the city of Sfax. Vulnerable zones also include 781 ha of industrial zones located mainly in Tunis and Sfax, and 560 ha of tourist zones largely located on the eastern side of the island of Djerba.

Tunisia has already lost more than 90 km of beaches due to erosion or due to the construction of artificial defense structures. Of the 570 km of existing beaches, 190 km are classified as very degraded and likely to disappear.[72] Tunisia is also expected to experience loss through the submersion of approximately 16,000 ha of agricultural land in low-lying coastal areas and approximately 700,000 ha of built-up areas. Salinization is expected to impact up to 50% of resources available in coastal aquifers, with the potential to indirectly jeopardize the sustainability of 38,000 ha of irrigable land by the 2050s (10% of currently irrigated land). The country's burgeoning tourism industry is expected to see a decline in activity due to retreating beaches, with losses estimated at USD 2 billion, approximately 0.5% of annual GDP. Losses are expected to occur primarily in the tourism sector (55%) and agriculture sector (45%), with the further loss of an estimated 36,000 jobs in tourism and agriculture sectors.[73]

The sustainability of fishing practices (foot-fishing, Charfia fishing) is also threatened by sea level rise. Inland fisheries are also threatened, especially on Kerkennah Island and it is estimated that the entire population of Kerkennah (15,500 inhabitants) for whom the only source of income comes from the sea (coastal fishing and

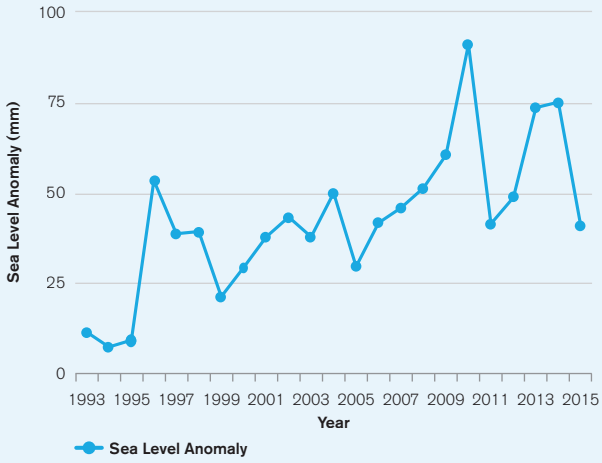
[71] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf

[72] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf

[73] Republic of Tunisia (2016). Nationally Determined Contribution. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Tunisia%20First/INDC-Tunisia-English%20Version.pdf

sponge fishing) will be affected. Moreover, human activities have already degraded ecological habitats on the Tunisian coastline. These degradations are likely to increase with SLR, the water warming and the increase of its salinity. Ecosystems' degradation could be accompanied by a proliferation of invasive alien species, as already observed for the blue crab (Portunis segnus), the Atlantic tropical crab (Libinia dubia) and the false Red Sea shrimp (Erugosquilla massavensis), which threaten the fish and seafood richness, as well as the fishing activity.[74] **Figure 17** shows the change in sea level for Tunisia since 1993.

FIGURE 17. Sea level anomaly of Tunisia, 1993–2015[75]



Adaptation Options

Tunisia is committed to enhancing the adaptive capacity and resilience of its coastal areas and recognizes that without major efforts, the physical, human and financial impacts are expected to be significant. While coastal protection to sea level rise is often costly, adaptation and mitigation efforts undertaken now are expected to reduce damage and loss in the long-term.[76] Tunisia has already protected approximately 30 km of its coastline through coastal defense structures, however new problems have emerged from these structures such as the disfigurement of the landscape, accumulation of algae, eutrophication of water in closed creeks, sedimentary imbalances, aggressive erosion in adjoining areas. The country's Coastal Protection and Development Agency (continues to search for new flexible methods for the protection of the coastline. These include beach top stabilization techniques such as beach replenishments, anti-wind poles and stabilization by geo-containers. A total of 6.5 km of coastline has already been protected between the sites of Tabarka, Korba, Bni Khiar, Mahdia, Chebba, Gabes and Jerba. The ongoing Tunisian Coastal Protection Program aims to protect an additional 27 km of coastline against erosion and marine submersion for the sites of Kerkennah, Rafraf, Sousse North, Soliman, Tabarka and Hammamet. Significant need remains in order to strengthen the country's institutional framework, governance, regulatory measures, knowledge and capacity to cope with this important challenge of accelerated SLR.[77] Efforts should also be made to increase community awareness about the risks of coastal zone erosion, aquifer salinization and sea level rise.

[74] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf

[75] WBG Climate Change Knowledge Portal (CCKP, 2020). Tunisia Impacts – Sea Level Rise. URL: https://climateknowledgeportal.worldbank.org/country/tunisia/impacts-sea-level-rise

[76] Brown, S. et al. (2011). Sea Level Rise and Impacts in Africa. URL: https://www.weadapt.org/sites/weadapt.org/files/legacy-new/placemarks/files/536cec204b2ea50585fbd9967d9-sea-level-rise-report-jan-2010.pdf

[77] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf

Institutional Framework for Adaptation

Tunisia was one of the first countries to integrate climate change within its Constitution, however it has yet to officially designate an institution to coordinate climate change related public policy and action. Currently, the primary institutions that support the coordination of climate change agendas and adaptation efforts are the Ministry of Local Affairs and Environment, the National Agency for Energy Management, the Ministry of Agriculture, and the Ministry of Water Resources and Fisheries. These agencies also serve as the Designated National Authority for the Clean Development Mechanism of the Kyoto Protocol. Sectoral specific agencies also contribute to the development of policies and measures to fight climate change.[78] The government has been relatively progressive in addressing its climate change needs and has focused on the increased participation of its citizens and made investment for improved decision making of social, economic and environmental issues related to climate change. The government has also worked bi-laterally with the FAO, World Bank, and United Nations to identify additional adaptation measures that can be undertaken. Tunisia has prioritized its wastewater management as a means to combat current and future water scarcity and usage inefficiency. The National Water Council, established in 2013, is responsible for updating water policies and strategies.[79]

Policy Framework for Adaptation

Tunisia submitted its Third National Communication in 2019, its Second Biennial Report in 2016, and its Nationally-Determined Contributions to the UNFCCC in 2016. These strategies are largely built on existing sectoral and cross-cutting national strategies, such as Tunisia's National Climate Change Strategy (2012), the Energy Efficiency Strategy, and the Tunisian Solar Plan. Tunisia is committed to increasing its adaptive capacity to climate change and increase sector collaboration.[80] To increase its adaptive capacity to projected impacts from climate change, Tunisia is committed to the increased use of renewable energy, advancing locally-appropriate and more efficient technologies to improve the country's energy efficiency and increase its water management effectiveness.[81]

National Frameworks and Plans

- Third National Communication (2019)
- Second Biennial Update Report (2016) French
- Nationally-Determined Contribution (2016)
- Second National Communication (2014) French
- De-Risking Renewable Energy Investment (2014)
- First National Communication (2001) French

[78] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf
[79] USAID (2018). Tunisia – Climate Risk Profile. URL: https://www.climatelinks.org/sites/default/files/asset/document/Tunisia_CRP.pdf
[80] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf
[81] Republic of Tunisia (2016). Nationally Determined Contribution. URL: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Tunisia%20First/INDC-Tunisia-English%20Version.pdf

Recommendations

Research Gaps

- Gain a better understanding of the timing and magnitude of incidence of several important indicators of climate change in the future, as well as the key vulnerabilities, development impact, and possible adaptation responses specifically for water resources and sea level rise
- Widen the participation of the public, scientific institutions, women and local communities in planning and management, accounting for approaches and methods of gender equity
- Strengthen environmental monitoring capabilities more effective environmental management
- Implement Monitoring, Verification and Reporting (MRV) systems to assist the country in managing climate change impacts and needed adaptation and mitigation strategies
- Increase understanding of risks and impacts to Tunisia's coastal zones, sea level rise impacts and coast agricultural zones.
- Strengthen the technical capacity to integrate climate-smart agriculture and climate change risk management into farmer's and the wider agricultural sector
- Design and implement a Technology Needs Assessment to understand needs of technology transfer and capacity building
- Increase capacity across sectors to understand climate change risks and adaptation needs[82]

Data and Information Gaps

- Develop early warning systems about dangerous hydrometeorological phenomena and climate risk management, specifically for sea level rise, water resources and health impacts
- Improve early warning systems specifically to support the agriculture, livestock and water resources sectors better prepare for increased aridity and longer dry seasons
- Ensure that nation-wide climate change and early warning systems are maintained, including monitoring networks at appropriate spatial density and frequency

Institutional Gaps

- Ensure integration of Tunisia's National Climate Change Strategy goals are developed within sectoral and regional plans and in line with financial opportunities with donors
- Develop a national monitoring, reporting and verification system
- Support facilitation of energy efficiency options through improved financing options and legal backing for public-private partnerships[83]
- Implement cross-sectoral climate-smart solutions at national and subnational levels for Tunisia's key sectors

[82] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf

[83] Tunisia (2019). Tunisia's Third National Communication as part of the UNFCCC. URL: https://unfccc.int/sites/default/files/resource/Synth%C3%A8se%20Ang%20Finalis%C3%A9.pdf

CLIMATE RISK COUNTRY PROFILE

TUNISIA

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