MIDDLE EAST AND
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Tunisia

World Bank Group

COUNTRY CLIMATE AND DEVELOPMENT REPORT

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1818 H Street NW, Washington, DC 20433
Telephone: 202-473-1000; Internet: www.worldbank.org

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Acknowledgements

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Acronyms and abbreviations

ANME	Agence Nationale pour la Maitrise de l'Energie (National Agency for Energy Management)
BAU	Business as usual
capex	Capital expenditure
CBAM	Carbon Border Adjustment Mechanism
CCDR	Climate Change and Development Report
CCS	Carbon capture and storage
CMIP	Coupled Model Implementation Project
CO2	Carbon dioxide
CPAT	Climate Policy Assessment Tool
CRDAs	Regional Commissions for Agricultural Development
DRF	Disaster risk finance
FNAC	National Forum of Climate Change Adaptation Actors
GDAs	Agricultural development groups
GDP	Gross domestic product
GHG	Greenhouse gas
GoT	Government of Tunisia
ICZM	Integrated coastal zone management
kWh/m3	Kilowatt-hours per cubic meter
LPG	Liquefied petroleum gas
LT-LEDS	Long-term low GHG greenhouse gas emission development strategy
m3	Cubic meters
MFMOD	Macroeconomic and fiscal model
Mm3	Million cubic meters
MoE	Ministry of Environment
ONAS	National Sanitation Office
PV	Photovoltaic
SOE	State-owned enterprise
SONEDE	National Water Works and Distribution Company
SSP	Shared Socioeconomic Pathway
TD	Tunisian dinars (currency)

TVET	Technical and vocational education training
MARHP	Ministry of Agriculture, Water Resources, and Fisheries
MRV	Monitoring, review, and verification
MW	Megawatt
MWh	Megawatt-hours
NAP	National Adaptation Plan
NDC	Nationally Determined Contribution
PPP	Public-private partnership
RCP 4.5	Representative concentration pathway of 4.5 (stabilized emissions scenario)
RCP 8.5	Representative concentration pathway of 8.5 (worst-case climate change scenario)
SMEs	Small and medium enterprises
SDGs	Sustainable Development Goals
SNBC&RCC	Stratégie Nationale Bas-carbone et Résiliente au Changement Climatique (National Low Carbon Strategy and Climate Resilience Strategy)
STEG	Société Tunisienne de l'Electricité et du Gaz (the Tunisian Company of Electricity and Gas)
STIR	Société Tunisienne des Industries de Raffinage (the Tunisian Company of Refining)
UGPO-CC	Unité de Gestion par Objectif–Changements Climatiques
UNFCCC	United Nations Framework Convention on Climate Change
VAT	Value-added tax
WWTP	Wastewater treatment plant

Executive Summary

Tunisia can reconcile a new economic model with the foundations for a durable, resilient development to accelerate economic recovery, secure jobs, and livelihoods in line with the government's strategies.

Tunisia is navigating a delicate economic situation amidst a changing political context. The political reforms that followed the 2011 revolution led to a lack of economic reforms and support to tackle pervasive barriers to investment, innovation, and economic activity. A series of negative shocks—including the conflict in Libya, terrorist attacks, and, more recently, the COVID-19 pandemic and commodity price increases linked to the Russian invasion of Ukraine—exacerbated this fragility. As a result, economic growth slowed (averaging 1.4 percent between 2011 and 2022, down from 3.5 percent between 2000 and 2011), and progress on reducing poverty slowed. Rising unemployment and inflation exacerbated social demands and political instability, eventually leading to political changes in July 2021 that include a new constitution and the introduction of a presidential system. With a stagnating economy, Tunisia has increasingly relied on recurrent public expenditures to meet citizens' needs without sufficiently tackling the root causes of economic problems. This rapid rise of recurrent expenditures, exacerbated by recent shocks, has led to growing fiscal and current account deficits as well as a mounting stock of debt that is increasingly difficult to finance.

Tunisia's economic challenges have been compounded by an increasing vulnerability to climate change. The country's location makes it one of the most exposed to climate change in the Mediterranean region, with temperature increases expected to be accompanied by reduced and more variable precipitation; a rising sea level with saltwater intrusion; an increase in forest fires; and escalating extreme weather in the form of floods and droughts. These climate-linked effects will deplete natural resources, exacerbate water scarcity, and drive losses of agriculture and coastal infrastructure. Some of these effects are already taking a toll. Four years of drought conditions culminated in a significant drop in Tunisia's agricultural production in 2022/23. Vulnerability to increasingly frequent and severe extreme weather events (especially flooding) and sea-level rise will also increase, as will the costs of coping with these risks. Some of these issues will drive energy demand (for example, for desalination, pumping, and cooling), resulting in higher emissions and air pollution while increasing dependency on imports.

This Climate Change and Development Report (CCDR) establishes the case for a new economic model to address Tunisia's challenging economic and social context and vulnerability to climate change. Building on extensive analyses and consultations (see Box 1 for our approach), the CCDR calls for a new model that emphasizes the role of the private sector in generating most jobs, while the state focuses on its regulating function, funding expenditures with the highest social and economic returns, and directing resources to interventions that are both economically and environmentally sustainable. The proposed model would involve major changes, such as using pricing to rationalize the consumption of resources and creating economic conditions that support private investments in climate adaptation and decarbonization. It would also involve a shift from recurrent public expenditures to public investments in adaptation and decarbonization.

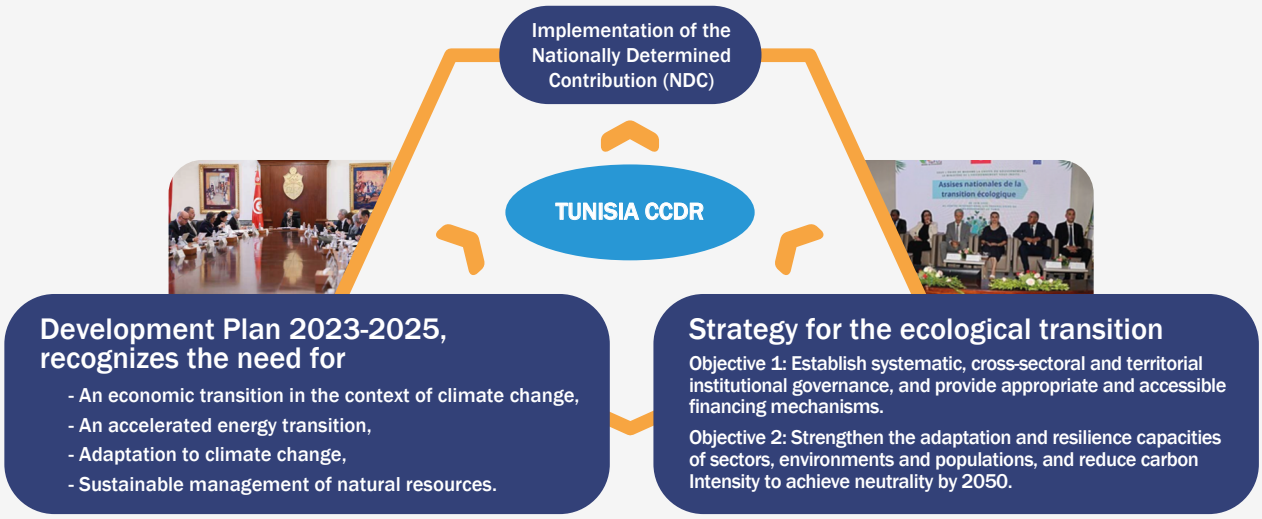
Box 1: About this Climate Change and Development Report

This Climate Change and Development Report (CCDR) explores the relationship between Tunisia's development goals and climate change, in terms of both risks and opportunities. Building on a body of quantitative and qualitative research as well as on modeling exercises, it analyzes the interplay between the country's development goals and climate change, examining the risks that climate change poses to development, as well as the opportunities stemming from the global trend toward decarbonization. Finally, it explores public policy and investment options that could achieve both climate and inclusive development objectives in a synergistic manner. The scenarios and policy options presented in the CCDR are informed by, but may differ from, national energy and climate policies and strategies. For example, the CCDR reference scenario for the energy sector is based on a least-cost optimization scenario that shows more ambitious results than the national strategy objectives.

This CCDR adopts an inclusive approach. To develop a better understanding of the on-the-ground effects of climate change already experienced in Tunisia today, the team engaged with a broad pool of stakeholders including the government, civil society, and key segments of the private sector. These engagements highlighted the potential benefits, impacts, and trade-offs for ecosystems and the most vulnerable pockets of society. They also validated the need for a two-pronged approach towards climate change resilience, adaptation, and mitigation that includes strengthening the legal framework to address Tunisia's needs in the energy, water, and urban sectors, and improving tangible and effective coordination between institutional, private, and civil-society actors.

The multisectoral engagements helped the team identify and verify the assumptions underlying the climate and development scenarios modeled in this report. The assumptions consider national and local economic and sectoral conditions (including financing options and the availability of technical skills); existing climate strategies, initiatives, and technologies; and opportunities emerging beyond Tunisia's borders in the context of a decarbonizing world.

Alignment with and contribution to country strategies



Source: Country Climate and Development Report

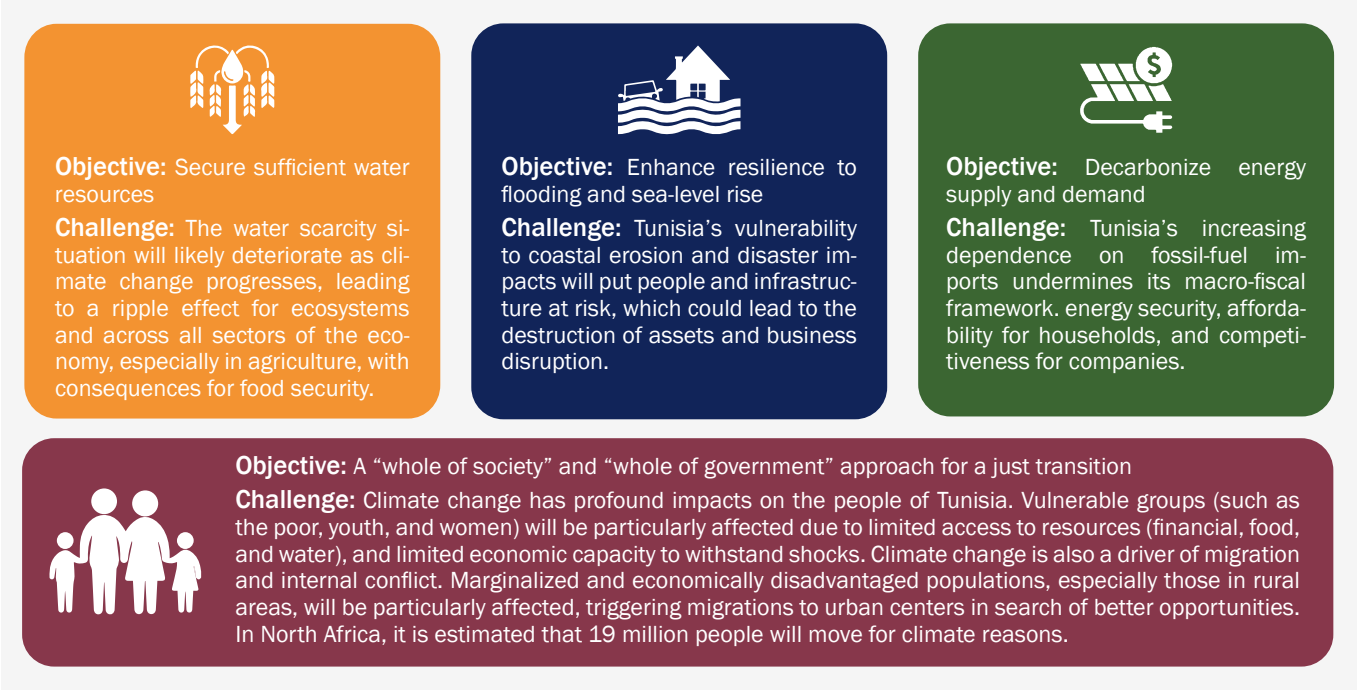
The Government of Tunisia has been developing high-level strategies to address climate change and foster an ecological transition, but the implementation of these strategies remains elusive. The country recently launched its National Strategy for Ecological Transition (SNTE, 2023/35/50), which seeks to implement a resilient, sustainable, socially fair, and inclusive development model that changes existing ways of consuming, producing, working, and living while promoting conservation, carbon neutrality and circularity. In addition, Tunisia's 2023–2025 Development

Plan recognizes the need for economic transition in the context of climate change, identifying the investment that will be needed to achieve the transition (TD 6.7 billion, or US$2.2 billion).[1] Tunisia has further committed to the ambitious goals of reducing unconditional 2030 emissions intensity by 27 percent and conditional emissions by 45 percent (against a 2010 baseline). Despite these commitments, funding shortages, frequent changes in government, public sector constraints, and an escalating fiscal deficit (driven in part by the limited efficiency in the energy public spending) have restricted state implementation of climate action.

Water scarcity, coastal erosion and flooding, and the energy sector's dependence on fossil fuels are Tunisia's most important development and climate challenges. Failing to address them would be costly for the economy in the near term.

Failing to take urgent and decisive action on the above objectives could result in significant socioeconomic, political, and humanitarian repercussions (summarized in Figure 1).

Figure 1: Summary of economic development and climate challenges

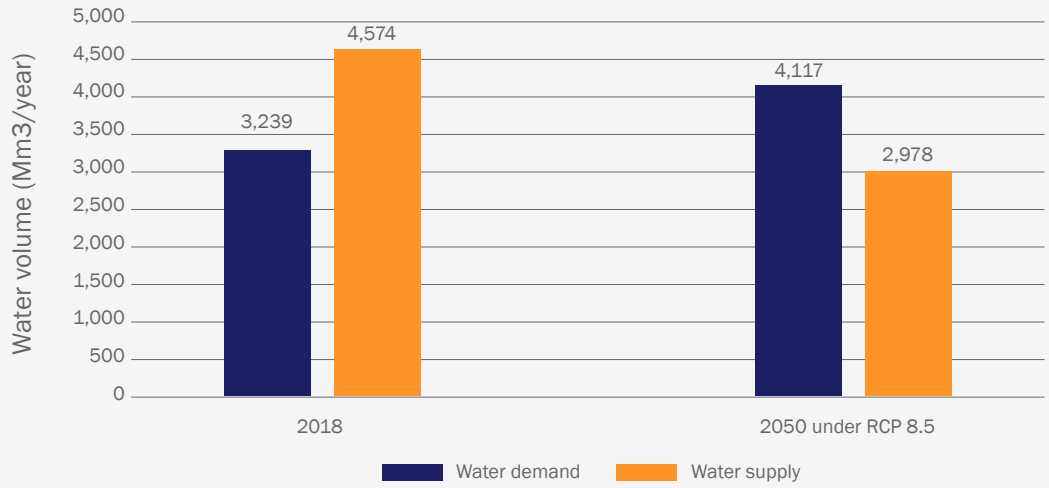


Water scarcity is already impacting almost every aspect of Tunisia's socioeconomic development. Water demand has increased in recent years due to urban growth, a rising population, and increased irrigation needs. By 2050, a simultaneous increase in the frequency and the intensity of climate change-induced extreme weather events is expected to drive a decline in water availability, with demand outstripping supply by 28% under a representative concentration pathway of 8.5 (RCP 8.5), which is the worst-case climate change scenario (Figure 2).[2] In all climate change scenarios, water quality and the storage capacity of dams decrease, while the incidence of water-borne diseases increase. Agricultural losses, especially in Tunisia's main agriculture systems (olive, oasis, cereal, and livestock), also increase, as do the incidence of disease, with the poor being the most vulnerable to these compounding impacts.

[1] See the preliminary version of the development plan 2023-2025.

[2] While long-term greenhouse gas emissions under an RCP 8.5 scenario are widely considered overly pessimistic, the Coupled Model Implementation Project (CMIP) climate change scenarios with RCP 8.5 (CMIP 5) provides a useful (and not implausible) high-warming forecast that is consistent with continued GHG emissions and high climate-change sensitivity or positive feedback from the carbon cycle.

Figure 2: Water supply and demand in 2018 (no drought conditions) and under RCP 8.5 with no action

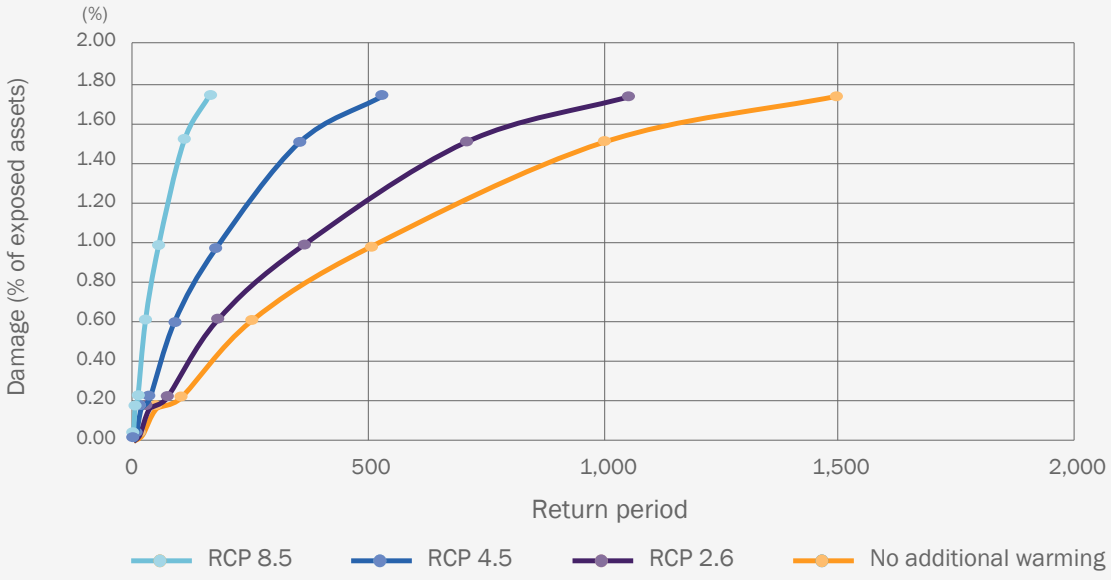


Source: World Bank staff estimation.

A significant share of Tunisia's land is exposed to climate-induced risks of shoreline erosion, permanent submersion from sea-level rise, and flooding. Climate change is expected to drive greater variability of precipitation, which increases the likelihood of catastrophic floods and associated asset damages as a one-in-1,500-years flood becomes a one-in-163-years flood under RCP 8.5 (Figure 3). Under both Shared Socioeconomic Pathway 2 (SSP2) and SSP3, 0.4 percent of the total land area in Tunisia—which includes 24 percent of the populous linear coastal distance—are likely to be affected by sea-level rise by 2050. Land losses[3] due to sea-level rise could amount to US$1.6 billion (SSP3), although this figure may reduce to US$44 million under SSP1 while adopting a strong integrated coastal zone management approach.

[3] Land losses have been evaluated using the discounted unit cost/coastal land market price (without considering the value of the lost economic activities on the land). The valuation has been done for each type of land use using different sources, including Heger and Vashold 2021, cited in Heger et al 2022.

Figure 3: Likelihood of flooding under different RCP scenarios



Source: World Bank staff estimation.

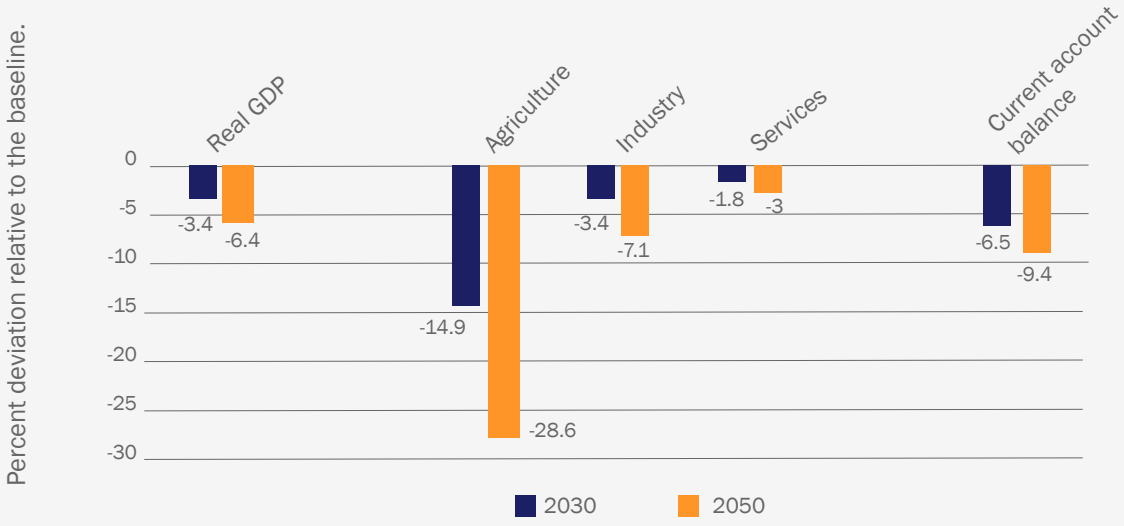
Surface area loss will result in pronounced indirect losses, with the tourism sector being among the worst affected. Assuming no adaptation measures are taken to protect the tourism sector in coastal zones, the direct and indirect consequences of surface area loss by sea-level rise would cost the Tunisian economy up to 6.9 percent of 2020 GDP by 2050 due to cascading impacts on hotel, restaurant, and catering activities; public revenue; tourism-related economic activities; and jobs.

If Tunisia does not urgently address these climate change-related risks, particularly water shortages, the economy could shrink by 3.4 percent of GDP by 2030 (close to TD 5.6 billion a year [US$1.8 billion] in net present value). Our modeling suggests that, compared with a baseline based on past trends, unaddressed water shortages, coastal erosion, and flooding could reduce real GDP by 3.4 percent in 2030 (under RCP 8.5). These annual losses could grow to 6.4 percent of GDP by 2050, or TD 10.4 billion (US$3.4 billion) in net present value terms. A large share of these losses is driven by the impacts of water shortages. The agricultural sector would therefore be particularly affected, with its value added expected to fall by 15 percent by 2030 (and by 29 percent by 2050). A decline in agricultural production would reduce net exports, while imports would increase to bridge the resulting supply-demand gap. Under this scenario, the current account deficit could deteriorate by more than 6 percent in 2030. This would exacerbate Tunisia's already fragile external balance. In addition, by 2030 the poverty rate would increase to 21.3 percent, which is a 1.5 percent increase relative to the baseline scenario.[4]

[4] Based on the official poverty line calculated in the 2015 Household Budget Survey of Tunisia's National Statistics Institute.

Figure 4: The economic costs of climate inaction

(Percent deviation of the scenario if no action is taken to reduce climate stressors in a business-as-usual scenario)



Source: World Bank staff estimation.

Decarbonizing the energy sector, which is 99 percent fossil-fuel based, would enhance Tunisia's energy security and consequently reduce its current account deficit, making it less vulnerable to international price fluctuations. The CCDR analysis indicates that energy import dependency would be reduced from 50 percent in 2022 to 2 percent in 2050 in a "deep decarbonization" scenario (see scenarios discussion under "Decarbonized energy supply", below). Decarbonizing the energy sector would help to reduce energy costs, making energy more affordable for households and companies while supporting Tunisia's ambition of becoming a regional energy hub for clean energy trade between African countries and Europe. Failing to decarbonize the energy sector, which accounts for 58 percent of the country's greenhouse gas (GHG) emissions, would make it difficult for Tunisia to comply with its Nationally Determined Contribution (NDC) obligations. The country's current account deficit and financing conditions would limit its ability to import the energy it needs to meet growing demand, and economic activity would be stifled.

Addressing water scarcity, enhancing the resilience of urban and coastal areas to climate stressors, and decarbonizing the energy sector would yield substantial developmental gains for Tunisia in the near term.

Enhanced water management and increased water supply

Managing water demand and improving efficiency are essential for maximizing existing conventional water resources. The country would benefit from prioritizing, among other measures, the regulation of water demand and targeted awareness campaigns. Iinstitutional reforms and establishing a water-monitoring and early-warning system would further enhance water governance and management. Strengthening the technical and financial capacities of institutions—including professional organizations and those in rural areas—will likely be critical for the effectiveness of water policies. Since water-related challenges in rural areas particularly affect women, this group should play a more active role in making decisions relating to the management of water resources.

Tunisia would benefit from drawing on non-conventional water sources to cope with demand-supply imbalances. Conventional water resources are almost fully utilized, and the development of additional built water storage will require thoughtful and purposeful design. Combining desalination with wastewater reuse could increase water supply by 693 million cubic meters (Mm^3), according to Tunisia's Water 2050 strategy.[5]

[5] Tunisia's Water 2050 strategy is available here: http://www.onagri.tn/uploads/Etudes/ITES-eau2050.pdf

Increased resilience and efficiency of the agricultural sector including through nature-based solutions

As the main consumer of water, the agriculture sector has an important role to play in improving irrigation efficiency to reduce water demand. The implementation of nature-based solutions can further increase water availability. To protect rural areas from climate-induced income stress, smallholder farmers (including herders) would benefit from upgrading their operations with climate-smart practices to increase productivity and promote more resilient, rainfed agriculture. Nature-based solutions—especially those that support the recharge of groundwater reservoirs by conserving and restoring forests, watersheds, wetlands, and oases landscapes—will play a crucial role in mitigating the anticipated decline in surface water.

Coastal zones defended against sea-level rise

Targeted interventions to protect coastal zones and their economic activities may help prevent some of the damage that could be caused by sea-level rise. The type of intervention depends on the coastal zone. For natural areas with assets (such as beaches), primary interventions would usefully focus on soft defense measures like adding sediment or sand along the shoreline (beach nourishment), conserving dunes, or implementing nature-based solutions such as increasing vegetation cover to stabilize soil. Developing a diversified tourism value chain—that is, one that offers year-round tourism that takes advantage of unique inland landscapes and heritage assets as well as coastal attractions—would further reduce risks to the tourism sector.

Critical infrastructure protected against flooding and sea-level rise

Tunisia would benefit from investing in enhancing multimodal transport to increase the resilience of the transportation network. Increased investment in railways would strengthen Tunisia's transport network resilience because having multiple modes of transport introduces alternatives into the overall transportation system. Seaports play a critical role in importing essential goods and present opportunities to improve resilience by upgrading infrastructure and strengthening connectivity with land transport, particularly railways. Resilience could be integrated into transport policies and mainstreamed in investment planning, programming works, the design and engineering of infrastructure assets, and the operation and maintenance of facilities, including when this is done by public-private partnerships.

Institutional mechanisms could usefully ensure that climate change risks are systematically included in infrastructure, land use, and urban planning. Tunisia has taken significant steps to improve its resilience to disasters, including publishing the 2030 National Disaster Risk Reduction Strategy and its Action Plan. Nonetheless, opportunities remain to improve its resilience, including updating and enforcing building codes and design standards, especially of key public infrastructure. Improving infrastructure resilience involves strengthening the capacity and authority of local institutions to manage and protect assets. Integrated coastal zone management (ICZM) has proven to be a successful tool for managing coastal erosion.

Social protection enhanced and insurance schemes developed

Improving the financial resilience of households, farmers, and businesses can protect the population's well-being in the face of climate risks. Disaster risk financing and insurance can address residual risk after disaster risk reduction efforts have reduced the impacts of disasters. Updating the social registry of the country's main social assistance program, AMEN, to include all vulnerable households would help with the issue of early warnings and would support a speedy response to potential future climate shocks.

Decarbonized energy demand in end-use sectors

An "avoid-shift-improve" framework is useful when considering decarbonization measures for the transport sector. "Avoid" refers to meeting mobility needs with fewer vehicular travels (for example, by digitalizing services, reforming the trucking industry to encourage the consolidation of demand, or by urban planning). "Shift" refers to switching from the currently dominant model of using private cars to more sustainable modes of transport that include walking, cycling, and using public transport or rail. "Improve", meanwhile, refers to improving the energy efficiency of vehicles and promoting electromobility and the integration of green hydrogen. Concrete policies and initiatives would send clear signals to the market to encourage the transition to a sustainable transport system that uses less fossil fuel and more clean energy.

For the industrial sector, cost-effective measures include improving production efficiency; increasing the use of alternative, cleaner fuels (including renewable energy through electrification and green hydrogen); reducing waste along product lifecycles; and using carbon capture and storage (CCS). Despite being aware of climate mitigation requirements, few companies demonstrate climate preparedness. Decarbonization would require scaling up energy audits and energy management systems; implementing new regulatory and innovative finance models to increase energy efficiency investments; and adopting new approaches to electricity demand management, including the use of demand-side response, behind-the-meter battery storage, renewable energy self-generation, and co-generation.

Greening the building sector requires scaling up and strengthening existing government programs, including those that focus on rooftop solar photovoltaic (PV) panels and solar water heating for poor and vulnerable households. Existing programs, while promising, experience financial, technical, and communication-related challenges that prevent them from reaching their full potential. The most important decarbonization measures for the building sector would focus on improving energy efficiency through better insulation and the use of natural cooling and heating techniques as well as more efficient appliances for lighting, cooking, heating, and cooling.

Decarbonized energy supply

Given the importance of electrification and green hydrogen in achieving net-zero emissions in the energy sector, decarbonizing electricity supply through renewable energy is highly recommended. This report explores potential pathways through three scenarios:[6] an "unconstrained optimized" scenario where electricity demand is assumed to follow a business-as-usual (BAU) trajectory (Scenario A), a scenario with imposed net-zero emission target in the electricity sector by 2050 (as Scenario B), a scenario with the same emission target as in Scenario B and the decarbonization of demand in the end-use sectors with increased electrification and the deployment of green hydrogen in the building, industrial, and transport sectors, which displaces the use of fossil fuels.

All scenarios entail a massive switch from natural gas to renewables, with solar and wind being the least-cost solutions for electricity production. A decline in thermal generation would reduce the need for natural gas, with positive outcomes for energy security and the trade balance. Due to the large penetration of renewables in the power sector, which are cheaper than thermal generation, and improvements in the efficiency of power plants, the average cost of electricity generation would decrease significantly in all scenarios. The current renewable power generation capacity of 467 MW is far from both the government of Tunisia's target of 4,800 MW and the optimal capacity of 5,900 MW (Scenario A) by 2030. The rapid expansion of renewable energy depends on initiating an integrated reform program that restores the sector's financial viability, including reforming public energy spending and financially restructuring and improving the performance of the Société Tunisienne de l'Electricité et du Gaz (STEG, the Tunisian Company of Electricity and Gas) to regain investor confidence.

Decarbonizing the energy sector would generate significant economic gains by helping Tunisia address its external imbalance and reducing energy costs, while driving large emission reductions. These mechanisms are captured in the results of macroeconomic modeling for the three scenarios (presented in Table 1). All scenarios lead to economic gains relative to the baseline inaction scenario, with the economy expected to be larger by between 1.1 percent (Scenario A) and 1.7 percent (Scenario C) by 2030. The GDP impact of Scenario C is largest in the short run (GDP 1.7 percent larger by 2030) because end-user sectors benefit from enhanced decarbonization, resulting in lower energy costs.

[6] The three scenarios were selected to investigate the cost of decarbonisation in the electricity sector. The assumptions used do not necessarily match those of Tunisia's National Energy Strategy and its Low Carbon Strategy. One of the scenarios is a "least-cost solution with no carbon constraint", to be able to compare results with a scenario of decarbonization of the electricity generation sector (with and without increased electricity penetration and the introduction of hydrogen). The present analysis focuses on the electricity sector as a critical sector to reach carbon neutrality and does not assume overall carbon neutrality of the energy sector or the whole economy.

Table 1: Macro impacts of decarbonization scenarios (percent deviation from baseline)

	Scenario C: Deep decarbonization		Scenario B: Green		Scenario A: Least-cost	
	2030	2050	2030	2050	2030	2050
Real GDP	1.1	1.4	1.1	1.4	1.7	1.4
Private consumption	0.5	1.2	0.9	0.9	3.1	7.9
Agriculture	0.3	0.9	0.3	0.8	3.2	5.6
Industry	1.2	1.7	1.3	1.7	1.8	1.2
Services	1.1	1.4	1.2	1.4	1.5	0.9

Source: World Bank staff estimation.

Total investment needs by 2050

This CCDR presents solutions for three key objectives and estimates the total investment needed to achieve a resilient and net zero[7] Tunisia by 2050 in net present value terms. Ultimately, the impact of the transition will depend on how these investments are financed and, more broadly, on the macroeconomic policy choices that will be made in the years and decades to come. Table 2 presents the costs related to sectoral interventions, where estimates were available.

Table 2: Investment and cost of operations until 2050 (in US$ million) [8]

Engagement dimension	Public or private	Investment cost up to 2030	Investment costs 2030-2050	Total investment costs
Addressing the water crisis	Public	3,069	10,505	13,574
	Private	683	2,798	3,481
Enhancing resilience to flooding and sea-level rise	Public	1,536	785	2,320
Decarbonizing the energy sector	Public	4,427	8,683	13,110
	Private	7,383	14,183	21,567
Total costs	Public	**9,032**	**19,973**	**29,004**
	Private	**8,066**	**16,981**	**25,048**

Source: Compiled by World Bank staff.

[7] The CCDR analysis focuses on achieving net zero in the energy sector, which is expected to contribute 59 percent of projected emission reductions to achieve net zero by 2050. It does not include investments required to reduce emissions in other areas such as agriculture, forestry and land use, industrial processes, and waste.

[8] Further information on how the investments were estimated, including assumptions and discount rates can be found in Chapter 3 of this CCDR.

The economic and poverty reduction gains of climate adaptation and decarbonization would be substantial…

Actions and investments to address climate change and decarbonize the electricity sector could increase GDP by 9 percent, reduce poverty by 12 percent, and slash energy emissions by 80 percent by 2030. Macroeconomic modeling suggests that actions to adapt to potential water shortages, flooding, and coastal erosion while decarbonizing energy demand and electricity supply would yield huge benefits to the economy. If all the recommended adaptation and mitigation actions are implemented, GDP could be 8.8 percent larger than in the inaction scenario as soon as 2030. Moderate poverty could be reduced by 2.5 percentage points, a 12 percent reduction relative to the level in the inaction scenario (21.3 percent). These results suggest that there is no trade-off between reducing emissions and maintaining economic growth because decarbonizing the energy sector would allow the country to largely address the external imbalance, generating large emission reductions along with economic gains.

…but the gains crucially hinge on financing the large investment needs of climate action

While the economic and environmental benefits of climate action are clear, identifying how to finance such action is crucial given Tunisia's limited access to international financing. While most of the funding for adaptation and decarbonization will likely come from private or concessional sources, public investments would also need to play a key role. Given the constraints to debt financing, fiscal policies—especially those that aim to reduce expenditure—could help finance the public investment needed for Tunisia's climate actions.

Financing climate investments would require repurposing recurrent expenditures, making public spending more efficient and removing barriers to private investment

Repurposing recurrent expenditures (including energy expenditures) and taxes on carbon and capital income represent the most significant opportunities to fund public investments in adaptation and decarbonization. Tunisia has one of the highest levels of energy public spending relative to GDP in the world, coupled with a relatively low level of environmental taxes. Its public spending on energy generates more negative environmental externalities (such as local pollution and global warming) than those it internalizes through taxation because environmental taxes represent a mere 6 percent of total tax revenues. Modeling suggests that repurposing public energy spending and increasing taxes on carbon and capital income would yield significant economic gains. Such fiscal policies would also prevent the country from needing to resort to costly debt financing for adaptation and mitigation investments. The combined adaptation and full decarbonization scenario, which is funded by improving the efficiency of public energy spending and increases in carbon and direct taxes, yield large economic gains by 2030 (+8.2 percent of GDP) while ensuring the sustainability of public debt. This fiscal policy could also help fund the decarbonization of the economy, achieving both economic and emission reduction benefits.

Tunisia's actions to better integrate climate indicators into public financial management are useful, but more is needed to secure sufficient public climate financing. The Ministry of Environment (MoE), in coordination with the Ministry of Finance's Budget by Objectives Unit, has initiated preparatory work to integrate climate indicators (emanating from national climate policies and targets) into the performance indicators of objective management units in key sectors. However, to effectively attract public finance for climate initiatives, Tunisia would benefit from developing a climate project database and a methodology to prioritize climate projects. Climate change considerations have also not yet been systematically included in Tunisia's public finances, fiscal risk statements, public investments, or procurement. State-owned enterprises are not yet required to report on climate risks, or to have formulated plans to address them. Even with decisive government action, attracting private, bilateral, multilateral, and international market financing remains key to meeting Tunisia's large climate investment needs. These needs are recognized in the NDC and could take the form of concessional lines of credit, grants, foreign direct investment, debt swaps or innovative financing via carbon markets.

Private funding will be crucial for ensuring sufficient climate investments. However, the challenging macro-financial and -economic environment is a key barrier to developing Tunisia's green finance market. Tunisia's macroeconomic difficulties and debt sustainability concerns have made it increasingly difficult for the country to access international capital markets. This has increased concerns of capital outflows, which have further limited the convertibility of the local currency. Tunisia's public and private sectors have limited instruments to unleash green finance, and there is a lack of eligible, bankable projects. Tunisia would benefit from a national climate finance strategy that accurately

assesses its climate investment needs and provides the market with certainty around regulatory changes. Addressing these issues requires concerted and decisive efforts by both the government and the financial sector. Dismantling rigorous restrictions to investments and competition would also revitalize the private sector and accelerate the climate transition. Decarbonizing key export sectors and integrating into green value chains would be important for ensuring future international competitiveness. The country's new public-private partnerships (PPP) framework may help the private sector partner with the state to develop the infrastructure needed for the climate transition.

Besides providing financing, the private sector is also crucial for developing the technologies and skills required to implement climate actions. This highlights the need to tackle constraints blocking its potential, which are often of regulatory nature. The private sector is likely to be instrumental in making production processes more climate friendly; in developing and maintaining activities that are resilient to the new climate conditions; and in developing the skills and inputs needed for the transition to a more sustainable path.

Human risks and opportunities

Tunisia's people need to be prepared for new climate realities. Tunisia could usefully leverage its existing social protection systems and build capacity to ensure a quick response to climate stressors and shocks. Such responsiveness would minimize the impacts of on people without exacerbating existing vulnerabilities. Emergency preparedness, including prepared health systems, would help maintain basic services while minimizing the negative impacts of quick-onset climate shocks. These measures would play a crucial role in mitigating distributional impacts. However, it is imperative to prioritize vulnerable groups and women. Strengthening social protection systems and ensuring equitable access to resources, health systems, and education would provide a strong foundation for those who are likely to be most affected by climate change.

Tunisia's people also need to be equipped for the jobs needed to realize a green and circular economy. Developing appropriate skills will be important as the country decarbonizes. The current education system appears to favor higher-level "green" skills, with relative gender parity in renewable energy-related programs. However, there is a substantial capacity gap when it comes to medium or low "green" skills, particularly at the technical and vocational education training level. Tunisia would benefit from making a concerted effort across education and training institutions—which should ideally be closely linked to private sector demand to promote quality and relevance—to ensure that there is a suitably qualified workforce to do the jobs required to meet its climate goals.

Policy recommendations

This CCDR makes recommendations to address three main climate and development challenges in Tunisia: water scarcity, sea-level rise and flooding, and decarbonization of the energy sector. It proposes specific sectoral actions as well as horizontal actions to address human capital gaps and create the right macro-financial conditions to finance the needed investments. Figure 6 summarizes these recommendations, framing them through a "whole of society" and a "whole of government" approach that aims to address institutional and political economy constraints. A "whole of society" approach mobilizes all actors and resources in united action while addressing the concerns and needs of vulnerable stakeholders. A "whole of government" approach is needed to tackle the level of complexity that the climate challenge represents. Responsibility for implementing Tunisia's NDC is currently fragmented between several institutions.[9] Greater cooperation across institutional boundaries at both the national and local levels, supported by greater clarity on roles and responsibilities, would support actions to address the three challenges listed above.

In light of Tunisia's current macro-financial constraints, the CCDR also proposes a condensed package of urgent actions that are affordable while delivering high impacts in the near term. The package is built around two key, urgent objectives for the Tunisian economy: addressing water shortages and transitioning the energy sector from fossil fuels to renewables. Because Tunisia cannot currently expand its debt, the country would also need to urgently pursue a third objective: creating the right macro-financial conditions for public and private investments to fund these objectives (Figure 5).

Figure 5: Recommended high-impact actions with near-term benefits for a green, resilient, and inclusive transition

In the medium to long term, the priority actions summarized in Figure 5 would need to be accompanied by other actions (Figure 6) to fully achieve the three identified objectives while also adapting Tunisia to the other climate stressors. Recommendations with high impact and near-term benefits (featured in Figure 5) are in bold in Figure 6.

[9] These institutions include the Ministry of Environment; the Ministry of Industry, Energy and Mining; the Ministry of Agriculture, Water Resources, and Fisheries; and their affiliated bodies.

Figure 6: Recommendations for green, resilient, and inclusive transition

"WHOLE OF GOVERNMENT" AND "WHOLE OF SOCIETY" APPROACH

ADDRESS WATER SCARCITY

Increase water supply and enhance water management

- **Control water demand through pricing and metering methods.**
- **Modernize, rehabilitate, and extend water networks to reduce water losses and waste, and improve network monitoring and management by digitalizing the water sector.**
- Strengthen the quality and distribution of non-conventional water sources such as desalinated water, including through public-private partnerships.
- Protect water and groundwater against misuse and agricultural pollution, including by establishing safeguard zones and by revising and implementing the new Water Code.
- Improve water management by developing contingency plans during droughts and by carrying out a water withdrawal inventory.

Increase the resilience and efficiency of the agricultural sector and leverage nature-based solutions

- **Incentivize (for example through tax incentives) and invest in protection and rehabilitation of ecosystems.** Scale sustainable land-use planning, water-management practices, and agroforestry.
- Develop and promote usage of, and research into, climate-smart agriculture and animal husbandry.
- Fight food loss and waste all along the agriculture, fisheries and livestock value chains.

ENHANCE THE RESILIENCE OF URBAN AND COASTAL AREAS

Defend coastal zones against sea-level rise and flooding

- Prepare and implement participatory integrated coastal zone management plans. Protect coastlines through soft and nature-based defense solutions.
- Freeze construction in affected natural space and urbanized areas. If needed, protect urbanized areas through additional sustainable breakwaters.
- Develop sustainable coastal tourism and a diversified tourism offering.

Protect people and infrastructure

- Develop asset management systems for essential infrastructure that incorporate climate risks and optimize lifecycle costs.
- Transfer governance of disaster risk management to municipalities.
- Identify critical infrastructure for retrofitting or upgrades.

Enhance social protection and develop risk-based insurance themes

- Advance disaster risk financing (DRF) by building capacity, formalizing DRF strategy, implementing public finance mechanism, and enabling local private insurance sector to provide coverage.
- Strengthen access to financial risk protection and ensure linkages between social registry and insurance eligibility. Maintain sufficient emergency contingency resources to quickly respond to climate-related shocks.
- Strengthen early warning systems and reinforce emergency preparedness and response plan.

DECARBONIZE THE ENERGY SECTOR

Decarbonize demand in the end-use sectors

- For all sectors: Encourage the use of renewable energy, enforce the existing legal framework for energy efficiency/conservation, and implement energy conservation/efficiency programs with demonstrable effects.
- Transport: Promote alternatives to road and private vehicle transport to reduce congestion, enforce emission standards, retire aged fleet, and establish incentives and infrastructure for electric vehicles.
- Industry: Enforce and scale up energy audits, energy management programs, and energy certification for energy-intensive sectors, accompanied by capacity-building and financing mechanisms (including the Energy Transition Fund). Pilot innovative decarbonization technologies and accelerate the self-generation and co-generation program.
- Buildings: Scale up rooftop solar photovoltaic and solar water heating, and the appliance replacement and retrofitting programs.

Decarbonize supply: focus on electricity generation

- **Enhance coordination and streamline the development of renewable energy.**
- **Develop adequate technical and market conditions to provide flexibility services to facilitate renewable energy integration.**
- Prepare a roadmap for green hydrogen and establish an intersectoral Green Hydrogen Council to implement it.
- Invest in and promote traceability-testing-certification systems, including for green hydrogen and electricity for exports.
- Adopt a whole-system approach for planning and operating the electricity system, including sector integration and coupling.

Enhance human capital

- Expand skilling, re-skilling and up-skilling and on-the-job training programs, especially on the energy transition.
- Higher education and vocational training: Expand climate-related programs; involve industry in developing curricula to ensure relevance.
- Raise awareness about climate change and green practices in the national curriculum. Train teachers and educators.
- Strengthen the capacity of primary health facilities to implement surveillance systems to improve climate responsiveness.

Improve institutions and engagement

- Establish an intersectoral National Climate Council chaired by the head of government and adopt climate change legislation covering existing gaps.
- Adopt climate indicators to measure adaptation progress for publishing on the government's climate portal. Starting with SOEs, adopt international best practice on reporting and disclosure standards.
- Establish climate focal points and provide support for community-based program investments in municipalities.
- Engage with affected stakeholders, including through organizing iterative outreach campaigns on climate change and setting up a national level multistakeholder network on climate change public policy planning and monitoring.

Create macro-financial conditions to support investments

- **Redirect recurrent public expenditures towards urgent adaptation investments.**
- Include climate-related and green criteria for public investment projects. Adopt methodology for integrating climate indicators in program budgets and launch a green taxonomy process.
- **Support private sector entry for green activities by, for example, eliminating prohibitive authorizations.** Simplify investment authorizations around clean energy. Reduce the regulatory power of sectoral incumbent.
- Assess the financial sector's exposure to climate risk and build capacity to diversify funding sources.
- Create an enabling platform to accelerate procedures for climate investments and to aggregate projects into bankable portfolios for concessional funds and blended finance and provide climate finance offering for vulnerable groups.
- Boost private participation, including by developing a regulatory framework for adopting new technologies. Incentivize green certification.

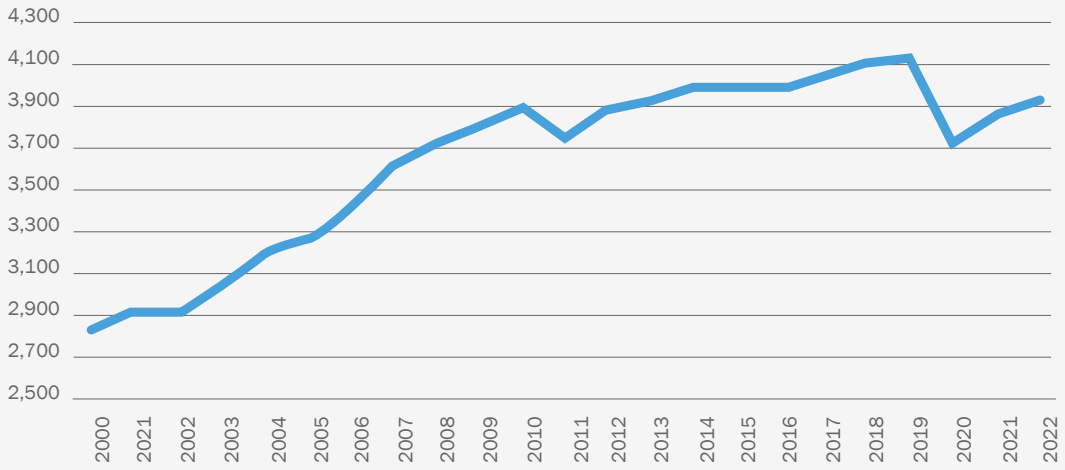
1. How Tunisia's Economic, Social, and Climate Change Challenges Interact

1.1. Economic and Social Challenges

Tunisia is navigating a difficult economic and political context. The political reforms that followed the 2011 revolution led to a fragmented political situation characterized by a high turnover of Cabinet Ministers and a fractured, polarized parliament.[10] These changes were not accompanied by economic reforms to tackle the pervasive barriers to investment, innovation, and economic activity that were prominent during the regime of Zine El Abidina Ben Ali.[11] A series of negative shocks compounded this fragility, including conflict in neighboring Libya; terrorist attacks; and, more recently, the COVID-19 pandemic and commodity price increases linked to Russia's invasion of Ukraine. As a result, economic growth slowed, and the country struggled to fulfill the revolution's aspirations.

Stalled economic and social progress, together with a decline in public trust, created conditions for the introduction of a new constitution and a presidential system in 2021. Yearly gross domestic product (GDP) growth declined to 1.4 percent on average since the revolution (2011 to 2022), down from 3.5 percent between 2000 and 2011. This slowdown has translated into an actual reduction in GDP per capita since 2014 (Figure 7). The employment rate—measured as the people over the working age population who are employed—also declined, from 40.3 percent in 2014 to 38.2 percent in 2022, compounding the pressure stemming from a high structural unemployment rate (15.5 percent on average in 2022). Vulnerable groups have been particularly affected by this decline, with 35.7 percent of young people (aged 15 to 24) and 23.6 percent of working-age women unemployed in 2021. Capitalizing on mounting public frustration, in 2021 the president suspended the parliament, changed the government, and drafted a new constitution. A referendum in 2022 approved the new constitution, which introduced a presidential system with a 94 percent approval rating and a voter turnout of 30 percent.

Figure 7: Tunisia's economic growth has slowed since 2011 (GDP per capita, constant 2016 US$)

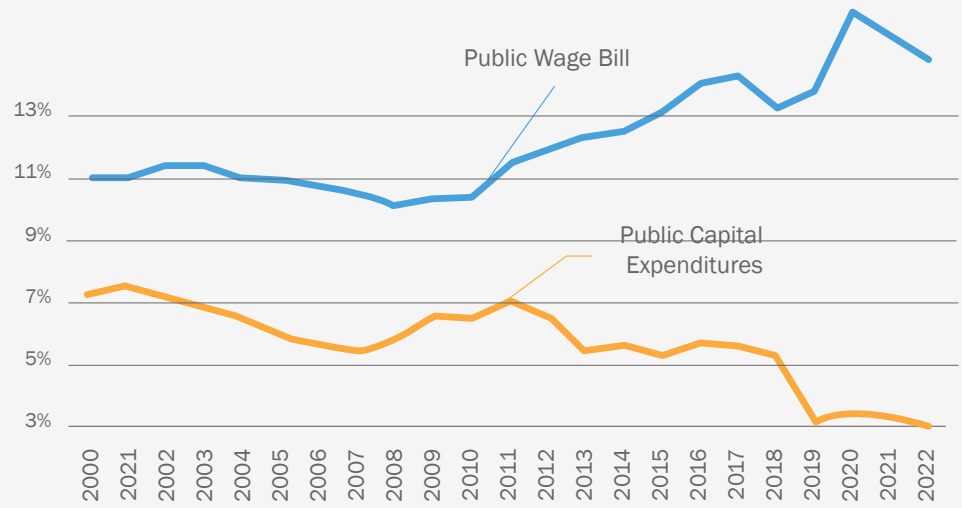


Source: World Bank staff estimates based on World Development Indicators and National Statistics Institute (Tunisia) data.

[10] Aliriza 2023.
[11] World Bank 2014.

With a stagnating economy, Tunisia has increasingly relied on public expenditures to meet citizens' aspirations without tackling the root causes of poor economic performance. Slowing economic growth and employment creation have prompted successive governments to increase public expenditure to try to deliver on its social contract with citizens. The public wage bill is a case in point: after a slight decline as a share of GDP, the public wage bill increased significantly from 10 percent on the eve of the revolution to well above 14 percent since 2016 (Figure 8). This is one of the highest shares in the world and was the result of large increases in public employment and in nominal wages. Other recurrent public expenditures followed similar trajectories, including untargeted consumer subsidies (notably for food and energy products), transfers to state-owned enterprises (SOEs), and social transfers. These measures may have helped many poor and vulnerable households at the early stages of the transition.[12] However, they did not tackle the causes of low economic growth and popular discontent,[13] including the quest for dignity and jobs for the Tunisian youth, which was at the heart of the revolution in 2011.[14] At the same time, these measures crowded out public investments, which declined from more than 6 percent of GDP during the pre-revolution years to 3 percent in 2022 (Figure 8). The declining capital expenditure (capex) weighs down on future growth and—as argued below—climate change preparedness.

Figure 8: A tale of two public expenditures: wage bill versus capex (as a percent of GDP)



Source: World Bank staff estimates based on World Development Indicators and National Statistics Institute (Tunisia) data.

The rapid increase of recurrent expenditures, exacerbated by recent shocks, has led to unsustainable fiscal and external deficits and a mounting stock of debt, which are increasingly difficult to finance. Expanding public recurrent expenditures caused the rapid escalation of fiscal and current account deficits. The COVID-19 pandemic (which brought with it costly response measures and a lowering of tax receipts) and the war on Ukraine (which has resulted in rising international prices of energy and food) have aggravated these deficits and boosted public debt. The latter increased from 40.7 percent of GDP in 2010 to 79.3 percent of GDP in 2022.

[12] The upscaling of the National Assistance Program for Families in Need was associated with a reduction in poverty from 20.3 percent in 2010 to 15.2 percent in 2015 (World Bank 2022).
[13] See World Bank (2014) and the forthcoming Tunisia Country Private Sector Diagnostic for detailed analyses.
[14] See Global Indicators for Regulatory Governance: Tunisia at https://rulemaking.worldbank.org/en/data/explorecountries/tunisia

Without a reform process to place the economy on a sustainable track, Tunisia lost access to international capital markets, aggravating the economic crisis. Insufficient reforms, along with the aggravating deficits, have prevented the country from accessing international capital markets since 2020. The ensuing difficulty in securing the necessary financing, particularly external financing, has aggravated the ongoing difficult economic situation. This became evident in 2022 when a hike in energy imports expanded the current account deficit to 8.5 percent of GDP, up from 6 percent in 2021. In the absence of capital market financing, this eventually led to the drawdown of foreign exchange reserves. With declining reserves and increasing SOE debt, the rising current account deficit translated into shortages of basic products including fuels, cereals, sugar, dairy products, coffee, and pharmaceutical products. This has contributed to the slowdown of Tunisia's post-pandemic economic recovery, which has been one of the slowest among countries in the MENA region, with 2022 real GDP still below the level in 2019. The decline in poverty in the early part of the 2010s has also been reversed, with the poverty rate increasing to 16.6 percent in 2021 from an estimated 13.8 percent in 2019. [15]

Tunisia needs a new economic model to accelerate economic recovery, secure jobs, and livelihoods, and lay the foundation for durable, resilient development. A new model would need to rely more on the private sector to create jobs and generate income for the population. This would require creating a more conducive environment for investments, particularly in new sustainable activities, by lowering barriers to entry for new businesses, and to new operations for existing businesses. At the same time, the public sector would need to focus more on public investments and less on untargeted recurrent expenditures such as in the energy sector. A reorientation of expenditures would allow the public sector to better protect vulnerable households as the structure of the economy evolves.

A new economic model would ideally also reverse Tunisia's historical over-exploitation of land and water resources. Tunisia's historical approach to natural resources has driven a decline in the country's biocapacity,[16] which has been in deficit since 1974 and declined since, reaching -1.33 global hectares[17] per capita in 2018. To accelerate economic recovery and ensure the well-being of Tunisia's population, it is imperative that this economic paradigm is revised. This entails emphasizing the role of the private sector, rather than the state, in generating most jobs, while focusing the role of the state on expenditures with the highest social and economic returns that also use resources sustainably, both from an economic and an environmental point of view.

1.2. Climate Change and Development Challenges

Tunisia's economic challenges are compounded by its increasing vulnerability to climate change. Due to a combination of political, geographic, and social factors, Tunisia is one of the countries most exposed to climate change in the Mediterranean. The main direct climate risks confronting Tunisia are temperature increases; reduced and more variable precipitation; rising sea levels and saltwater intrusion; and escalating extreme weather phenomena such as floods and droughts, but also forest fires (Figure 9, Figure 10). Some of these issues drive demand for energy (for example, for desalination, pumping, and cooling), resulting in higher emissions and air pollution. Climate change is therefore associated with key indirect economic costs and risks in Tunisia's economy. These risks include susceptibility to global energy prices, water scarcity and agriculture loss, health deterioration, depletion of natural capital,[18] coastal infrastructure and tourism losses, losses in labor productivity, and vulnerability to disasters.[19] Changing weather patterns will also increase migration flows, particularly agriculture-dependent regions, with families forced to abandon their lands to seek alternative means of income. This would place additional pressure on Tunisia as a transit hub and urban areas.[20] As the effects of climate change intensify, so too will the costs of coping with these risks.

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[15] The 2021 figure is based on the 2021 national survey on the budget, consumption, and standard of living of households. The 2019 figure is an estimate based on the 2015 household budget survey, inflation, and economic growth data.

[16] Biocapacity refers to ecosystems' capacity to produce biological materials used by people and to absorb waste material generated by humans, under current management schemes and extraction technologies.

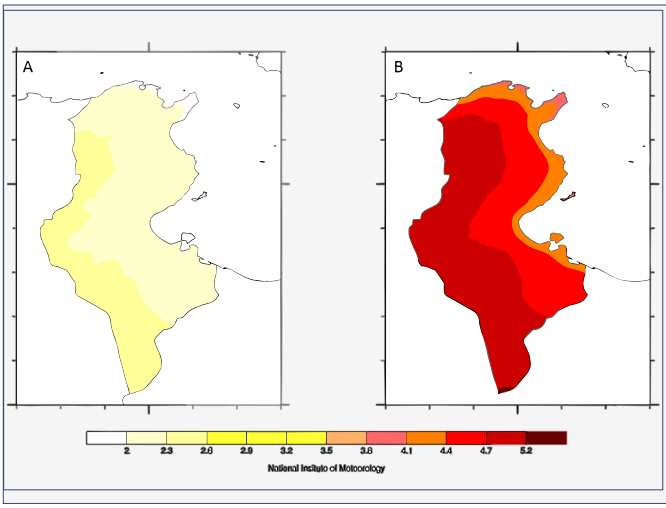
[17] "Global hectares" is the accounting unit for biocapacity accounts, allowing researchers to report on both the biocapacity of the Earth or a region and the demand on biocapacity. Global hectares are productivity-weighted, meaning they account for different land types with different productivities.

[18] Climate change is expected to accelerate loss of biodiversity, including of non-timber forest products that the poor depend on for livelihoods.

[19] World Bank 2022.

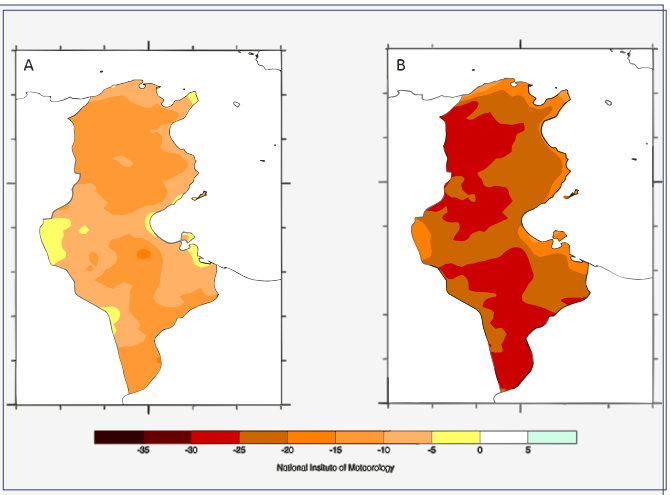
[20] Tunisia is a place of transit from Sub-Saharan Africa, with Italy as its first destination due to its geographical proximity. Between 2020 and mid-2021, migration from and through Tunisia rose to levels not seen since the 2011 revolution (Il Sole 24 Ore 2023).

Figure 9: Under a worst-case climate change scenario[21] temperature increases by between 2°C and 2.3°C until 2050 and between 4.1°C and 5.2°C until 2100



Source: World Bank.

Figure 10: Under a worst-case climate change scenario, precipitation decreases between 1 percent and 14 percent until 2050, and between 18 percent and 27 percent until 2100[22]



Source: World Bank.

Tunisian people are likely to be strongly affected by climate change, particularly vulnerable groups. Poor and low-income households in particular are exposed to natural hazards and climate change due to limited access to resources (financial, food, water, and non-timber forest products); limited economic capacity to withstand shocks; and increased physical vulnerability (due to densely populated dwellings and substandard housing quality).[23] Some climate-related risks may also exacerbate territorial disparities, for instance, in the case of water scarcity. Access to drinking water and sanitation is more limited in rural areas in the center and north-west of the country.[24,25] , Children and the youth in interior regions also tend to have even poorer human capital outcomes. The Early Grade Reading Assessment shows learning outcomes are better in coastal regions than in the interior, and children in the southwest region are twice as likely to be stunted relative to the national average.

This report identifies securing water availability, ensuring resilience to sea-level rise and flooding, and decarbonizing the economy as the most economically impactful climate-related objectives for Tunisia. Without urgent and decisive action by the government and broader society in these areas, there could be significant socioeconomic, political, and humanitarian repercussions. Figure 11 summarizes the interaction between development and climate challenges and how they will intensify.

Properly addressing these risks will help bring about the much-needed change in Tunisia's economic model. The goals of enhancing water availability, reconstructing capital stock lost to inundation, and decarbonizing the energy sector with strong private sector participation could generate new jobs and provide financing. Each of the three goals would focus public expenditure on investments with particularly high economic and social returns. Pursuing these goals would also entail the more sustainable use of water, land, and energy resources; a reduction in wastage that uses pricing to rationalize consumption; and leveraging Tunisia's large renewable resource potential. Implementing these policies through a "whole of society" [26] approach that mobilizes all actors and resources in united action and addresses the concerns and needs of vulnerable stakeholders will ensure that rights are protected, so facilitating a just transition. Such changes in Tunisia's economic model have the potential to put the country on track for inclusive, resilient, and sustainable growth.

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[21] A worst-case scenario assumes emissions would result in a representative concentration pathway of 8.5 (RCP 8.5). While this scenario is considered increasingly unlikely, it is not implausible.

[22] Figures differ depending on the data source and methodology used. According to an official government website (https://climat-c.tn/INM/web/precipitation) precipitation could decrease by 6 percent under an RCP 4.5 scenario and by 9 percent under an RCP 8.5 scenario by 2050. Temperatures could increase by 1.6°C under RCP 4.5 and 1.9°C under RCP 8.5 by 2050.

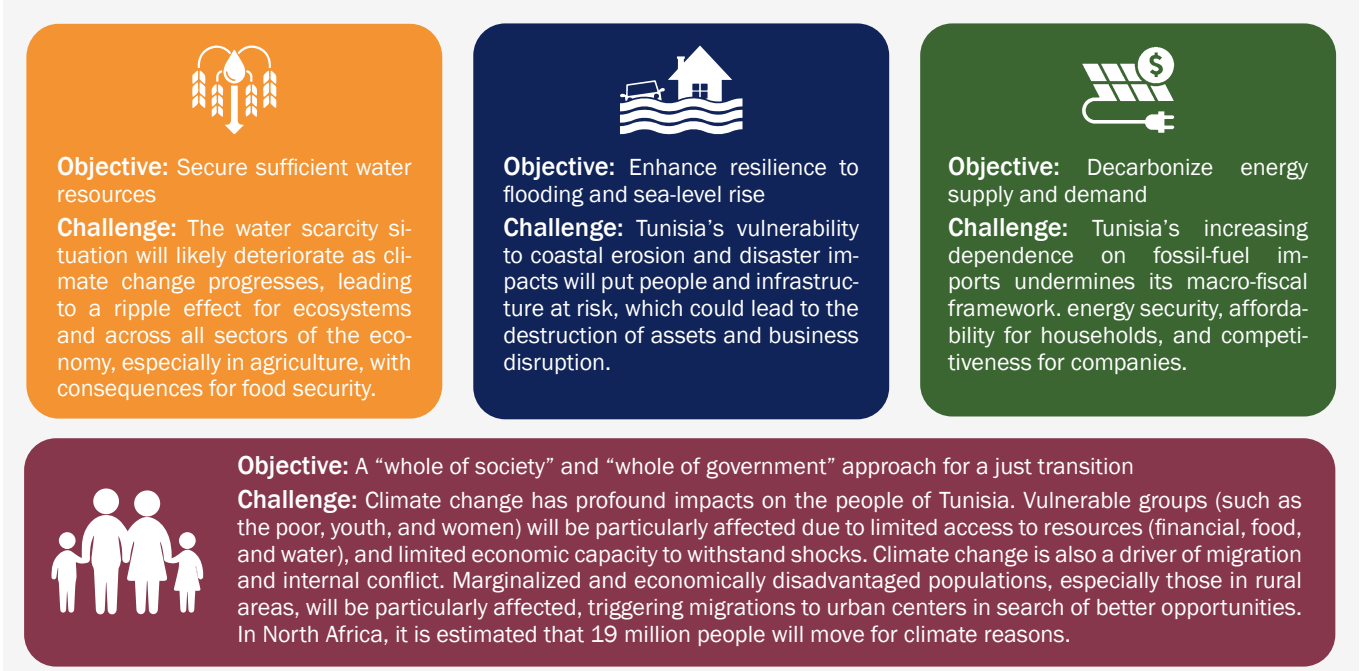
[23] World Bank 2021.

[24] World Health Organization 2015.

[25] International Labor Organization 2022.

[26] A "whole of society" approach includes and establishes rights and responsibilities for all elements and levels of society, builds wider understanding and ownership of climate problems and transitions, includes vulnerable communities that are most affected, and establishes broad societal commitment and action.

Figure 11: Summary of economic development and climate challenges



Box 2: Climate modelling for the CCDR

This report presents three climate scenarios to illustrate the range of climate change impacts. Each climate scenario corresponds with a different level of average warming. These scenarios are created using a collection of climate models known as the Coupled Model Intercomparison Project (CMIP). This report draws on the latest climate modeling using both Shared Socioeconomic Pathway (SSP), the climate scenarios of the sixth phase (CMIP6), and Representative Concentration Pathways (RCP) the climate scenarios of the fifth phase (CMIP5). As such, the climate scenarios RCP and SSP are comparable. For instance, SSP3 (CMIP6) and RCP7-8.5 (CMIP5) both indicate a 4°C average warming and a worst-case climate scenario. The choice between SSP (CMIP6) and RCP (CMIP5) in this report depends on the availability of technical modeling in each sector. In particular, the analyses of sea level rise use the SSP scenarios, while the analyses on water shortage and flooding adopt the RCP scenarios. To harmonize the scenarios, the following comparisons are drawn:

CCDR scenario	CMIP6	CMIP5	Average warming by 2100
Recent policies and highly dangerous climate outcomes (pessimistic case)	SSP3	RCP 7–RCP 8.5	+4°C
Recent commitment and dangerous climate outcomes	SSP2	RCP 4.5	+2.5°C
Successful decarbonization and limited warming (optimistic case)	SSP1	RCP 1.9–RCP 2.6	+1.5°C

Source: Compiled by World Bank staff.

1.2.1. Water scarcity

The water sector in Tunisia faces severe pressure, to the extent that water supply was heavily rationed in 2023. Since independence, Tunisia has focused on mobilizing water resources through supply measures such as the construction of large dams and interconnections between regions. Some demand initiatives, such as the National Water Saving Program for the irrigated sector, have also been implemented. Despite these measures, per capita water availability in 2021 was only 395 cubic meters (m^3), well below the absolute water scarcity threshold of 500 m^3.[27] In 2019, Tunisia was already in the top decile of countries in terms of water stress (measured by the share of freshwater withdrawal as a proportion of available freshwater resources).[28] After four consecutive years of drought since 2019, water stress has become even more severe. The harvest season for most crops has been severely affected. For example, cereal production is expected to decrease from 750,000 to 250,000 metric tons in the 2022/23 season, a quantity that will barely suffice for seed production. In April 2023, the government started implementing nightly cutoffs of water supplies to homes and prohibiting the use of water for irrigation or the watering of green spaces and other public areas.

The current water crisis is also a symptom of some persistent challenges. The Société Nationale d'Exploitation et de Distribution des Eaux (SONEDE, National Water Works and Distribution Company) primarily provides drinking water in urban areas, while 41.3 percent of rural areas are covered by Groupements de Développement Agricoles (GDAs, agricultural development groups). Although drinking water infrastructure has made it possible to achieve a 100 percent drinking-water supply rate in urban areas and 95 percent in rural areas, financial performance of the water and sanitation sector's SOEs, which are meant to operate on a commercial basis, is declining. [29]

Due to charging water tariffs much lower than production costs, all national water institutions operate under financial deficits, ultimately exacerbating water loss challenges. The water network's efficiency has worsened during the past decade, with water losses increasing from 25 percent in 2010 to 34 percent in 2021 for SONEDE. This figure exceeds 50 percent in rural areas managed by GDAs, which is considered high in a country with scarce water resources.[30,31], Despite several increases to the drinking and sanitation water tariff in recent years, tariffs remain insufficient to cover operational costs, leading to increasing financial deficits.[32] The treated wastewater price charged by the Office National de l'Assainissement (ONAS, National Sanitation Office) is also insufficient to support network maintenance and complementary treatments. As a result, only about 2 percent of Tunisia's irrigated land can be directly irrigated with treated wastewater. Past tariff increases have not been sufficient to improve the financial performance of SOEs.

Insufficient tariffs contribute to SOEs being heavily reliant on state subsidies to partially cover operational expenses. In 2018, the state supported a difference of 3.1 billion Tunisian dinars (TD) (around US$997 million), or 82 percent of all water costs when considering the water cycle from mobilization at dams to sanitation and reuse.[33] ONAS also benefits from a direct balancing subsidy. These subsidies have had an impact on demand, exacerbating issues with water resource management in Tunisia. The water footprint of Tunisian consumption has been estimated at 2,200 m^3 per inhabitant per year, which is 60 percent higher than the global average.[34] There is also a low efficiency of water-use rate, estimated at US$10.32 per m^3 in 2020.[35]

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27 FAO Aquastat data 2021.
28 FAO Aquastat data 2021.
29 World Bank 2019.
30 Water losses in rural drinking water networks represent not only technical losses, but also commercial losses due to illicit connections and unbilled water volumes.
31 Water sector note. Tunisia CCDR. April 2023
32 Despite the latest 2021 increase, the drinking water tariff is still considered as low compared to the regional benchmark. The rate of the first consumption block (<20 m3 per quarter) is around 0.06 USD/m3 and the second consumption block is (between 20 and 40 m3 per quarter) is around 0.21 USD. In contrast, for instance, in Rabat, the rate for the same block is 0.70 USD/m3.
33 This share of the total cost supported is TD 1.5 /m3 (MARHP 2022).
34 Chouchane et al. 2013.
35 Compared to US$11.52 /m3 for all of Middle East and North Africa (Rossi et al. 2019).

SOEs are further vulnerable to the high and volatile price of large energy imports. SONEDE is the largest individual consumer of electrical energy in Tunisia. The utility's reliance on brackish water and seawater desalination plants has led to increased energy costs to produce drinking water. SONEDE's electricity consumption is high, at 0.67 kilowatt-hours per cubic meter (kWh/m³) in 2021 compared with the median European energy consumption of 0.51 kWh/m³. After its desalination plants were commissioned, SONEDE's average energy cost of drinking water increased from 0.82 TD per cubic meter (TD/m³) in 2015 to 1.30 TD/m³ in 2021, while the average sale price evolved from 0.56 TD/m³ in 2015 to 0.94 TD/m³ in 2021.

Agriculture is the largest water user in the country, accounting for more than 75 percent of total water usage when agricultural use is not restricted. The low cost of irrigated water has led to its overexploitation. The agricultural sector is important for the national economy, contributing 9.6 percent of GDP in 2022 and employing 14 percent of the active population in 2019.[36,37] It also contributes to food security.

A**lthough 90 percent of arable land is rainfed, irrigated agriculture consumes the largest share of water and contributes to 36 percent of the value added by agriculture.**[38,39] To improve surface water mobilization, between 35 and 56 percent of total agricultural sector investments since 1990 were related to water. However, the economic return of surface water mobilized for irrigated agricultural activity covers only 40 percent of the cost invested per cubic meter.[40] Subsidies have partly prevented progress in reducing water demand from irrigated agriculture. For instance, the price of irrigation water for public schemes (representing 56 percent of all irrigable area) from large dams has remained unchanged since 2004, at 0.065 TD/m³, representing only 15 percent of the cost in 2018. [41]

Land-cover changes have had a significant impact on water yields, the storage capacity of dams, and other freshwater systems. Ecosystems, especially forests and oases, play a crucial role both as water reservoirs and in protecting dams from siltation by preventing or reducing both soil erosion and the transportation of debris that would otherwise be deposited in dams and weirs. Tunisia's surface water is mobilized from 37 large dams, which have a total capacity of about 2,313 Mm3, primarily for local irrigation and livestock needs. [42] Accumulated siltation in dams is reducing their ability to store surface water; indeed, in 2021, large dams had accumulated an average silting rate of 22.59 percent. [43]

The crucial role of ecosystems in supplying water has long been neglected, with freshwater allocated entirely to the needs of drinking water and irrigation. For instance, the Ichkeul ecosystem has been deprived of freshwater, with levels below minimum ecological standards, by the construction of six dams on the main wadis (ravines) that supply it.[44] Moreover, intensive agriculture and the misuse of fertilizers have resulted in a decrease in groundwater quality, with the concentration of nitrates increasing. Land degradation causes an estimated economic impact of between 2 and 7 percent of national GDP per year. [45]

Tunisia's water scarcity is further compounded by suboptimal demand-side practices. The structural decline in water resource availability and increasing droughts have led to large-scale groundwater exploitation and illegal access to deep aquifers. Overall, the number of authorized water drillings for groundwater in 2021 was 14,117, compared with 20,350 illicit drillings. Aquifer extraction rates have increased by up to 400 percent in some regions. When groundwater is extracted to excess, the pressure in the aquifer decreases, causing saltwater from the sea to enter and mix with the freshwater in the aquifer. Up to 85 percent of all groundwater resources already display salinity levels above the minimum threshold value of 1.5 grams per liter. Limited awareness and preparedness at the company level exacerbates water scarcity challenges. According to the 2020 World Bank Enterprise Survey, only around 7 percent of Tunisian companies had adopted water management measures. [46,47],

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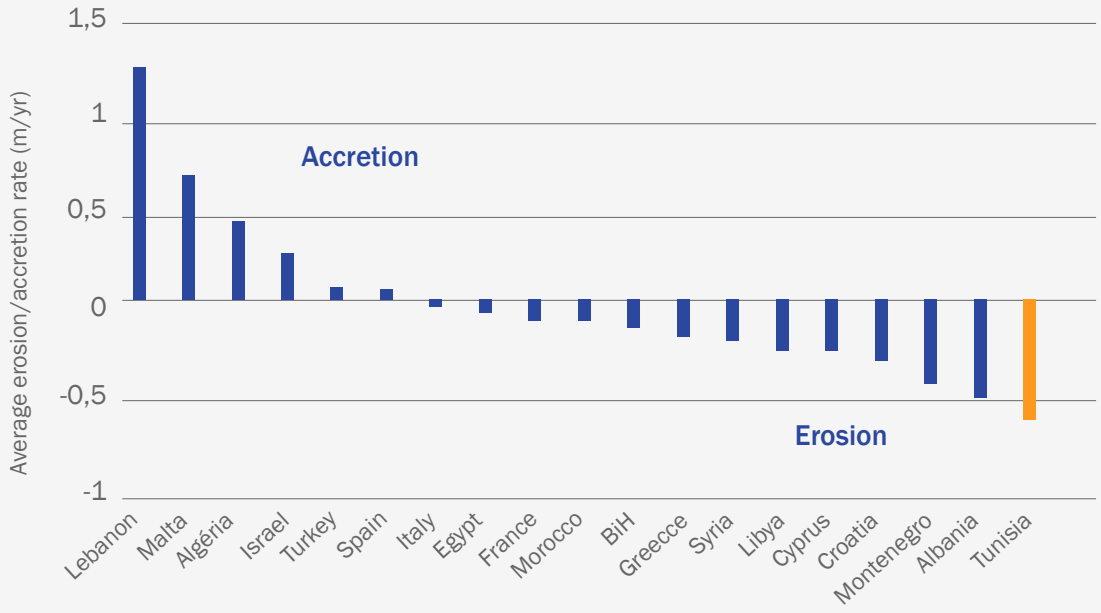
36 World Bank data: Agriculture, forestry, and fishing value added % Tunisia's GDP.
37 World Bank 2022.
38 GIZ 2019: https://www.giz.de/en/downloads_els/Rapport%20Final%20V4.pdf
39 World Bank data: Agricultural irrigated land
40 MARHP 2022.
41 Water pricing study developed by the General Directorate of Rural Engineering and Water Exploitation in 2018.
42 FAO Aquastat data 2021.
43 Dams lose 22 Mm3 capacity each year (MARHP 2022).
44 Sejnene dam, Joumine, Ghezala, Tine, Melah, and Douimis are under construction.
45 Water sector note. Tunisia CCDR. April 2023.
46 Based on World Bank Enterprise Survey data.
47 Almost one in five large companies (>100 full-time equivalent [FTE] employees) have implemented measures versus 3 percent for small companies (5–19 FTEs).

Climate change is expected to worsen the water scarcity situation, with Tunisia experiencing a trend towards aridification due to higher temperatures, increased evapotranspiration, and decreased rainfall. Under a stabilized emissions scenario (RCP 4.5), the frequency of dry years in Tunisia will increase to 52 percent (10 out of 19 years) between 2031 and 2050. This will increase to 79 percent (15 out of 19 years) under RCP 8.5, exacerbating the already challenging water situation, particularly in agriculture and rural areas. [48]

1.2.2. Sea-level rise and flooding

Tunisia's vulnerability to coastal erosion and disaster impacts is a growing concern, with several factors contributing to this situation. The country's urbanization levels have led to a concentration of population and economic activity (including tourism and industry) along coastal zones, which are prone to floods and sea-level rise. Tunisia's 1,300 kilometers (km) of coastline are already receding at the fastest rate in the Maghreb, the second-fastest-eroding region globally.[49] Coastal erosion, calculated at 70 centimeters per year between 1984 and 2016 (Figure 12), also poses risks to the country's irrigated agriculture in the form of the salinization of fields and the inundation of low-lying wetlands.

Figure 12: Coastal erosion in the Mediterranean (1984 to 2016 average) [50]



Source: Based on data from World Bank 2021b.

[48] It is important to note that projections of climate extremes point to an increase in both the frequency and intensity of droughts. World Bank 2018.
[49] World Bank 2021b.
[50] World Bank 2021b.

Coastal zones host two-thirds of the country's population and 90 percent of economic activities, including the bulk of the tourism sector. Almost 90 percent of beds in Tunisia are in coastal zones, with about 80 km (6 to 7 percent) of the Tunisian coastline consisting of tourism-focused real-estate complexes.[51] The tourism and travel industry is vital to the Tunisian economy, contributing 14.2 percent of GDP and employing 11 percent of the population in 2018.[52,53] However, the sector is still recovering from the impacts of the COVID-19 pandemic, with tourist arrivals in July 2022 still 30 percent lower than in February 2020 amid growing competition from other holiday destinations. Moreover, as the current tourism business model is mainly developed around beach tourism activities, the generated benefits do not substantively contribute to economically weaker or rural areas in the country. [54]

Inadequate and dated urban infrastructure, which is less able to withstand shocks, contributes to the country's climate and disaster vulnerability. While droughts are more frequently recorded (accounting for 54 percent of disasters reported between 1957 and 2018), floods account for the most significant economic losses (approximately 60 percent of total losses over the same period), the highest number of casualties, and the highest number of people affected (around 560,000).[55] Tunisia is building a strong evidence base to inform appropriate disaster planning, with authorities on track to model flood risk as the Ministry of Finance and the Tunisian General Commission for Agricultural Development build analytical tools to assess the impact of floods in Tunisia. A database of building exposure to climate-related disasters has also been developed, and preliminary hazard and vulnerability modeling has been conducted for flood risk, both pluvial and fluvial.[56]

Tunisia's current transport infrastructure also displays weak resilience, both as a network and as infrastructure. Network resilience refers to a network's ability to continue functioning even if a segment is disrupted. Tunisia's freight transportation is highly reliant on roads (94 percent) and lacking in multimodality, with the market share for railways shrinking to six percent in 2020.[57] Infrastructure resilience is the ability of a system to absorb and recover from disruptions. Although Tunisia's road management (operated by Tunisie Autoroute, a semi-public limited company with private law status that operates various motorways as a concessionaire) is robust and the country continues to upgrade its road infrastructure, the supply and export of goods is nonetheless at risk of disruption. Criticality analysis for this report showed the important roles that the country's north-south corridors along the coast play in transporting goods, while highlighting the importance of east-west corridors to protect the population in the lagging regions in the west.[58] Ports, which account for 90 percent of Tunisia's foreign trade, also display vulnerability in that they struggle with existing physical capacity constraints of infrastructure in urban settings, with little or no prospect for capacity expansion. Most trade passes through the Port of Radés. [59]

These vulnerabilities are already causing monetary losses for private sector operators and driving climate awareness. According to the 2020 World Bank Enterprise Survey, around 24.5 percent of Tunisian construction and 17.2 percent of Tunisian transport companies had suffered monetary losses from extreme weather events (such as storms, floods, droughts, or landslides) in the preceding three years, versus an average of 7.5 percent for all companies.[60] In the north-east, 12.2 percent of companies reported experiencing such losses, higher than other regions. Affected companies seem to become more aware of climatic considerations, with 16 percent of impacted companies having incorporated sustainability considerations into their strategic objectives, versus only 6 percent for non-impacted companies. Yet, the affected companies did not display higher rates of energy or water management measures, suggesting remaining obstacles (such as not having sufficient resources) to the implementation of adaptation or resilience measures.

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51 Kacem 2022.
52 Heger, M., Vashold, L., Palacios, A., Alahmadi, M., & Acerbi, M. (2022). Blue Skies, Blue Seas: Air Pollution, Marine Plastics, and Coastal Erosion in the Middle East and North Africa. World Bank Publications.
53 https://www.statista.com/statistics/1253720/tourism-employment-as-share-of-total-employment-in-tunisia/
54 Statista 2023.
55 World Bank 2020.
56 After the Nabeul floods in September 2018, the Government of Tunisia and the World Bank initiated a dialogue that resulted in Program for Results financing in 2021 to support the government's integrated disaster risk management and financing program.
57 Ministry of Transport 2018.
58 Criticality analysis evaluates the resilience of a transport network and identifies vulnerable or "critical" network links which, if disrupted, have relatively higher impact on the overall network performance. It estimates traffic volumes on the road network using a gravity model, allocating the demand proportionate to the import entry point and population. The roads with the highest criticality include RN14, RN8, and the A1.
59 International Trade Administration 2022.
60 World Bank 2020b.

Tunisia's Disaster Risk Finance (DRF) framework is insufficient to cover losses incurred by climate-related disasters, exposing much of the economy to a large ex ante variability of incomes. Existing DRF mechanisms (Table 3) only cover a fraction of economic and financial losses. With an insurance penetration rate (that is, the ratio of total premiums as a percentage of GDP) of just 2 percent, most households, businesses, and small and medium enterprises (SMEs), including farms, lack domestic private insurance to cover catastrophic risks. The Government of Tunisia (GoT), bears the burden of providing relief to affected populations in the aftermath of a disaster, so multiplying the macro-fiscal impacts of disaster shocks and hindering Tunisia's long-term growth prospects. Agricultural insurance is emerging, representing 0.42 percent of the total volume of insurance premiums in 2021, but products are insufficiently developed to meet farmers' need to cover yield losses, as an example.[61] According to the Tunisian Ministry of Agriculture, losses due to catastrophic climatic hazards over the past eight years (2014 to 2022) stand at TD 345 million (US$112 million), of which the state has borne 40 percent of the losses.[62] Compensation through budgetary instruments has also been provided for direct losses suffered by SMEs (for example, through the 2011 Fund and Law 24–2019) and the agricultural sector (for example, through the Fund for Climate-Related Agricultural Losses).

Table 3: Current disaster risk finance instruments in Tunisia[63]

Instrument	Details
Insurance	• **Natural Catastrophes (NAT CAT) insurance for households:** Optional extension on home and car insurance. Low penetration rate: non-life market premium (property and casualty) is estimated at around 1.31 percent of GDP (compared to 1.74 percent in Morocco).[64] • **NAT CAT insurance for companies:** According to Law n°80-88, fire insurance for "industrial, commercial, and hotel risks" is mandatory. • **Agricultural insurance:** About 8 percent of farms have some kind of insurance, mainly large operators to comply with lending requirements. No parametric (index-based) insurance products are available.
Contingency funds	• **Fund for Climate-Related Agricultural Losses:** Aims to compensate uninsured farmers, herders, or fishers for damage caused by severe weather disasters. • **Guarantee Fund for the Insured (ad hoc):** Aims to cover insured in case insurance companies go insolvent. After the flooding of Nabeul in 2018, Law 24-2019 extended the scope of the fund to compensate SMEs impacted by the flood. • **Compensation fund for SMEs impacted by the revolution (ad hoc):** Created by Law 40-2011 to provide compensation for direct financial damage suffered by SMEs due to acts of fire, looting, and destruction committed during the 2010/11 revolution.
Budgetary instruments	• **State budget:** Three percent of the state's annual budget can be allocated to unforeseen expenses. • **Budget of the Tunisian Union of Social Solidarity:** The Tunisian Union of Social Solidarity is an NGO subsidized by the state to help the poor and manage social solidarity programs during catastrophic events. It is under the supervision of the Court of Auditors. • **National platform 1818:** Allows for the creation of an ad hoc bank account to collect donations following a disaster. Under the supervision of the Ministry of Finance.
Residual risk financing	• **Budget reallocations** • **Aid from donors** • **Emergency loans:** Up to 1 percent of the annual state budget in case of exhaustion of unforeseen expenses.

Source: World Bank team assessment.

[61] Fédération Tunisienne des Sociétés d'assurance 2022.
[62] Atlas Magazine 2023.
[63] World Bank team assessment.
[64] AXCO 2022.

Despite heavy public spending on social protection, which contributes to resilience in climate-related disasters, many people in need are not supported by the national social protection system. The country's main social assistance program, AMEN, was adopted in 2019 and still has limited coverage. It provides permanent cash transfers to about 10 percent of the population, while 16.6 percent of the population lived in poverty by 2021 (INS 2023).[65] With the support of the World Bank, the social assistance program is being transformed to improve targeting and make it more transparent and equitable. Heavy reliance on subsidies aggravates fiscal pressures while administrative fragmentation contributes to inefficiencies.

Tunisia's coastal and urban zones will face elevated climate change pressure. Sea levels are projected to rise by up to 0.3 m by 2050 and up to 0.7 m by 2100 under RCP 8.5, exacerbating the already accelerating trend of coastal erosion. Additionally, the frequency and severity of extreme weather events will increase, putting more people at risk and causing cascading economic consequences by destroying assets and disrupting business.

1.2.3. Dependence on fossil fuel imports

The energy sector is critical for both Tunisia's economic development and its climate change mitigation ambition. Energy accounted for 3.3 percent of GDP, 18 percent of merchandise imports, and 72 percent of the overall trade balance in 2022. While Tunisia contributes only 0.08 percent to global greenhouse gas (GHG) emissions, its emissions have been increasing in step with GDP growth.[66] In 2020, energy accounted for the largest share of GHG emissions (58 percent); followed by agriculture, forestry, and other land use (22 percent); industrial processes (12 percent); and waste (8 percent). In line with the government's low carbon strategy, energy is expected to contribute 59 percent of emission reductions to achieve net zero by 2050.

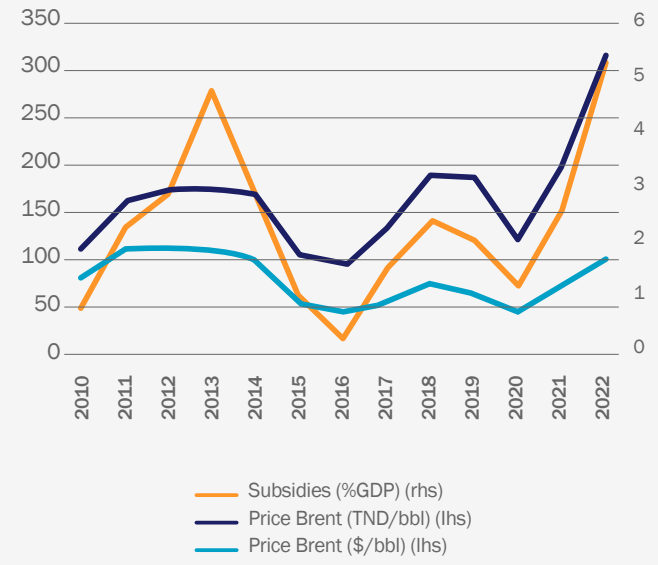
Tunisia's energy sector faces interlinked challenges: financial deficit of state energy companies and a high dependence on imported fossil fuels. Tunisia is increasingly dependent on imports to meet its energy demand: its import dependence rate, which was 7 percent in 2010, climbed to 50 percent in 2022, driven by rapidly growing demand and diminishing national resources. This resulted in an energy import bill of TD 15 billion (US$4.9 billion), or 10.3 percent of GDP, which accounted for most of the increase in the current account deficit in 2022. A growing dependence on imports has exposed Tunisia to fluctuations in the international oil price and its own exchange rate (Figure 13). Price fluctuations and potential shortages, combined with dwindling foreign reserves, present a major risk for the private sector, negatively impacting its international competitiveness. However, despite the global energy price spike, most energy products continue to be priced below cost, requiring subsidies from the state's budget.

Energy subsidies have been a significant expenditure in Tunisia's budget, averaging 6.4 percent of public expenditure and 2.14 percent of GDP over the 2011 to 2021 period. In 2022, energy subsidies rose to 5.3 percent of GDP and 15 percent of public expenditure. Because the government's budget deficit often prevents it from fully paying subsidies, the deficits end up accumulating in the energy sector, particularly in the two SOEs, Société Tunisienne des Industries de Raffinage (STIR, the Tunisian Company of Refining,) and Société Tunisienne de l'Electricité et du Gaz (STEG, the Tunisian Company of Electricity and Gas), which dominate the petroleum and electricity/natural gas sectors, respectively. Figure 14 shows that even before the 2022 price shock, both STEG and STIR experienced substantial and growing debt due to the sector's dependence on imported fossil fuels. The country's energy mix is highly carbon-intensive, dominated as it is by natural gas (53 percent) and oil (46 percent), with renewables accounting for only 1 percent of primary energy. The limited penetration of renewable energy is partly due to the financial deficits of the sector's SOEs, which undermine investor confidence.

[65] Based on data from Statistics Tunisia's "2021 National Survey on the Budget, Consumption and Standard of Living of Households." Available at: https://www.ins.tn/en/statistiques/102.

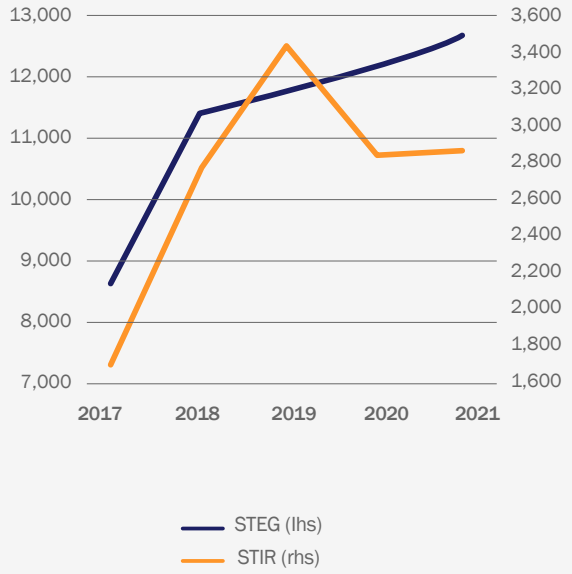
[66] CO2 emissions GDP has remained stable at around 0.6 kg per 2015 US$ since 2010, compared with the European Union decreasing from 0.25 kg per US$ to 0.18kg per US$ from 2010 to 2019 (International Energy Agency 2020).

Figure 13: Comparison of brent price (in US$ per barrel and TD per barrel, left axis) and subsidies (in percent of GDP, right axis)



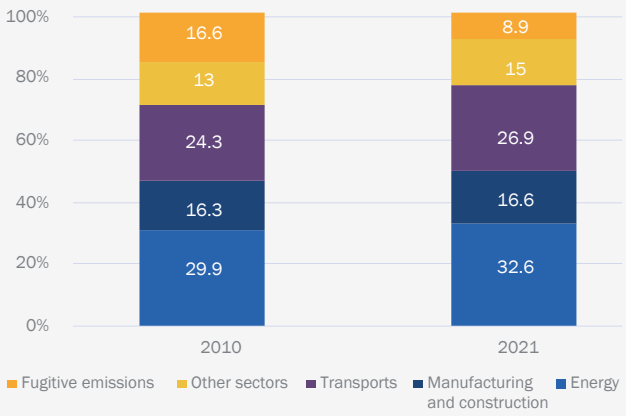
Source: World Bank 2023.

Figure 14: SOE debt is mounting due to need to absorb energy subsidies (TD million)



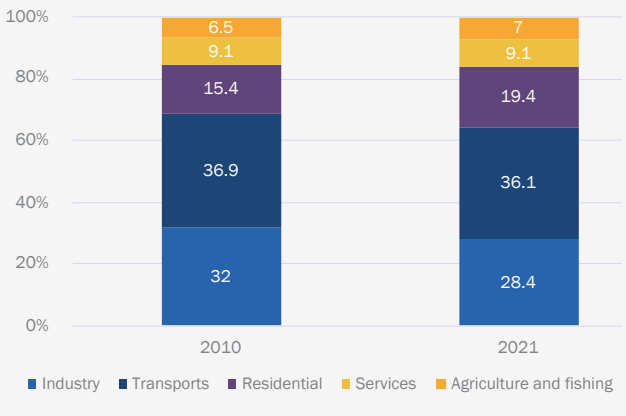
The sectors that contribute the most to energy consumption and emissions are transport, industry, and buildings (the residential and commercial sector, including energy used for cooking and appliances). Emissions from the energy sector are dominated by energy transformation, which is mostly electricity production and is 98 percent gas-based. This is followed by the end-use sectors of transport (27 percent); industry (17 percent); residential, commercial, and agriculture (15 percent); and fugitive emissions (9 percent) (Figure 15). In terms of energy consumption, the transport sector is the leading consumer (36 percent), followed by industries and buildings (residential and commercial) with 28 percent each, and agriculture (7 percent) (Figure 16).

Figure 15: Energy emissions (C02 equivalent) by sector



Source : Rapport Biannuel Actualisé de la Tunisie la Convention Cadre des Nations Unies sur le Changement Climatique 2022.

Figure 16: Final energy demand by sector



Source: Stratégie énergétique 2035.

Oil is the main fuel in the transport sector (96 percent). Road transport accounts for 89 percent of transport energy consumption (of which around 66 percent comes from diesel and the rest from gasoline and liquefied petroleum gas) and most of transport emissions.[67] Steadily increasing use of passenger cars has created near-permanent traffic congestion, driving increased emissions and air pollution. The number of private cars in operation rose from 950,000 in 2010 to 1.8 million in 2016.

The dominance of road transport can be attributed to a combination of insufficient public transport, inefficient traffic management systems, and the heavy use of road transport for freight. Even though Tunisia has railway infrastructure (with commercially viable intercity and commuter corridors) and a solid institutional foundation, the railway sector has experienced plummeting demand: rail traffic systems account for only 5 percent of all interurban passenger journeys and 14 percent of total freight transport. Urban tram or light-rail systems are only present in Tunis.

Public mass transport and bicycle traffic are underdeveloped relative to their potential. Demand for both buses and metro rail have persistently declined due to a rapid increase in the use of private cars, growing competition from other modes (including formal and informal taxi operators), and an overall perception of poor performance due to lack of public resources to upgrade and maintain the aging fleet. The number of passengers using the three largest state-owned public-transport operators decreased by 32 percent between 2010 and 2015. These SOEs have become structurally loss-making and in need of significant state financial support. Traffic safety also remains an impediment to walking and cycling to access public transport, especially in urban areas.[68] Modernizing the collection of safety data for statistical purposes, strengthening traffic management,[69] and public awareness campaigns would help promote urban streetscapes and support effective planning to encourage the use of sustainable transport.

Industrial energy sources are mostly petroleum products (39 percent), which includes pet coke (largely consumed in the cement sector) and natural gas (37 percent). Disaggregating by subsectors, non-metallic minerals make up between 83 and 85 percent of industrial energy use.[70] Separate from emissions from industrial energy use, yet within emissions from industrial processes, cement production is the largest emitter of GHGs, averaging 70 percent over the period 2010 to 2020.[71] This is followed by the production of bricks (14 percent of emissions on average), the usage of hydrofluorocarbons (HFCs) (6 percent), and the usage of nitric acid (5 percent).

Few companies have tried to improve energy efficiency or transition to renewable energy.[72] Five percent of companies across all sectors have installed onsite renewable energy generation capacity, and only one in five companies reported implementing an energy management system.

Compared with other end-use sectors, the residential and commercial sector (often labeled "buildings", although it includes energy for cooking and appliances) has the highest share of electricity penetration. It is also the sector where the share of renewable energy is highest, at 26 percent of the sector's final energy use if biomass is included. Population growth and improving living standards are expected to drive rapid growth of this sector's energy use, which is expected to reach 35 percent of total energy consumption by 2030. With almost 2.4 million housing units in 2014 and an estimated need of about 40,000 new units a year, Tunisia's housing stock is likely to reach 3.2 million units in 2030. [73] In the residential sector, a steady increase in electrical appliance ownership has resulted in climbing electricity consumption. Growing use of air conditioning, in the tourism sector especially, is also driving electricity consumption.

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67 Pipelines are included in the transport sector and account for natural gas consumption, which makes up 4 percent of transport energy use.

68 In 2012, "pedestrian" was reported as the second cause of road traffic accidents (19 percent) after "private vehicle" (33.4 percent). Traffic accidents by road type were more concentrated in urban agglomerations (42.1 percent) compared with national roads (15.6 percent) and regional roads (9.1 percent). Geographically, most accidents were reported in Greater Tunis (41.2 percent), suggesting the prevalence of traffic safety challenges in urban areas. Most recent statistics (2012) as reported in the National Transport Development Plan 2040, published in 2017.

69 For example, lowering speed limits and improving road infrastructure with safety features.

70 Non-metallic minerals include the production of cement, phosphate processing, ceramics, glass, and lime products. The transformation of non-metallic minerals into these products is often an energy-intensive process.

71 One of the main ingredients in cement, clinker, is made by heating limestone to extreme temperatures. The process releases carbon trapped in the stone, which combines with oxygen in the atmosphere to form CO2. It is an unavoidable part of the process.

72 World Bank 2020b.

73 Programme for Energy Efficiency in Buildings 2019.

Decarbonization is both a mitigation strategy and a solution to the country's need to improve energy security and drive economic development. Major decarbonization solutions entail efforts to conserve energy, improve efficiency, and increase renewable energy penetration. These solutions are expected to reduce not only Tunisia's emissions and air pollution, but also its dependence on imported fossil fuels, so improving energy security and relieving pressure on both the trade and current account deficits. Investing in clean energy can also generate jobs and create opportunities for the private sector, leading to important socioeconomic benefits. The competitiveness of renewable energy would also help reduce the overall cost of energy supply while reducing vulnerability to international price fluctuations, ultimately enhancing energy affordability for households and competitiveness for businesses. Lower energy costs would reduce the pressure created by energy subsidies and help the sector regain financial viability. This, in turn, would attract private finance for renewable development, creating a virtuous cycle for the sector.

2. Climate Change Strategies, Policies, and Institutions

2.1. An Ambitious Climate Change Agenda with Opportunities and Challenges

The Government of Tunisia (GoT) considers climate action a key priority and has taken decisive steps. The government recently launched its Strategy for Ecological Transition, an all-encompassing strategy that seeks to implement a resilient, sustainable, socially fair, and inclusive development model that transforms ways of consuming, producing, working, and living in an integrated manner. The strategy has five objectives, which include a climate objective to strengthen the adaptation and resilience capacities of sectors, environments, and populations, and an objective to reduce carbon intensity to achieve neutrality in 2050. In addition, the country's 2023–2025 development plan recognizes that, in the context of climate change, any economic transition would benefit from prioritizing accelerating the energy transition, adapting to climate change, and ensuring the sustainable management of natural resources. Achieving these goals is projected to require TD 6.7 billion (US$2.2 billion).[74] The recently launched process to prepare Tunisia's ecological transition strategy 2035 envisions the convergence of sectoral strategies towards sustainability, while improving resources management efficiency in development activities. It includes a key axis centered on the promotion of adaptation, resilience, and carbon neutrality by 2050.

Tunisia is also committed to the international climate change agenda. Tunisia submitted its third National Communication on Climate Change in 2019 and its National Adaptation Plan (NAP) is being developed. Ahead of the 2021 United Nations Climate Change Conference, Tunisia submitted its updated Nationally Determined Contribution (NDC), in which it increased its unconditional and conditional 2030 emissions intensity targets by 27 percent and 45 percent against a 2010 baseline, respectively.[75] The updated NDC includes upgraded mitigation objectives (with emission reductions stemming predominantly from the energy sector) and reinforces interventions for the most vulnerable sectors, which includes water resources, the coastline, ecosystems, tourism, and health. It also emphasizes an integrated urban planning approach to enhance local capacities. The updated NDC is aligned with Tunisia's development needs and aspirations. It includes components on gender mainstreaming and social resilience to leave no one behind [76] and ensure alignment with the United Nations' Sustainable Development Goals (SDGs). In November 2022, the country issued a combined National Low Carbon Strategy and Climate Resilient National Development Strategy for 2050 (SNBC&RCC 2050), building on the country's long-term low-emissions development strategy (LT-LEDS). The SNBC&RCC 2050 is the main policy document for integrating mitigation and adaptation in different economic sectors.

Despite committing to combating climate change, Tunisia's escalating fiscal deficit and lack of private finance limit programs implementation. The country needs about US$19.4 billion over the period 2021–2030 to achieve its NDC commitments. This includes:

- US$14.4 billion for mitigation, of which 60 percent would need private financing
- US$4.3 billion for adaptation
- US$700 million for capacity-building actions.

The financial requirement for the adaptation component of Tunisia's updated NDC amounted to more than US$400 million in 2021 (that is, nearly 1 percent of Tunisia's GDP). This figure is expected to reach US$475 million in 2030. Although the NDC includes estimations of financing needs and Tunisia has prepared and drafted various Nationally Appropriate Mitigation Actions, lack of funding limits implementation. In the case of renewable energy, for example, the GoT attracts private investment through three regimes: (i) concessions for large projects; (ii) authorizations for small and medium projects (up to 10 MW for solar photovoltaic [PV] and 30 MW for wind); and (iii) self-generation for industrial customers. There have been two rounds of calls for proposals under the concession regime and four

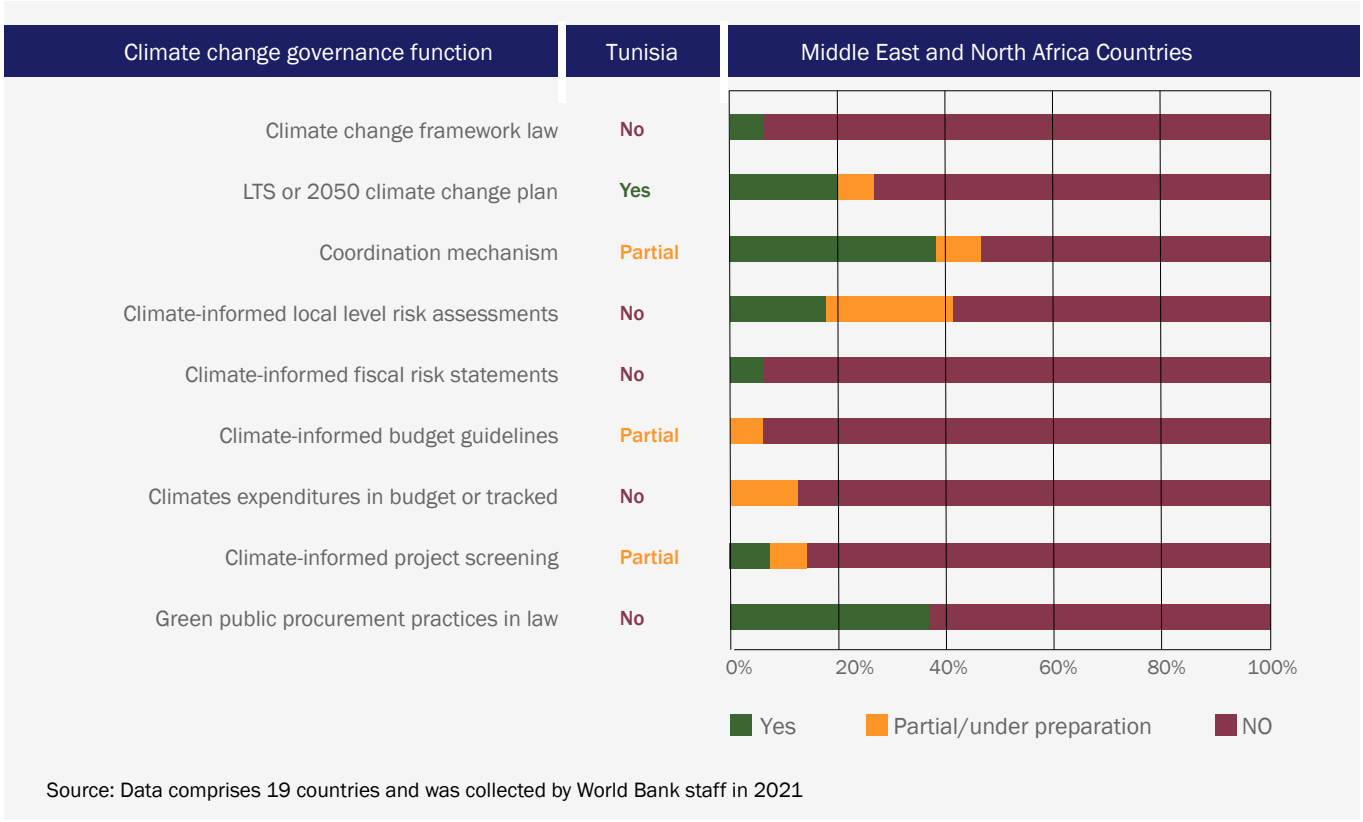
[74] See the preliminary version of the development plan.
[75] CO2 consumption per unit of GDP.
[76] The updated NDC also underscores the importance of limiting the impacts of climate change on poverty, strengthening social protection, and ensuring access to sustainable employment for the households and communities most vulnerable to climate change.

rounds under the authorization regime, attracting significant international and local private investors. However, due to various barriers (mainly investor risk perception and lack of financing), by the end of 2021 only a limited number of projects had been implemented.[77] Climate investments will likely need to attract different sources, including the private sector, as US$11 billion is supposed to be mobilized from international sources according to the NDC (see Chapter 4).

Frequent changes within the government and public sector bottlenecks have further restricted the state's ability to implement climate action. Fiscal and economic stresses have gradually reduced fiscal space for public investment and increased the costs of borrowing. Further, structural bottlenecks in the public administration (including challenges in procurement and expenditure controls, limitations inherent in the framework for project management entities) complicate timely and impactful climate action. Collectively, these challenges make the rapid formulation, implementation, and management of public sector action, including investment projects, very challenging, and in turn are likely to moderate expectations regarding the expected speed and adequacy of the public sector climate response. While resolving these structural issues requires several medium- to long-term public sector changes, the development of a special projects facility for both own-financed and donor-funded climate investments with accelerated procedures—including the contracting of procurement and contract-management functions—could be a possible solution.

Although Tunisia has succeeded in producing strategic documents and setting up a coordination mechanism to implement its climate change strategy, it falls short on embedding its commitment in policies, processes, and systems (Figure 17). Climate change considerations have not yet been systematically included in Tunisia's public finances, fiscal risk statements, public investments, or procurement. SOEs are also not required to report on climate risks or have plans to address them.

Figure 17: Assessment of Tunisia's climate change governance functions



Source: Data comprises 19 countries and was collected by World Bank staff in 2021

[77] Three projects totalling 12 megawatts (MW) had been constructed under the authorization regime, 435 MW had been constructed under the old self-generation regime, and 20 MW of solar had been installed by STEG.

To strengthen climate governance, the government created a dedicated structure to enable coordination between sectors. However, this structure has limited resources to fulfill its mandate. In 2018, the Unité de Gestion par Objectif–Changements Climatiques (UGPO-CC, Management Unit by Objective-Climate Change) was created at the Ministry of Environment (MoE) to coordinate climate change action between ministries, private actors, and other stakeholders. In 2020, two technical advisory committees were formed to focus on adaptation and mitigation. Other sectoral agencies contribute to the development of policies and measures on an ad hoc basis. In practice, however, the UGPO-CC has limited human resources and its budget is mostly provided through cooperation projects. The committees have met three times since their creation in 2020. Consultations with civil society organizations attest to this issue, while underscoring the lack of a coherent approach to involving non-government organizations and local communities.

Leadership and responsibilities for the implementation of climate change reforms are not clearly delineated between different actors. The institutional arrangement does not provide clarity on roles, responsibilities, or leadership at the national and local levels. NDC implementation is fragmented between several institutions, mainly the MoE; the Ministry of Industry, Mining, and Energy; the Ministry of Agriculture, Water Resources, and Fisheries (MARHP); and their affiliated bodies. Lack of access to information and the limited influence of the UGPO-CC also remain important challenges.

Comprehensive climate change legislation could help enhance implementation of Tunisia's climate objectives. Although legal texts approving and acceding to international legal agreements are in place, these have not yet been translated into comprehensive climate legislation. [78] There is also no legislation or guidance on the institutionalization of climate change (beyond the coordinating role of the MoE), or practical mechanisms for adopting a "whole of society" approach to enable stakeholders from all sectors to act for a just climate transition. National framework legislation on climate change would serve to enshrine stable, ambitious objectives; create mechanisms for realizing these objectives; and ensure proper oversight and accountability. [79]

In 2022, national consultations were initiated to propose climate policy legislation, either as an independent climate law or for integration into the upcoming environmental code. Specific legislation would help Tunisia implement its NDC, its long-term strategy, and the upcoming NAP by clarifying, among other issues, intermediate and sectoral targets; the frequency of risk and vulnerability assessments; the mechanisms to be used (for example carbon pricing or sectoral regulation); coordination mechanisms; the roles and responsibilities of subnational governments and SOEs; finance mechanisms; and the monitoring, review, and verification (MRV) system that is to be used to track progress. However, to be effective such legislation would need to be accompanied by sustained implementation support and associated resources.

Stakeholders' technical capacities and climate tools, including the MRV framework, can be enhanced. The implementation of NDC objectives requires the transfer of skills and technical capabilities to the public sector, the private sector, and civil society. Support is needed for investments in training and skills development, planning, and awareness-raising, which are essential for long-term market development.53 Improving and formalizing an MRV system in line with the enhanced transparency framework of the Paris Agreement is another priority. Improved transparency will allow for better monitoring and evaluation of climate action while promoting accountability.

[78] Existing legislation includes: Organic Law No. 2016–72 of October 2016, which approves the Paris Climate Agreement for the implementation of the United Nations Framework Convention on Climate Change (UNFCCC); Law No. 93–46 of May 1993, which ratifies the UNFCCC; and Law No. 2002–55 of June 2002, which approves the accession of the Republic of Tunisia to the Kyoto Protocol.

[78] The World Bank Reference Guide to Climate Change Framework Legislation highlights 12 elements that should be integrated in "good" climate change laws: https://openknowledge.worldbank.org/handle/10986/34972.

2.2. Challenges to Integrated and Inclusive Climate Governance

The UGPO-CC plays the role of national coordinator between the different actors responsible for achieving the objectives of the NDC. The Forum National des Acteurs de l'Adaptation au Changement Climatique (FNAC, National Forum of Climate Change Adaptation Actors) was established by the UGPO-CC to facilitate knowledge exchanges, build capacity, and provide support to various actors engaging in climate change initiatives. This forum includes local authorities that are part of a common sub-forum. However, FNAC is not sufficient to ensure effective coordination between national actors and local authorities. In practice, each local authority coordinates directly with central sector ministries.

Inclusive multistakeholder and multilevel planning is nascent, yet likely to be essential for sustained and inclusive "whole of society" efforts to strengthen climate action and accountability. The 2022 constitution assigns responsibilities to local authorities for environmental management, among other responsibilities, though no new related law has yet been developed. As a result, the new arrangements need to be defined. According to the Organic Law of Local Authorities (2018) (which had formalized the decentralization process), environmental preservation, waste management, and sustainable development are operationally assigned to local authorities, while policymaking is centralized. This has had the effect of reducing engagement and coordination between ministries and local authorities and weakening climate governance and interventions. There is a need to reinforce governance frameworks that embed the participation of other stakeholders (such as the private sector, NGOs, the media, academia, and the financial sector). Consistent, inclusive, and results-oriented multistakeholder engagement is needed to support a "whole of society" approach that draws on the capacities of various actors and that maximizes the potential social co-benefits of climate change mitigation and adaptation (for example, gender equity, non-discrimination, and good labor practices). This "whole of society" approach should ideally consist of three streams of action, including:

- **Accountability for climate finance** and performance toward climate commitments
- **Collaboration in the development of climate policies,** strategies, and programs
- **Direct action that mobilizes communities and individuals** in support of Tunisia's effort to reduce its carbon footprint and establish more resilient communities.

Despite coordination challenges, climate change has been progressively adopted in local development and sectoral strategies. The strategies for the three cross-sectoral objectives identified in this report are summarized in boxes 3 to 5. Local climate change strategies represent an evolution towards multilevel planning and enhanced local climate governance to specifically address climate threats in a given vulnerable zone. Examples are the local strategies and action plans of the municipalities of Gabes, Mateur, Ayn Darahim, and Tataouine; the Nabeul Governorate Post-Flood Recovery Action Plan (2019); and the emergency response plans for the island of Djerba and Ghar el Melh/Kalaât el Andalous.

Box 3: Policies and strategies to address water scarcity

Water policies are evolving towards communities, business, and food resilience. The updated strategic framework, Water 2050, tackles the challenges of water supply and demand management through innovative water development sources, more efficient infrastructure, and water savings technologies. Adaptation to climate change is also a pillar of Reuse 2050 and Water 2035 (the SONEDE strategy), which calls for higher reliance on non-conventional water sources. The legal framework is under review through the draft Water Code, which mainly targets illegal drilling and aims to reorganize water management at the rural level. Despite Tunisia having 231 wetlands occupying 1,250,200 ha, ensuring freshwater for ecosystems is not part of the Water 2050 strategy. Food resilience will primarily be addressed by the upcoming National Plan on Climate Change Adaptation for Food Security. Tunisia has also developed a national strategy to combat desertification.

Box 4: Policies and strategies to enhance resilience of urban and coastal zones

Urban and coastal management policy frameworks integrate climate action, but implementation remains challenging. The country's strategic orientation towards building urban and coastal resilience was initiated in the 2012 National Strategy on Climate Change, followed by:

- The 2030 National Strategy on Disaster Risk Management (2021) and its Action Plan, which seek to address the causes and effects of disaster risk by planning disaster response, recovery resilience, and reconstruction
- The Integrated Management of Coastal Zones Protocol (ratified on November 29, 2022)
- The Code on Landscape Management and Urbanism
- The Plan for Urban Planning.

In 2022, Tunisia submitted its Voluntary National Report for the Midterm Review of the Implementation of the Sendai Framework for Disaster Risk Reduction 2015–2030. The Ministry of Equipment and Housing is responsible for the development of sector policies, while the Agency of Coastal Protection and Management, which is affiliated to the Ministry of Environment, is responsible for coastal zone management with the support of local authorities. The National Strategy on Tourism Development 2035, which is spearheaded by the Ministry of Tourism, outlines a concerted effort to transition towards sustainable tourism.

Box 5: Policies and strategies to develop renewable energy and improve energy efficiency

Tunisia plans to reach carbon neutrality by 2050 and become a regional energy hub, exporting clean energy to other African countries and Europe through the Italy-Tunisia (Elmed) interconnector, supported by the World Bank. This will require decarbonizing the energy sector by increasing the share of renewables in the energy mix and improving the energy efficiency of end-user sectors. On paper, Tunisia's policies and regulations are largely supportive of renewable energy and energy efficiency, scoring 77 and 66 respectively on Regulatory Indicators for Sustainable Energy. However, to date the implementation of current policies and strategies has been limited and, in the case of renewable energy, policies relating to transparency of the utility and renewable grid integration are incomplete.

The following key strategies and policies are in place:

- **Renewable energy:** The National Strategy for the Green Economy 2030 sets the agenda for achieving net-zero carbon emissions. The SNBC&RCC 2050 targets 50 percent renewable energy by 2035 and 80 percent by 2050—a substantially more ambitious target than the 30 percent by 2030 initially proposed by the Tunisia Solar Plan of 2015, which was recently updated to 35 percent. Although the Transversal Law (2019) allows industrial customers with demand above 1 MW to form special-purpose vehicles to sell self-generated electricity to each other, in effect allowing third-party access to transmission and distribution networks for the first time, the implementation of this legislation requires two additional ministerial decrees (relating to the wheeling charge for medium-voltage network and to the contractual framework to sell excess energy to STEG).
- **Energy efficiency:** In February 2023, Tunisia released Energy Strategy 2035, complemented by strategies to improve the efficiency of end-use sectors. An example is the Sustainable Cities 2050 strategic program, which aims to reduce congestion and achieve carbon neutrality in all Tunisian cities by 2050. Despite advances in Tunisia's regulatory framework since the 1990s, the following gaps remain: financing mechanisms are limited; minimum performance standards and energy labelling systems still need to be developed; and tariffs need to be strengthened to provide sufficient incentive for energy conservation and efficiency improvements.

3. Key Objectives for Resilience and Decarbonization

The previous chapters discuss how Tunisia's economic development and climate change interact, and describe the strategies, policies, and institutions in place to address climate change at the national, local, and sectoral levels. If Tunisia is to achieve its ambitious climate goals and enhance the resilience of its economic drivers and communities, it would benefit from focusing on the following key objectives:

- Ensure enough water is available for all
- Enhance the resilience of urban and coastal areas to climate stressors
- Decarbonize the economy.

This chapter estimates the costs of inaction on these objectives and recommends next steps towards achieving them to help Tunisia and its people successfully cope with, and manage, the impacts of climate change.

3.1. Addressing Water Scarcity

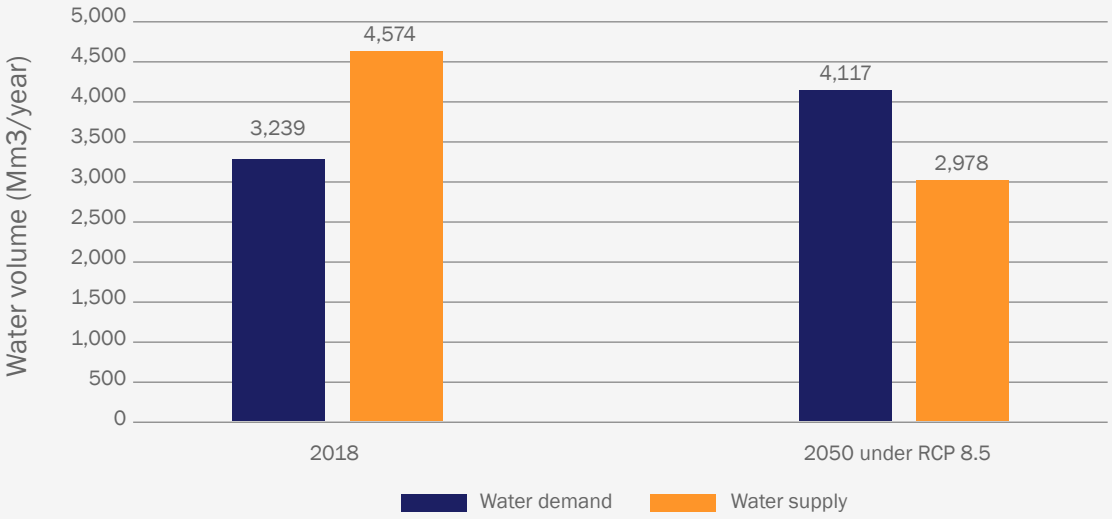
3.1.1. The costs of inaction on water resources

By 2050, overall water resources per person per year could decrease by 43 percent (from 366 m^3 to 210 m^3) under RCP 4.5, and up to 66 percent (to 122 m^3) under RCP 8.5.[80] Tunisia's current water resources have been estimated at 4,929 million m^3 (Mm^3) of water, of which 55 percent is surface water (2,731 Mm^3), 16 percent is groundwater (770 Mm^3), and 29 percent is found in deep aquifers (1,431 Mm^3).[81] As climate change alters the water cycle, surface water resources could decline by 41 percent by 2050, of which a third would be due to an increase in evapotranspiration and two-thirds would be due to a decrease in rainfall under RCP 4.5.[82] Coastal areas would be disproportionately affected as losses at coastal aquifers could potentially reach 50 percent of resources in 2050 due to the combined effects of rising sea levels and salinization.[83]

Water demand has increased in recent years due to urban growth, rising populations, and increasing irrigation needs. The rate of increase differs from region to region and sector to sector. Under RCP 8.5, expected increases in water demand, coupled with reductions in supply, are projected to result in a demand-supply gap of 1,139 Mm^3 per year, or 28 percent of demand being unmet, by 2050 (Figure 18).[84] A simultaneous increase in the frequency and intensity of climate change-induced extreme weather events will likely drive a decline in water quality while increasing the incidence of water-borne diseases, with the poor disproportionately impacted.[85]

[80] Agence Française de Développement 2020.
[81] MARHP 2022.
[82] Agence Française de Développement 2020.
[83] Agence Française de Développement 2020. Only RCP 4.5 information is available.
[84] Agence Française de Développement 2020.
[85] Only 61 percent of schools and 53 percent of preschools provide basic sanitation services (UNICEF 2022).

Figure 18: Water supply and demand in 2018 (no drought condition) and under RCP 8.5 with no action [86, 87]



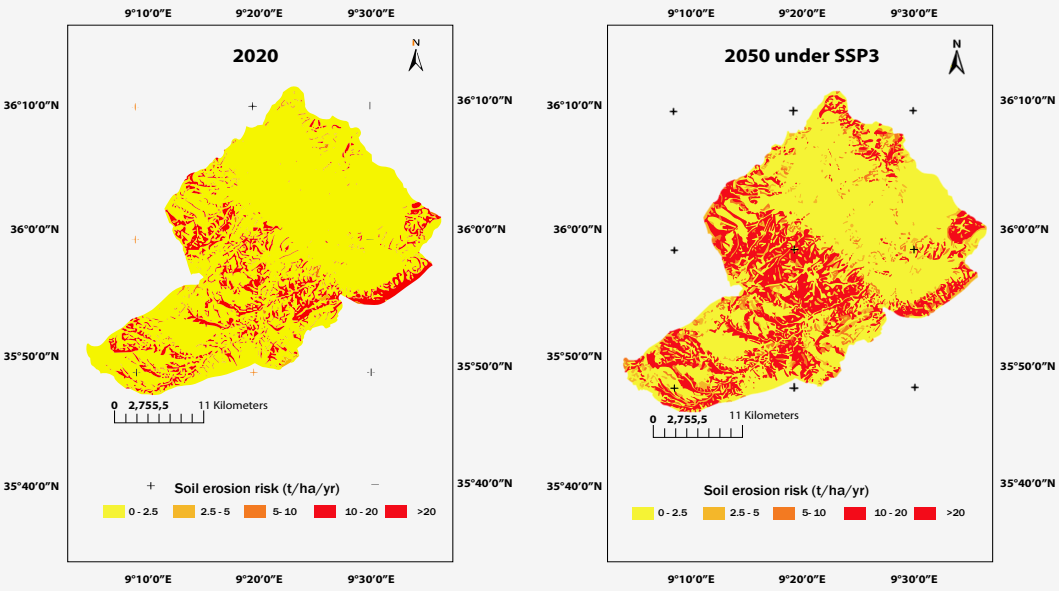
Source: Generated by World Bank team.

Reduced water availability could affect agricultural production, compounding agricultural losses from climatic disturbances and further straining people's livelihoods. Major agriculture systems in Tunisia (olive, oasis, cereal, and livestock) are among the most vulnerable to climate change, with water availability being a major concern.[88] The projected drop in yield for olives, which accounted for 40 percent of total agricultural exports in 2019, could reach 69 percent under RCP 8.5. Soft wheat and barley are expected to experience similar drops in yield (35 percent decline for soft wheat and 41 percent for barley) by 2050 under RCP 8.5.[89, 90] Agricultural lands favorable to olive and cereal cultivation are also expected to shrink due to the northward migration of bioclimatic stages. This is cause for concern because cereals are particularly essential for national food security and are crucial for the livelihoods of many rural households, especially in the northern regions.[91] By 2100, olive cultivation is projected to lose about 14 percent of its current area under RCP 8.5, and about 5 percent of its current area under RCP 4.5.[92] Climate change is also expected to cause the loss of at least 30 percent of agricultural jobs by 2050, driven in part by the irreversible desertification of the country's oases, where agriculture is the main source of livelihoods.[93]

[86] Agence Française de Développement 2020. For current demand and supply, baseline estimates are based on potable, agricultural, industrial, and tourism demands and on conventional and non-conventional water supply sources. For future demand and supply, estimates are bases on potable and agricultural water demands and on conventional and non-conventional sources.
[87] There are differences in terms of results and methods. For instance, the Water 2050 strategy forecasts a reduction in conventional water resources of around 30 percent by 2050.
[88] Agricultural production is primarily composed of livestock (37 percent), arboriculture (mainly olive production, 28 percent), market gardening (16 percent), and cereals (10 percent).
[89] Agence Française de Développement 2020.
[90] Under RCP 4.5, yields could decline 67 percent for olive oil, 42 percent for soft wheat, and 54 percent for barley.
[91] When the Ukraine war escalated, food prices surged by 15.1 percent and the food trade deficit rose by 50 percent to TD 2.9 billion (2.2 percent of GDP) within a year (National Observatory of Agriculture and Institut National de la Statistique [National Statistics Institute]).
[92] By 2100, olive area cultivation is projected to be affected between -27 percent and +7 percent under RCP 8.5 and between -17 percent and +11 percent under RCP 4.5.
[93] Ministry of Environment 2021.

By 2050, climate change could degrade Tunisia's critical ecosystems and soils by a further 28 percent under SSP3, linked to an increase in soil erosion (Figure 19) and a reduction in water yields, soil quality, and the storage capacity of dams.[94] Ecosystems,[95] scrublands, and oasis ecosystems are under threat due to increased temperatures and reduced rainfall, which harm trees and reduce ecosystem productivity. Climate change is expected to increase the frequency and intensity of wildfires and allow pests such as bark beetles to thrive and spread. The Aleppo pine, a widespread tree species in Tunisia, is already experiencing increased mortality rates due to warmer temperatures. Estimates put the loss of forest due to fires at 180,000 ha by 2030 (17 percent of the current forest area).[96]

Figure 19: Soil erosion at Siliana watershed in 2020 (left) and 2050 under SSP3 scenario (right, projected)



Source: Generated by World Bank team.

Failure to act would result in huge water losses by 2050, with agriculture and ecosystem services (which the poor and vulnerable depend upon for their livelihoods) being especially hard hit. The water shortage is projected to generate considerable losses, especially for irrigated agriculture, which accounts for almost 36 percent of value added by the agriculture sector. Agricultural production is expected to drop by between 29.1 percent (under RCP 4.5) and 33.1 percent (under RCP 8.5) relative to projections under a scenario of no climatic stress. At current 2022 prices, these losses would translate into TD 4.0 billion and TD 4.6 billion, or between 2.8 percent and 3.2 percent of GDP. These direct (partial equilibrium) sectoral losses would then generate macroeconomic (general equilibrium) losses.

3.1.2. How to solve the water crisis

Enhance water management and increase water supply

Managing water demand and improving efficiency will be essential for optimizing existing conventional water resources in Tunisia. Regulating water demand—including through measures such as pricing, quotas, and metering—

[94] Further information on the impact of climate change on landscapes can be found in the background note on landscape management. In terms of method, the first step was to identify the current and potential future benefits associated with different land uses and management practices by mapping and valuing ecosystem services using the InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) model, which involves the assessment of ecosystem services quantity provided by different land uses and then estimating their economic value. The next step was to assess the costs of inaction and the benefits of adaptation measures to address climate change. The costs of inaction were assessed by estimating the economic losses associated with the impacts of climate change on ecosystem services.

[95] Ecosystems function as water reservoirs and protect dams from siltation.

[96] Ministry of Environment. 2021

should ideally be a priority.[97] Effective demand management controls could be accompanied with targeted awareness campaigns about the value of water and conservation methods. Digitalization of the national water management system could further improve network monitoring and management and facilitate water accounting, water valuation, and demand management policies.

Accompanying institutional reforms and establishing a water-monitoring and early-warning system would further enhance water governance and management. Proposed reforms under the responsibility of the contracting authority include:

- Work towards the institutional and financial evolution of SONEDE towards better transparency and cost-efficiency to attract private capital.[98]
- Revise, approve, and implement the New Water Code[99] to: (i) integrate the environmental right to water; (ii) align the cost of water with uses and types of water (green, blue, and gray); (iii) specify the role of GDAs in the protection of water; (iv) consider the risks of climate change; and (v) give a more important role to the Water Council, among others, while ensuring that measures suggested by the Water 2050 strategy are integrated.
- Establish a regional monitoring and early-warning system to help people prepare for water stress and increasing droughts. Investing in hydrometeorological and early warning services in Tunisia could generate a 3:1 rate of return, with an average reduction of US$12.4 million in annual disaster losses.[100] Such a system could be established at the regional level to track changes in water, efficiency (physical and hydraulic), and productivity (agronomic and economic).[101]

Enhancing the technical and financial capacities of institutions—especially in rural areas—is critical for the efficiency of water policies. Water management is assigned to the MARHP and its related body, SONEDE. Water planning and management capacities would need to be reinforced and coordination between ministry services and water users (or water-user associations) improved. This is especially important for rural water distribution, which is managed by 2,500 GDAs under the support and direction of regional commissions for agricultural development. Most of these entities struggle with lack of technical and functional capacity[102] and do not operate under efficiency and performance-based principles, precluding cost recovery and contributing to high water losses due to poorly operated and maintained distribution systems. Most of the rural population is deprived of effective support or regulation regarding sanitation (which is managed by ONAS).

Water-related challenges in rural areas particularly affect women, who are unable to play a more active role in making decisions relating to the management of water resources. In times of drought or restrictions on irrigation water, women need to go further to fetch water for their families and livestock. The Ministry of Agriculture has introduced an indicator that tracks the participation rate of women in the boards of rural drinking-water GDAs and asked technical directors to address this issue. Nonetheless, data on 1,364 GDAs shows that the participation of women in leadership structures remains low due to cultural barriers, especially when it comes to boards of directors, in which only 13 women take part across all GDAs.[103]

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[97] Water can be priced using both direct price (tariff or fee) and quantity regulation instruments (quota). To improve water resource management, countries have been establishing agencies—typically at river-basin scale—to assess and monitor the water balance and regulate the use of water through quantity restrictions or quotas. Quotas function as implicit caps for user groups. Examples include quantity restrictions on water supply for irrigation (devised by a ministry of agriculture) and quantity restrictions on water supply to households (devised by utilities and monitored and enforced by local government). Tariff reforms have been implemented to regulate water demand, cover utility operating costs, and generate external financing to build water infrastructure to reduce water wastage in the course of service delivery and increase the supply of water resources through desalination or wastewater treatment and reuse. Surveys can help to define willingness of citizens to pay. (World Bank 2023c).

[98] A change in SONEDE's status towards a performance-based company should be approached with a thorough analysis based on prior financial, organizational, and commercial studies, and would take into account all economic, legal, social, and national security aspects.

[99] Tunisia's Water Code was adopted in 1975 and has not been amended. A new water code would ideally reflect the ecological, political, and economic changes that Tunisia has undergone, aim to combat illegal well-drilling, and organize water groups.

[100] Global Facility for Disaster Reduction and Recovery 2022.

[101] The Ministry of Local Affairs and Environment developed a meteorological alert tool, Carte de Vigilance, to provide weather warnings. The proposed hydrometeorological mapping and early warning system could build on these efforts.

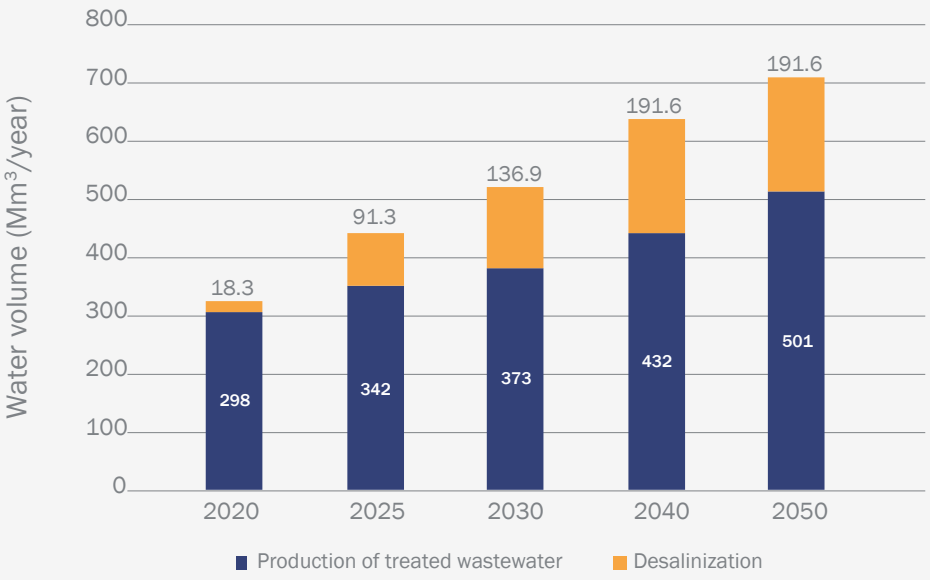
[102] GDAs are also responsible for operating and maintaining public irrigation schemes. This is part of the reason public irrigation schemes are not properly maintained and leak or lack water.

[103] A board usually consists of three to six members. Assuming four board members on average, this gives a percentage of 0.23 percent women participation on boards.

Tunisia would also benefit from turning to non-conventional water sources (for example, by investing in seawater desalination and the reuse of treated wastewater), to complement conventional water sources and cope with demand-supply imbalances. Conventional water resources, in the form of available renewable surface water or groundwater, are almost fully utilized and the development of additional built water storage will require thoughtful and purposeful design.[104] To bridge unmet demand, SONEDE has focused on non-conventional drinking water sources, including seawater desalination. Tunisia has experience with the desalination of deep brackish water, but the exploitation of seawater only began in 2018, when Djerba station was commissioned. Several new desalination stations are under construction. In addition to surface water storage, alternative groundwater storage techniques may also be further pursued locally, where feasible, in the form of aquifer recharge, storage, and recovery, and by using underground dams.

Combining desalination with wastewater reuse could increase water supply by 693 Mm³, according to the Water 2050 strategy (Figure 20). To control the cost of energy and reduce emissions, renewable energies (and especially solar panels) have been proposed for production, transfer, distribution, and treatment operators as well as for key energy consumers including SONEDE, GDAs, ONAS, and SECADENORD. [105] At the SONEDE level, this means installing mini power stations at pumping and water-desalination plants. [106] In addition, Tunisia could take advantage of recent technology improvements in desalination to maximize water recovery and reduce the volume of brine produced and discharged back into the ocean, so limiting harmful effects on the marine environment. This could be complemented by regularly monitoring discharge to analyze the effects of seawater desalination facilities on the ecosystem.

Figure 20: Possible mix of seawater desalination and wastewater treatment capacity in Tunisia [107,108]



Source: World Bank staff estimates.

[104] World Bank 2023b.
[105] SECADENORD provides, manages, and maintains canals used for transporting water.
[106] This is in line with an ambitious Tunisian energy transition program, which combines energy efficiency and renewable energies until 2030.
[107] Tunisia's Water 2050 strategy: http://www.onagri.tn/uploads/Etudes/ITES-eau2050.pdf
[108] Estimations in the Water 2050 strategy differ slightly from SONEDE's desalination capacity expansion projections. SONEDE's national desalination program estimates higher total capacity increases of about 320.47 Mm3/year by 2050 using both brackish and seawater desalination plants.

The above measures could be accompanied by soft incentives to reduce environmental degradation and combat food and water waste to improve resilience. Water demand and governance measures could be accompanied by awareness campaigns to improve uptake. There are also significant losses throughout the food value chain that are, ultimately, water losses. For instance, about 10 percent of the total volume of cereals produced is lost due to mechanical damage during harvesting in addition to wastage on the consumption side. [109] Even though reduction of food loss and waste in Tunisia could increase the resilience of the food sector, awareness and communication on the subject are still rare. Measures such as information campaigns, training, and community campaigns can help change behaviors to reduce wastage throughout the production chain, up to the final consumer. Community participation efforts could leverage existing initiatives such as community-based soil and water conservation programs. Public and private investments for cold chain and modern logistics are needed to transform Tunisia's outdated food system.

Increase the resilience and efficiency of the agriculture sector and leverage nature-based solutions

As the largest consumer of water in the country, Tunisia's agricultural sector could improve irrigation efficiency and water-use productivity to reduce water demand from irrigation systems, avoid imbalances, and prevent conflict between water users. Irrigation accounts for 75 percent of demand from groundwater, 23 percent of demand from surface water, and 2 percent of demand from wastewater reuse.[110,111], The current average demand for water per hectare actually irrigated is estimated at 4,500 m^3 and differs significantly by region and crop. [112] Demand has been growing steadily over the years, with variations by region, resulting in a structural and spatial imbalance between supply and demand. [113] Pressure will increase in the agricultural irrigation sector because the urban, industrial, and tourism sectors are likely to be prioritized in times of water scarcity. The Water 2050 strategy expects a 25 percent reduction in irrigated water use by 2050.[114]

To protect rural areas from income stress, smallholder farmers (including herders) could upgrade their operations with climate-smart practices and increase their productivity efforts. Tunisian agriculture is subject to many constraining factors, including land fragmentation, lack of modernization, and limited primary and secondary processing. These factors could compromise the profitability and sustainability of Tunisian agriculture in coming decades. There is a need to disseminate innovative and climate-resilient agricultural practices, which include the use of digital solutions [115] and the farming of resilient species and livestock breeds. The development of index insurance or insurance based on statement could provide guarantees for losses of yield or annual farm turnover.

Nature-based solutions—especially those that support the recharge of groundwater reservoirs by restoring forests, wetlands, and oases—could play a crucial role in mitigating the impacts of climate change in Tunisia. Nature-based solutions have a proven ability to recharge aquifers, mitigate the decline in surface water, and prevent siltation of dams. Such solutions include:

- Enhancing water and soil conservation upstream of watersheds
- Adopting nature-based sediment protection measures upstream of dams
- Implementing upstream afforestation and reforestation measures to increase groundwater resources and prevent soil erosion by stabilizing soil and reducing water runoff [116]

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[109] The average wastage of a subsidized baguette is 900,000 units per day.
[110] Agriculture Note–Tunisia CCDR. April 2023
[111] Chahed and Hamdane 2013.
[112] The average water consumption for wheat is 2,179 m3/ha, with a significant regional disparity (3,407 m3/ha in Kairouan, 813 m3/ha in Siliana, and 618 m3/ha in Jendouba). The cultivation of irrigated wheat produces an average yield of 3.9 t/ha (4.2 t/ha in Jendouba, but only 3.7 t/ha in Kairouan and Siliana). The average water productivity is 7 kg/ha/mm (8 kg/ha/mm in Kairouan, 6 kg/ha/mm in Jendouba and Siliana) (Mazhoud et al. 2020).
[113] Sixty-one percent of water resources concentrated in the north.
[114] To reach 25 percent, the GoT would have to eliminate leaks and increase irrigation water efficiency, irrigation intensification (capital per cubic meter of irrigation water used), and tariffs.
[115] Digital tools can help analyze soil moisture to optimize automatic watering. Several smart irrigation apps have been developed to help farmers schedule irrigation and improve water productivity while considering water availability constraints. Some target cereals (such as the IREY app of the National Institute of Fields Crops, INGC) while others target all crops (for example the MABIA app, developed at the National Agronomic Institute of Tunisia). The cereals app helped increase water productivity from 0.9 kg/m3 to 1.9 kg/m3 while the MABIA app increased crop yields by 18 percent, reduced the total number of irrigations by 15 percent, and improved crop water productivity by 69 percent compared with traditional irrigation practices. More communication is needed to raise Tunisian farmers' awareness of these apps.
[116] Agroforestry can take several forms, including silvo-pastoral and silvo-arable systems. In Tunisia, afforestation and reforestation can build on existing initiatives, such as the Green Tunisia initiative, which aimed to plant 100 million trees by 2020.
ments in the agricultural sector for climate resilience and nature-based solutions.

- Using a combination of contour ridges and micro-basins on agricultural lands and tree orchards to prevent soil erosion and ensure water availability.

Agroforestry—a sustainable land-use system that combines indigenous, drought-tolerant, multipurpose tree species with crops and/or livestock—can further mitigate the effects of climate change by enhancing food security and contributing to a community's income while improving soil fertility and increasing carbon sequestration. Promising tree species include the Carob tree (Ceratonia siliqua) and the olive tree, the latter of which grows in highly degraded agricultural land and could increase olive yield in Tunisia by 44 percent in 2050.[117]

Box 6: Strengthening workforce capacity to address water scarcity

Tunisia's current education system has limited capacity to provide the skills needed to achieve a successful water transition. The education system needs to work with the public and private sectors to ensure that it offers training in skills and knowledge that are current and relevant to improving water security. Specific skills and knowledge needed include wastewater treatment plant (WWTP) operation and management; environmental water policy; water chemical testing and analysis; the management and preservation of natural water resources; and non-conventional water use.

Across 42 universities, 187 degree programs are offered, with relatively even coverage of these five areas. However, there is a large gap in the training of technicians at universities, with only five degree programs reported (one in WWTP operation, one in management and environmental water policy, and three in water chemical testing and analysis). The development of skills at technical and vocational education training (TVET) level is also limited, with only three degree programs reported (two in water chemical testing and analysis, and one in management and preservation of natural water resources).

Source: World Bank (Forthcoming). Jobs and Skills Survey, Climate Change and Human Capital in Tunisia.

3.1.3. Summary

Table 4: Costs of investments[118] to address water scarcity until 2050 (in US$ million)

Engagement dimension	Public or private	Investment cost up to 2030	Investment costs 2030–2050	Total investment costs
Increase water supply and efficiency of infrastructure and technologies [119]	Public	2,442	9,820	12,262
	Private	453	2,268	2,721
Increase the resilience and efficiency of the agriculture sector and leverage nature-based solutions[120]	Public	627	685	1,312
	Private	230	530	760
Total	Public	**3,069**	**10,505**	**13,574**
	Private	**683**	**2,798**	**3,481**

Source: World Bank staff estimation.

[117] This includes investments in the agricultural sector for climate resilience and nature-based solutions.
[118] The investment costs are capex discounted at 6 percent and represent additional climate action.
[119] This includes investments in wastewater; desalinization; extension of water infrastructure in rural areas; loss reduction; renewable energy; and enhancing water management.
[120] This includes investments in the agricultural sector for climate resilience and nature-based solutions.

3.2. Enhancing Resilience to Flooding and Sea-level Rise

3.2.1. The costs of inaction of sea-level rise and flooding

A significant portion of Tunisia's territory is exposed to the risks of submersion from sea-level rise and/or flooding. Under both SSP2 and SSP3, 0.4 percent of the total land area in Tunisia, which includes 24 percent of the linear coastal distance, could be affected by sea-level rise by 2050, with the populated coastline of Tunisia significantly affected in terms of shoreline erosion and extended coastal inundation or the permanent submersion of low-lying coastal areas. By comparison, 15 percent of the linear coastal distance would be affected under SSP1. [121]

Climate change-induced erosion and submersion could cause loss of land worth US$1.6 billion (under SSP3) and US$1.5 billion (under SSP2) by 2050.[122] However, adopting a strong integrated coastal zone management approach under SSP1 would dramatically limit loss of land to US$44 million.[123] These costs are likely to be significant due to the concentration of economically important infrastructure, even though climate change is expected to affect only 27 percent of coastal zones that are important for environmental and economic sustainability in 2050 (under SSP2 and SSP3). [124] Under threat are agricultural areas (12 percent), natural areas with assets (9 percent), and urbanized areas (2 percent) (Figure 21). Sea-level rise is expected to exacerbate climate change-induced inland losses (see Section 3.1.1) and reduce coastal agricultural land, with submerged agricultural land estimated to be 9 percent tree crops, 14 percent annual crops, 5.8 percent irrigated crops, 49 percent pastures, and 9.9 percent miscellaneous agricultural areas. [125] Coastal populations are also expected to increase, heightening vulnerability.

The indirect costs of surface area loss could be even more pronounced, with the tourism sector being among the worst affected. In a scenario where no adaptation measures are taken to protect the tourism sector in coastal zones, the direct and indirect costs of sea-level rise to the Tunisian economy could amount up to 6.9 percent of 2020 GDP by 2050 due to cascading impacts on hotel, restaurant, and catering activities; public revenue; tourism-related economic activities; and jobs. [126] In the case of inaction under the SSP3 scenario, 0.8 percent of tourism-sector jobs in the threatened coastal zone—the equivalent of 1,110 jobs—may be lost by 2050. Figure 22 highlights the tourism sector assets that are most likely to be affected. Tunisia's road network is also at risk of coastal erosion and submersion, disrupting the movement of goods.[127]

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[121] Sea-level rise is expected to be similar under the different SSP scenarios by 2050 and will only diverge by 2100. This report focuses on climate-induced erosion. Existing drivers of coastal erosion (such as coastal subsidence due to heavy infrastructure near the coast or aquifer-water extraction), coastal infrastructure (such as ports), defense developments, and land reclamation leads to increasing shoreline vulnerability and more exposure to sea-level rise and storm surges.

[122] For details about assumptions and hypotheses, see the Technical Note on the impact of climate change on the coastline, definition, and assessment of scenarios with respect to the risks of coastal erosion and sea-level rise (June 2023).

[123] For this modeling, the report looks at interventions in SSP1, which considers the best adaptation measures (SSP3 considers inaction).

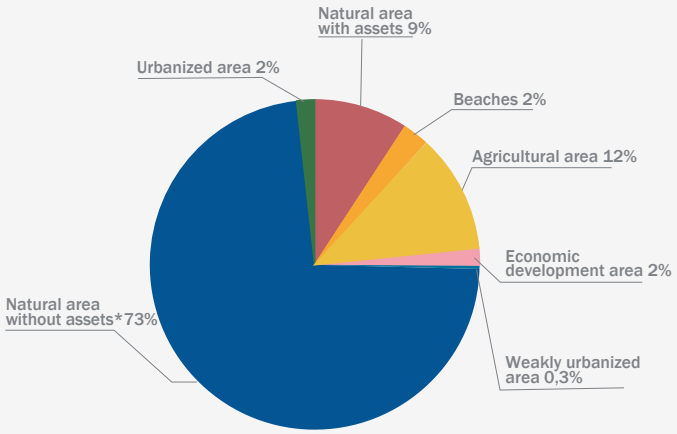
[124] By 2100 climate change would affect 32 percent of coastal zones that are important for environmental and economic sustainability.

[125] Agence Française de Développement 2020.

[126] The impact and GDP loss would be mainly linked to direct costs related to land losses and related infrastructures or buildings (hotel, ports, and shops) rather than on jobs lost.

[127] Some 54 km of road assets are within the area projected to experience coastal erosion, consisting of 0.8 km of primary, 21.9 km of secondary, and 31.8 km of tertiary roads. Regarding 100 cm FABDEM, 5.2 km of road assets are within the hazard area, out of which 5.2 km motorway, 45.3 km primary, 232.1 km, and 220.1 km tertiary roads. These include some segments of motorways with high network criticality especially in the south along the coastline, which should be prioritized in executing measures to enhance resilient transport network.

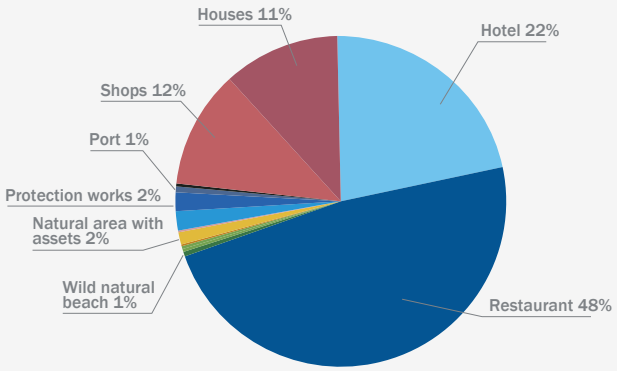
Figure 21: Distribution of coastal areas that could be affected by erosion and marine submersion due to climate change (as a percent of the total area threatened by 2050)



* Refers to natural areas with biodiversity conservation issues but without applicable specific decrees or regulations and with no tourism activity, economic activity, housing/population activities or infrastructure threatened.

Source: World Bank staff estimation.

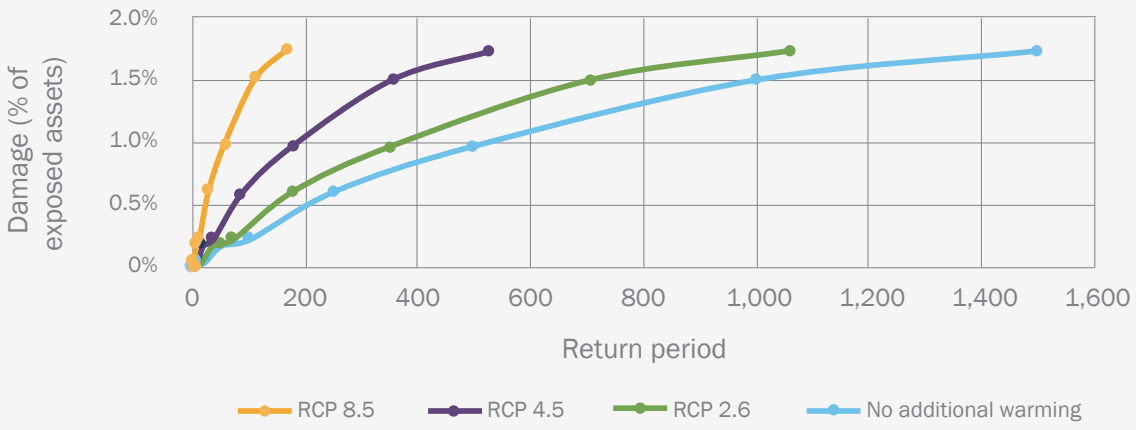
Figure 22: Share of tourism-related assets in areas that could disappear due to coastal erosion and marine submersion



Source: World Bank staff estimation.

The likelihood of catastrophic floods and associated asset damages is expected to increase as a one-in-1,500-years flood becomes a one-in-163-years flood under RCP 8.5 (Figure 23). Climate change is expected to drive increases in temperature and greater variability of precipitation. This would be accompanied by an increase in the frequency and intensity of floods, especially in the eastern Mediterranean coastal region. The northernmost Mediterranean coastal region may also experience flooding, but to a lesser degree. Assuming no reconstruction takes place, losses in Tunisia could amount to TD 238 million (around US$76 million) by 2050. In general, the north is still expected to receive the most flooding across all scenarios, even though there are large floodplains in many other parts of the country.

Figure 23: Likelihood of flooding under different RCP scenarios [128]



Source: World Bank staff calculations.

[128] Based on empirical and extrapolated distribution functions to calculate expected annual damages (deterministic case) and median and outlier responses (stochastic case). (Source of data: https://www.preventionweb.net/english/hyogo/gar/2015/en/home/). There are limitations and uncertainty, particularly related to the underlying flood modeling and the assumption of the theoretical framework by Myhre et al. 2013.

The impact of flood risks attributable to climate change on road network assets is likely to be significant, which could constrain the government's fiscal space for ensuring the mobility of people and goods across the country. Figure 24 shows the road network links exposed to significant direct flood risks, suggesting that the impact may vary by region within the country. Given a 100-year flood event, the expected costs of rehabilitating road assets from potential flood events (direct risk) may, on aggregate, amount to US$276.7 million in 2050 under an RCP 8.5 scenario, and US$332.5 million under an RCP 4.5 scenario (median).[129] Projections show that the eastern Mediterranean coastal region may be prone to larger direct impacts, while possible road damage in northmost Mediterranean coastal regions may be less pronounced because inundation depths are expected to be less severe, causing less damage to road assets.[130] This is in addition to the indirect cost of flood events, such as the economic cost of diverting traffic to alternative routes, which could reach US$15.5 million (RCP 8.5) and US$17.8 million (RCP 4.5 at median) in 2050, by road segment (a link between two intersections).[131] Figure 25 shows the road links with the highest expected economic costs under an RCP 8.5 scenario.

Figure 24: Tunisia road network links most exposed to direct risk of 100-year flood (RCP 8.5 scenario), 2050 median

Source: World Bank team estimations.

Figure 25: Tunisia road network links most exposed to indirect risks of 100-year flood (RCP 8.5 scenario), 2050 median

Source: World Bank team estimations.

[129] Estimates range between US$102.9 million and US$450.5 million under RCP 8.5, and between US$121.6 million and US$543.4 million under RCP 4.5. The cost of rehabilitating paved roads is on average 30.7 percent higher than the cost of periodic maintenance. However, direct comparison requires caution because periodic maintenance works vary in quality, affecting the speed of asset deterioration and recovery costs when climate disaster risks materialize (World Resources Institute 2020).

[130] Road network density is also high in the northernmost Mediterranean coastal region.

[131] Indirect risk (the economic cost of diverting traffic when a road link is blocked) is not appropriate to aggregate because the sum of indirect risks of road links is not the same as the economic risk of blocking the same links.

3.2.2. How to prepare for sea-level rise and flooding

Defend coastal zones against sea-level rise and flooding

Targeted coastal zone interventions to protect coastal zones and their economic activities may help to prevent some of the damage. The type of intervention depends on the affected coastal zone (Table 5). For natural areas with assets, including beaches, primary interventions would usefully focus on soft defense measures such adding sediment or sand along the shoreline (beach nourishment), conserving dunes, and implementing complementary nature-based solutions such as increasing vegetation cover to stabilize soil. The level of urbanization determines if additional hard measures are needed. Interventions in coastal zones could target tourism infrastructure. In highly urbanized areas, soft measures may be complemented by sustainable hard defense measures such as breakwaters, raising existing infrastructure, or building new infrastructure. Hard defense measures should ideally be sustainable coastal protection investments that do not cause further coastal erosion elsewhere. Stopping shoreline retreat may also prevent negative effects on groundwater aquifers and vegetation coverage. If left unchecked, such negative effects would further magnify Tunisia's water scarcity.

In addition to defense structures, building a sustainable and diversified tourism value chain and offerings would be essential for further reducing the risks to the tourism sector. The tourism sector could develop year-round tourism that is tailored for different regions, taking advantage of unique landscapes as well as cultural and heritage assets such as Roman ruins. The more the tourism offering diversifies from coastal zones and focuses on sustainable tourism, the more the impacts of the sector on biodiversity and coastal erosion would be mitigated. This, in turn, would provide protection against some climate change impacts. Creating a more sustainable and diversified tourism value chain could create an annual net present value of US$1.8 billion by 2050.

Table 5: Interventions by surface type under an ambitious adaptation scenario

Area type	Sub-area	2030	2050	2100
All areas		Integrated coastal zone management		
Urbanized area *Area with high density of roads, buildings, houses, infrastructures*		Nature-based solutions; sustainable hard defense structures (breakwaters, groins)	Nature-based solutions; no new buildings (building freeze); economic reconversion plan [132]	Maintain actions in place
Weakly urbanized area *Mainly residential area*		Urgent occasional relocation; building freeze	Nature-based solutions (case-by-case)	Relocation; renaturation
Agricultural area *Cultivated area, fields, agricultural activity*		Compensation measures for farmers in the event of marine submersion; building freeze	The state buys back submersible land; passive ex-post management	The state buys back submersible land; passive ex-post management
Natural area with assets [133] *Natural areas not anthropized but with interesting characteristics (including high biodiversity and ecosystems services) and with strong potential for nature-based activities development*		Building freeze	Maintain actions in place	Maintain actions in place
Port *Port and landing dock*		Raising infrastructure; resizing and retrofitting	Raising infrastructures; resizing and retrofitting; reconversion plan	Port reconversion
Beaches *Dune type tourist beaches*	Wide beach with dune and important natural or agricultural areas behind	Dune conservation	Beach nourishment (case-by-case)	Relocation of activities
	Wide beach with dune and without important natural or agricultural areas behind	Dune conservation; building freeze	Dune conservation; building freeze	Dune conservation; building freeze
	Narrow beach with urbanization behind	Beach nourishment; hard defense structures	Beach nourishment; building freeze; reconversion plan	Relocation
	Narrow beach with important natural or agricultural areas behind	Beach nourishment; hard defense structures	Maintain actions in place	Maintain actions in place
Economic development area *Mixed areas where high-value-adding buildings or infrastructure are concentrated (oil terminals, shops, and so on)*		Structures or beach nourishment if beach in front	Conversion; relocation	Conversion; relocation
Coastal Coastal protection works *Any protective infrastructure or works (for example, breakwater, sea wall)*	Outside the port, in an urbanized area	Maintenance, or raising of infrastructure or works; beach nourishment; hard defense structures; relocation plan	Maintenance or raising of infrastructures or works; beach nourishment; hard defense structures; building freeze	Relocation plan; renaturing; reconversion of the area
	Outside the port in a weakly urbanized area	Building freeze	Maintaining or raising infrastructure or works; reloading; relocation plan	Relocation plan; renaturing; reconversion of the area
	Outside the port, outside urbanized or industrial areas	If agricultural area, once-off compensation	Renaturing	Renaturing

Source: Compiled by World Bank team.

[132] In this case, an economic reconversion plan is a strategy that both the government and private sector could follow to transform the coastal economy from one focus to another. It could involve changing resources and workforce from sectors impacted by coastal erosion and submersion to other areas.

[133] While natural areas are assets per se, for the purpose of this report, the definition of natural areas with assets has been adopted as presented in the table

Protect people and infrastructure

Tunisia would benefit from investing in multimodal transport and building the resilience of both infrastructure and the network to climate-related shocks. At the asset level, Tunisia could strengthen the resilience of road assets to identified flood hazards, including by building thicker pavements, applying sealant to paved roads, and adding riprap and new piles to bridges. Focusing the analysis on highways, the investment needed to build thicker pavements to boost Tunisia's resilience against a 100-year flood hazard in 2050 would be as follows: [134]

- **Under the RCP 4.5 scenario:** 382 km of road links are exposed to flood risk at the median and introducing the resilience measure is likely to cost US$183.4 million at the median.[135]
- **Under the RCP 8.5 scenario:** 398 km of road links are exposed to flood risk at the median and introducing the resilience measure could cost US$152.8 million at the median.

Increasing investments in railways would serve to strengthen network resilience. Promoting multimodal transport provides network redundancy so that operations can continue even if one transport mode experiences disruption. Modernizing railways (for example, updating signaling systems) would improve operational quality to achieve safe operations under severe operating environments and stressors. The GoT has demonstrated a commitment to strengthening the country's logistics sector. Over the longer term, rail is set to absorb around 40 percent of funds earmarked by the National Transport Master Plan for 2040, with the segment's 19 projects amounting to TD 28 billion (US$9.7 billion). These investments could usefully focus on recovering the financial sustainability of the public railway operator, SNCFT, through adequate compensation mechanisms for providing railway services of a public good nature while targeting strategic investments for commercially viable markets.

Resilience should ideally be mainstreamed in investment planning, programming works, the design and engineering of infrastructure assets, and in the operation and maintenance of facilities. Network criticality can be used as a factor for planning infrastructure development projects and programming asset maintenance works. Prioritizing the connectivity of lagging regions when planning high-quality road corridors would strengthen the economic resilience of these regions when such connectivity is accompanied by measures to support productive economic activities. Infrastructure owners' asset management systems and plans should ideally be upgraded to incorporate climate and disaster risks. Transport authorities would benefit from: (i) building capacity to prepare and respond to disruptions and asset damages and losses, (ii) clarifying responsibilities, (iii) strengthening coordination among authorities to minimize the impact of disruptions, and (iv) introducing effective measures to build resilience. For facilities of strategic importance, PPPs could be contracted to ensure adequate maintenance and operation, and incentivized by linking key performance indicators with funding, which could, in turn, be sustainably sourced from user charges (for example, tolls). Seaports are Tunisia's economic driver not only for freight transport, but also for car ferries and cruises anchored to the country's prominent tourism industry. Opportunities for improving ports include: (i) upgrading port facilities; (ii) strengthening the coordination of policies, planning, and investments with other authorities including municipalities; and (iii) enhancing connectivity with the land transport network, particularly railways. Developing a logistics strategy for the public railway operator, SNCFT, would be an important step towards improving railways and encouraging a shift from trucks to rail. Reforming customs regulations and port tariff regimes to improve operational efficiency (for example, processing times) are also essential for the resilient supply of imported goods.

To future-proof Tunisia, institutional mechanisms could ensure that climate change risks are systematically included in infrastructure, land-use, and urban planning. Tunisia has taken significant steps to improve its resilience to disasters, including publishing its 2030 National Disaster Risk Reduction Strategy in 2021. Nonetheless, opportunities remain to improve the country's resilience, including updating and enforcing building codes and design standards, especially of key public infrastructure. Indeed, the 2030 National Disaster Risk Reduction Strategy states that disaster risk reduction must be included in urbanization programs. This has not yet resulted in shifts in the

[134] Following Miyamoto International (2021), the cost of thicker pavement was assumed to cost 20 percent of the initial road investment costs. The unit road investment cost for each road class assumed unit investment costs (for example, 2x2 lane highways) from the Tunisia Transport Development National Plan 2040 (2017). The analysis employed the same approach as the plan to apply the 20 percent contingency to the estimated investment needs.

[135] Estimates range between 140 km and 190 km of road links exposed to the flood hazard, and between US$67.0 million and US$299.7 million in investment needs.

strategies of the Ministry of Equipment and Housing or the Ministry of Local Governance, although some projects by international donors do implement disaster risk reduction standards (for example, the European Union-funded prison building program includes anti-seismic measures). As already noted, in slightly urbanized areas affected by sea-level rise or flooding, it would be useful to focus on relocating economic activity and implementing a freeze on new buildings. Institutional mechanisms would also help respond to climate shocks in a timely manner. Some local initiatives already draw on best practices, for example, the city of Ayn Darahim has built innovative disaster risk management rooms to cope with extreme events. Ayn Darahim is in a mountainous area that is particularly exposed to natural disasters that include landslides, forest fires, and severe cold snaps.

Building the resilience of infrastructure also means strengthening local institutional capacity to manage and protect assets. Involving local authorities by giving them the authority to plan and make decisions would encourage implementation of protective measures. In the case of coastal erosion, integrated coastal zone management (ICZM) is a proven tool that uses zoning to identify priority areas, inform interventions, and develop local investments, plans, and policies. Multistakeholder participation in ICZM planning at the municipal, national, and regional (subnational and multinational) levels is key for designing effective solutions that not only target coastal erosion, but also aim to improve the integrated land-use planning and management of coastal areas. The need for local governance on climate change is demonstrated by the fact that Tunisia has different bioclimates, requiring different actions in different municipalities. The 2018 Local Government Code (Organic Law No. 2018–29 of May 9, 2018) has transferred a certain number of disaster risk management-related prerogatives to municipalities, but decentralization has faced delays.[136,137]

Enhance social protection and develop risk-based insurance schemes

Given current disaster risk financing gaps, there is a strong need to improve financial resilience at the micro and meso levels (households, farmers, and businesses), as well as to reduce fiscal impacts and economic losses. Disaster risk financing addresses residual risk after disaster risk reduction efforts have decreased the impacts of disasters. In the agricultural sector, the development of index insurance or insurance based on statement could guarantee losses of yield (crop or livestock) or annual farm turnover. At the sovereign level, a comprehensive disaster risk finance strategy based on a risk-layering approach may enable the government to more cost-effectively and efficiently cover its disaster risk financing needs.[138] Given the low insurance penetration rate and limited growth of the domestic insurance market, initiatives to broaden financial inclusion and develop catastrophic and other (non-catastrophic) risk cover are needed to enable the private insurance market to support greater financial resilience. Box 7 provides an illustrative cost-benefit analysis to show how layering different disaster risk financing instruments would improve Tunisia's financial resilience to climate-related disaster risk. Different disaster risk financing instruments have different cost-effectiveness for disasters of varying frequency and severity.

Tunisia would benefit from leveraging its existing social protection systems and building capacity to ensure a quick response in the event of climate stress and shocks. Such a response could minimize the impacts of climate change on people without exacerbating existing vulnerabilities.The country's main social assistance program, AMEN, maintains a database of poor and vulnerable households. The government successfully used this database to provide social assistance to nearly a million additional households during the COVID-19 shock, demonstrating how the system could be leveraged for future shocks, including climate stresses and shocks. [139] It would improve Tunisia's resilience if the database included all vulnerable households to facilitate early warning and a speedy response to potential future shocks. Delayed social assistance or insurance disbursements can aggravate the human impact and economic costs of a disaster. Improved targeting of financial risk protection schemes for health, especially the free health insurance (Assistance Médicale Gratuite; AMG), would be possible by scaling up the AMEN program and integrating the AMG into the AMEN targeting system.

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136 The 2018 Local Government Code (Organic Law No. 2018–29 of May 9, 2018) has transferred a certain number of disaster risk management-related prerogatives to municipalities, but decentralization has faced delays.)

137 The decentralization process was halted with the freezing of the activities of parliament in July 2021 (delay in laws of competencies transfer) and with the dismissing of municipal councils in March 2023.

138 Tunisia is in the process of drawing up its NAP-food security component, which includes a feasibility study for the creation of a Climate Change Adaptation and Resilience Fund to cover economic, environmental, and social issues.

139 The registry includes contact and geolocation information for surveyed households, facilitating early warning alerts and recovery initiatives in the event of a natural disaster. The system also includes a mobile payment platform that further facilitates its responsiveness. At present, roughly 70 percent of the 900,000 households on the social registry have been surveyed and about 70 percent receive payments digitally.

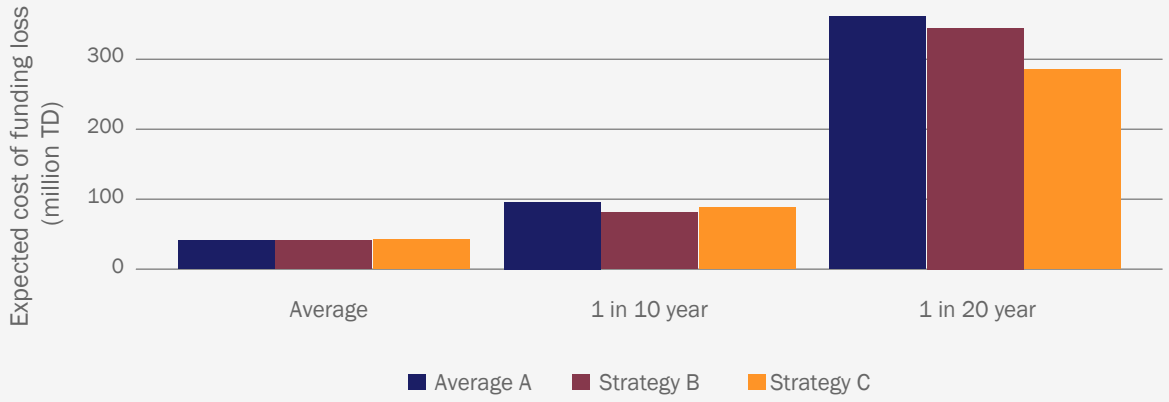
Box 7: Illustrative disaster risk finance analysis

This analysis considers three simplified, illustrative options for disaster risk finance instruments that may be used in combination with ex-post borrowing: Strategy A (reserve fund), Strategy B (reserve fund and contingent credit), and Strategy C (reserve fund, contingent credit, and insurance). Different costs are associated with using different financing instruments. For example, when using insurance, an upfront premium is paid.

The analysis assumes that government emergency funding needs are approximately 15 percent of the flood damages modeled using a catastrophe risk model (in other words, approximately TD 30 million, TD 90 million, TD 200 million, and TD 300 million for flooding with a return period of 5 years, 10 years, 15 years, and 20 years, respectively). The funding available under the illustrative disaster risk finance instruments is TD 30 million from the reserve fund (to cover approximately 1-in-5-year emergency funding needs), TD 60 million from the contingent credit line (to cover return periods of approximately 5 to 10 years), and TD 55 million from the insurance layer (to cover half of the financing needs for return periods of approximately 10 to 15 years).

One way of comparing different disaster risk finance strategies is to compare the expected cost of these strategies at different magnitudes of losses. This can help determine where one strategy may be more cost efficient for the government. Figure 26 presents the expected costs of different strategies in financing contingent liabilities for different return periods. On average, there is a small opportunity cost savings for Strategy B and Strategy C compared with Strategy A. The benefits, however, are substantially higher for more severe flooding (higher return periods), as shown in 1-in-10-year flooding and 1-in-20-year flooding (for which the contingent credit and insurance instruments contribute to meeting the funding needs). This highlights the potential for such instruments to provide a cost-effective method for risk financing when combined in a risk-layering approach. These instruments can also help reduce the need for budget reallocations following disasters, which can negatively impact welfare and increase budget volatility.

Figure 26: The expected cost of funding average, 1-in-10-year, and 1-in-20-year losses over the next year under each of the modeled illustrative disaster risk finance strategies



Source: World Bank staff estimation.

Box 8: Strengthening workforce capacity to enhance resilience of urban and coastal zones

Tunisia's current education system has limited capacity to provide the skills needed to enhance resilience to sea-level rise and flooding. The development of these skills is already under way, although at a limited scale. A survey of 42 higher education and technical and vocational education training (TVET) institutions found that both types of institution offer relevant programs (resilience to climate-related natural disasters; designing and implementing infrastructural projects; green building architecture; geographic information systems [GIS]; urban and coastal planning; and the environmental impact of land use and territorial planning).

Specifically, the survey found that, at university level:

- Roughly half of the universities polled provide relevant degree programs (42 programs in total)
- For Master's, engineering, and Bachelor's degrees, the most common relevant program focuses on climate change broadly
- Between 8 percent and 50 percent of responding universities offer courses linked to the six relevant skills
- Capacity is more limited at TVET institutions, of which only one institution reported offering courses linked to only three relevant skills (green building architecture, GIS, and the environmental impact of land use and territorial planning) and general climate change.

Source: World Bank (Forthcoming). Jobs and Skills Survey, Climate Change and Human Capital in Tunisia.

3.2.3. Summary

Table 6: Costs of investments to increase resilience of coastal areas plus costs (in US$ million) until 2050

Engagement dimension	Public or private	Investment costs up to 2030	Investment costs 2030-2050	Total investment costs
Protecting coastal zones against erosion [140,141]	Public	1,373	785	2,157
Protect critical infrastructure against climate shocks ,[142,143]	Public	163	0	163
Total	Public	**1,536**	**785**	**2,320**

[140] The investment costs for each period (2030/2050/2100) (CC adaptation actions or capital expenditure [CAPEX]) are non-cumulative data. The total CAPEX 2050 does not include the total CAPEX 2030. The estimate of the cost of each policy or investment action for adaptation was based on discounted unit costs (that is, in 2023 value). No operating expense (OPEX) has been calculated. With regard to the prospective in dynamic mode (CBAM projection period year 0 to year 100): there is no integrated discount rate, from year to year on the value to be invested smoothed per year. For example, the total investments to be made in 2030 seen above have been smoothed over the period N0 to N30, linearly, without discounting, in current USD value (and not constant). Same for 2050 and 2100.

[141] This includes investment in coastal zones against sea-level rise and diversifying the tourism sector.

[142] The investment costs are CAPEX, discounted at 6 percent and represent additional climate action.

[143] This includes investment in capacity building for local authorities and building resilience of road infrastructure.

3.3. Decarbonizing the Energy Sector

3.3.1. The costs of inaction in the context of a decarbonizing world

Without decarbonizing the energy sector, growing energy demand and continued dependence on fossil fuels will likely keep prices high, in part due to exposure to international oil price fluctuations. The energy sector may become stuck in a vicious cycle of deteriorating financial viability, which would limit its capability to invest in decarbonization and would require a choice to be made between passing the costs to consumers or passing it to the government (through subsidies). Energy affordability and competitiveness issues would be exacerbated. Industrial sectors in Tunisia would also be affected by rapidly shifting consumer preferences towards more sustainable products and services, as well as policies such as the European Union's carbon border adjustment mechanism (CBAM).

Tunisia's current account deficit and financing conditions may limit its ability to import the energy it needs to meet growing demand, thus stifling economic activity. With a large structural current account deficit and limited capital inflows (from both foreign direct investment and portfolio), Tunisia is expected to maintain large external financing needs. Recent evidence has shown that financing these needs without accessing international capital markets will become increasingly challenging, limiting Tunisia's ability to import energy and other inputs for its industrial activities. Projections carried out for this report suggest that, given prevailing current account deficit trends and external financing conditions, Tunisia's energy imports would have to be reduced by 3.5 percent to preserve a level of foreign exchange reserves covering at least two months of imports.[144] This energy supply constraint would significantly affect production across all sectors. An analysis conducted for this report and based on World Bank Enterprise Survey data suggests that doubling the number of power outages would reduce the value added by Tunisian manufacturing and service companies by 8.7 percent.[145] For households, it would mean reduced mobility and comfort, since energy is a critical input for transport, cooking, heating, and lighting. Rationing energy and power outages could incite social unrest in the country. An energy shortage would also generate large losses and inflation at the macro level, as discussed in Chapter 4.

Failing to decarbonize the energy sector would lead to higher GHG emissions, making it difficult for Tunisia to comply with its NDC obligations. The government's SNBC&RCC 2050 points out that, under a business-as-usual (BAU) scenario, net emissions would grow by 2.7 percent per year, reaching 78 million tons CO_2 equivalent (CO_2e) by 2050 (from 35 million tons CO_2e today). Emissions from the energy sector would therefore be more than double the current level. Using the latest Social Cost of Carbon figures, this implies an annual cost of US$6 billion (14 percent of Tunisia's GDP in 2020).[146] The increase in emissions under a BAU scenario would also be associated with additional ecological, social, and economic costs, such as increased air pollution, which adversely affects health. Even though emission intensity would decrease, there would still be a significant increase in energy consumption (from 8 million tons of oil equivalent today to more than 18 million in 2050).

3.3.2. How to decarbonize energy supply and demand in end-use sectors

Decarbonization of the energy sector depends on a two-pronged approach focused on decarbonizing demand (especially the major energy consuming sectors of transport, industry, and buildings) and decarbonizing supply (focusing on the electricity sector). The government's SNBC&RCC 2050 expects energy emission reductions to primarily come from the electricity sector (46 percent) and the end-use sectors (45 percent). This requires significantly scaling up renewable energy use and improving energy conservation and efficiency in both the electricity production and end-use sectors.[147] Figure 27 summarizes the possible levers for achieving carbon neutrality.

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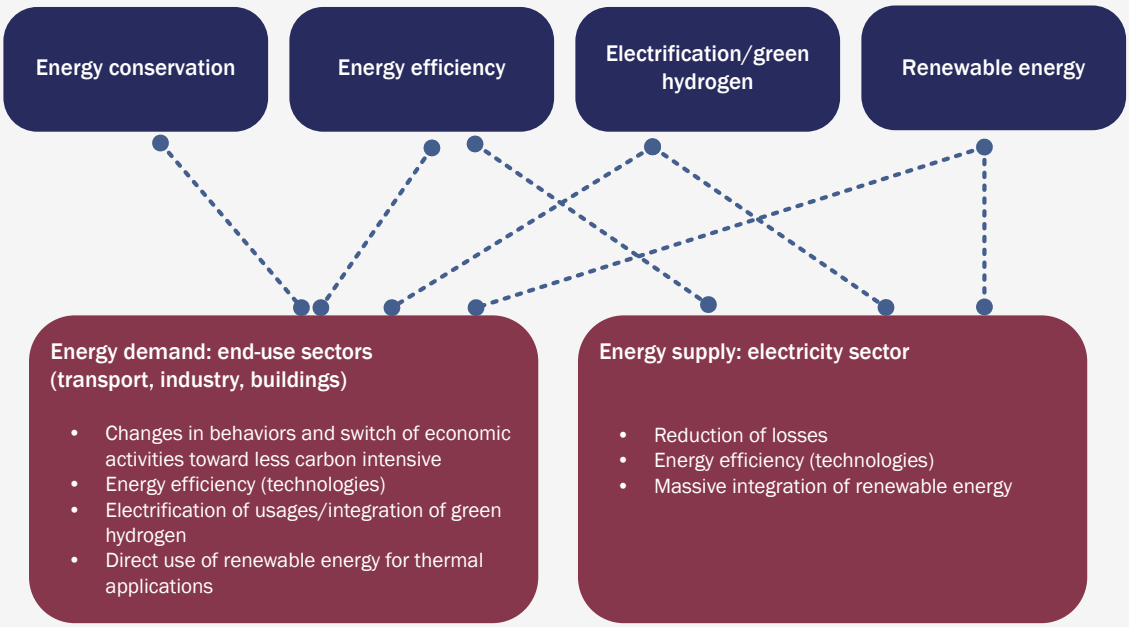
[144] Total imports should drop by 7 percent to maintain the minimum level of reserves. However, energy imports need to fall by less because they are assumed to be less responsive to import restrictions as they are more crucial for the functioning of the economy.

[145] Considering the relatively low average number of power outages reported by Tunisian companies (1.1 in 2020), a 3.5 percent drop in energy imports could be compatible with a doubling of power outages.

[146] The Social Cost of Carbon estimates the economic damages that would result from emitting one additional ton of CO2 (CPAT estimate of US$75/tCO2) to help understand the economic impacts of decisions that would increase or decrease emissions.

[147] Energy conservation entails changing behaviors and processes to consume less energy. Energy efficiency entails improving technologies and processes to use less energy for the same output.

Figure 27: Levers for achieving carbon neutrality in the energy sector



Source: Note sur la Stratégie Bas–carbone Tunisie.

Decarbonize energy demand in end-use sectors

Changing behaviors and production processes while improving energy efficiency so that less energy is needed per unit of production or activity are the two most important decarbonization mechanisms across all end-use sectors. The resulting decline in energy intensity would enable the country to decouple GDP growth from energy demand. STEG estimates that, with these measures, final energy demand will grow by only 1 percent annually from 2022 to 2050, compared with 2.8 percent under BAU (Figure 28).

Decarbonization also requires increasing the penetration of electricity. This will allow for the shift to clean energy because renewable energy can seldom be used directly, except when using solar energy to heat water or to dry items. The share of electricity in final energy use in Tunisia was only 18.5 percent in 2021 (excluding losses), compared to around 23 percent in Europe and 20 percent in the world on average (excluding Sub-Saharan Africa). An electricity forecast prepared by STEG projects an electricity penetration rate of 54 percent in 2050 under the decarbonization scenario (called “net zero” in the projection), versus 29 percent under BAU. Green hydrogen and its derivatives (for example, ammonia), which can be produced using renewable energy, also help decarbonize sectors such as transport and heavy industry. Higher penetration of electricity and hydrogen is expected to decrease primary energy intensity by 3.2 percent annually, compared with 1.4 percent in a BAU scenario (Figure 29). The rest of this section outlines strategies for decarbonizing the end-use sectors that consume the most energy (transport, industry, and buildings).

Figure 28: Final energy demand by sector

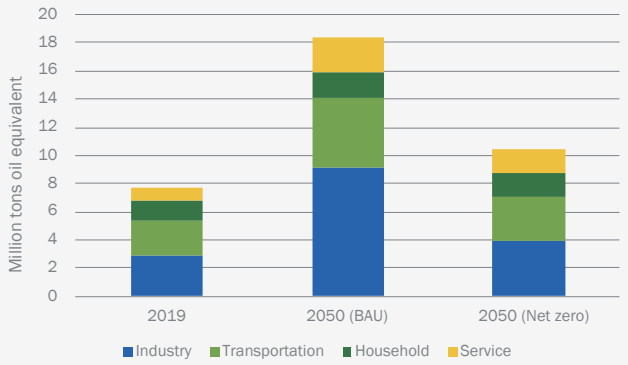
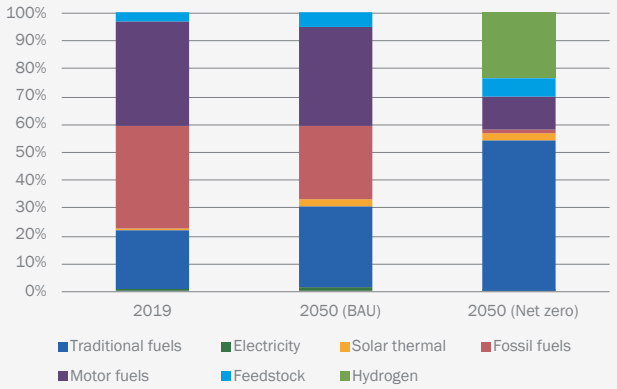


Figure 29: Final energy demand by sources



Source: STEG estimation

The "avoid-shift-improve" framework is useful in considering measures to decarbonize the transport sector. "Avoid" refers to meeting mobility needs with fewer vehicular travels (for example, by digitalizing services, trucking industry reforms to encourage consolidating demands, and urban planning). "Shift" refers to switching from the currently dominant private car model to more sustainable modes, including walking, cycling, public transport, and rail. "Improve" refers to increasing energy efficiency of vehicles and promoting electromobility and the use of green hydrogen. These measures would require policy and reform measures that encourage behavioral changes to be developed via thorough and sensible consultations with stakeholders. For sectors that possibly involve public operators (for example, railways and public transport), regaining the financial sustainability of incumbent public operators would be an important consideration alongside reform and investment measures.

Road transport presents opportunities such as:

- **Improving motor vehicle fleet composition** by enforcing emission standards and the mandatory retirement of aged fleet
- **Demand management measures** such as congestion charging and road pricing
- **Traffic management improvements** such as intelligent transport systems and street parking.

The maritime and port sector is rapidly transitioning by improving fuel efficiency, increasing the use of green fuels, and implementing energy efficiency measures at facilities. Seaports could further decarbonize by obtaining power from renewable sources (such as solar panels) at their premises and building rooftops, with possible visibility impacts. Decarbonizing the maritime sector would present an opportunity for Tunisia to position itself as a regional enabler for stronger connectivity with Mediterranean basin countries and the rest of the world.

Promoting renewable energy and electromobility will be essential for a low-carbon transition in the transport sector. Under the net-zero strategy, STEG assumes that all new car sales after 2040 are electric vehicles and there is early retirement of conventional cars starting in 2035. Under such conditions, electric vehicles could provide 78 percent of intracity passenger mileage and 90 percent of intercity passenger transport mileage in 2050 under a decarbonization scenario. In addition, green hydrogen would be used in buses and freight trucks. These estimates are ambitious, given that electricity is almost non-existent in the transport sector and Tunisia has yet to develop a hydrogen industry. However, Tunisia has the double advantage of extensive road networks and relatively concentrated populations in few urban centers, which allows for the rapid rollout of charging infrastructure. Experience in regional counterparts suggest that used car imports could serve as an entry point for electrifying motor vehicles. Tunisia already has a sensible set of measures in place to manage the import of used cars, with a progressive-age tax and age restrictions of five years. The United Nations Environment Programme has rated Tunisia's vehicle regulatory environment as "good". To pave the way for a low-/zero-emissions fleet, Tunisia would benefit from, among other interventions, enhancing regulations to ensure the quality of imported electric vehicles and investing in infrastructure for electric vehicles.

Tunisia's government could accelerate transport decarbonization by implementing concrete policies and initiatives that send clear signals to the market and encourage the transition to a sustainable transport system. The effort to decarbonize transport could usefully prioritize providing safe, reliable, green, and resilient public transport services to encourage a shift from private cars. The National Agency for Energy Management (ANME) is already implementing an electromobility promotion program and there are policies to encourage electric vehicle transition.[148] However, the related policies, initiatives, and investments need to be harmonized.[149] The Ministry of Transport, the MoE, the Ministry of Industry, municipal authorities, and ANME could usefully develop clear, time-bound, and specific policies, regulations, and standards around electric vehicles and buses. Public transport is a suitable entry point for electrifying motor vehicles because of its co-benefits, which include abating air pollution and enhancing vulnerable groups' access to opportunities and services, so improving inclusiveness. Developing vocational training for e-technologies will be essential for supporting the currently nascent e-mobility industrial and infrastructure ecosystem, while materializing the job-creation potential of the transition. Public transport is also highly visible, creating opportunities to promote the green transition of mobility. National and local government could identify options for grants or initial subsidies for e-bus trials and incorporate plans into strategy documents that assign responsibilities and specify timelines. For public transport more broadly, the GoT could establish a working group (consisting of the Ministry of Transport, local authorities, bus operators, external experts, and public transport users) tasked with reforming public transport business models, building institutional capacity, and collecting data. Promoting the use of railways would require policy reforms, institution-building, and targeted investments to develop viable railway operators and improve the performance and quality of railway services so that they may compete against more carbon-intensive modes of transport. Incentivizing the switch from individual to collective transport and adopting urban and land-use planning to reduce travel distance and incorporate collective transport could also be pursued. These measures would require coordination between various government agencies.

For the industrial sector, cost-effective measures include improving production efficiencies, increasing the use of alternative cleaner fuels (including renewable energy by switching to electricity and increasing the use of green hydrogen in place of fossil fuels), reducing waste along product lifecycles, and carbon capture and storage (CCS) for the remaining emissions. An example is the cement industry, which is responsible for 10 percent of national final energy consumption and is a major emitter of GHG (accounting for 14 percent of national GHG emissions, including energy and process emissions)[150] that would be subject to the European Union's CBAM.[151] Replacing fossil fuels with green hydrogen, reducing the amount of clinker, or capturing and utilizing carbon dioxide emissions are all potential tactics for reducing GHG emissions in this sector. Changing the cement produced for types that do not rely on burning clinker may also be a viable alternative. CCS is a proven technology that could offer a cost-effective decarbonisation pathway.[152] Another technology being investigated is the use of concentrated solar power to produce high-temperature heat. Tunisia is also the world's eighth-largest producer of phosphate rock and a significant producer and exporter of fertilizers, for which the feedstock could be replaced by green ammonia.

Even though Tunisian companies are aware of climate requirements, there is limited climate preparedness. All industries that consume more than 800 tons of oil equivalent per year are required to carry out an energy audit every five years to benefit from a 70 percent subsidy. However, the obligation relates only to conducting audits and not to implementing energy efficiency measures. ANME's data indicates that the implementation of energy efficiency investment programs has been limited due to lack of technical capacity and funding. The Energy Transition Fund initially offered promising credit lines to industry, but its size and scope have been shrinking in recent years. The World Bank Enterprise Survey found that about 77.5 percent of companies that emit carbon dioxide regularly monitor their emissions. The main exception is the food industry, where only around 10 percent of companies have such

[148] The program focuses on testing electric or hybrid vehicles in national transport, setting up charging infrastructure, training stakeholders on the technical aspects of electromobility, setting up appropriate regulatory and fiscal frameworks, and formulating a strategy to develop electromobility in Tunisia.

[149] For example, the Finance Act 2023 lowered the tax on the import of charging equipment for electric vehicles by 17 percent, while the Ministry of Industry announced an incentive program with a TD 10,000 subsidy when replacing an internal combustion engine vehicle with an electric vehicle, while providing exemption from import duties.

measures in place. About one in three Tunisian companies (32 percent) reported monitoring energy consumption[153]. Climate ambition in Tunisia's private sector is low. Only about 1 percent of GHG emitters have committed to emissions targets, and even fewer monitor emissions along their supply chain. About 16 percent of Tunisian companies have implemented energy consumption targets, with innovative, large, or exporting companies scoring higher.

This points to a need for greater effort to mobilize energy efficiency measures, especially within the SME segment. As noted above, climate preparedness and policy support (for example through subsidized energy audits) are more prevalent among larger industrial companies. Decarbonization is likely to require a scaling-up of energy audits and energy management systems; the implementation of new regulatory and innovative finance models to increase energy efficiency investments; and new approaches to electricity delivery, including renewable energy self-generation, and co-generation. These measures would also need to cover SMEs, which experience more difficulty accessing technologies and finance. Another strategy would be to promote industrial zones to aggregate energy demand. The energy forecast prepared by STEG (detailed below) anticipates a gradual reduction in energy intensity and increased penetration of electricity and green hydrogen in major sectors, reducing the use of fossil fuels to less than 5 percent by 2050.

The government has implemented successful programs to green the building sector, including rooftop solar PV and solar water-heating for poor and vulnerable households. However, these programs face financial, technical, and communication-related challenges that prevent them from reaching their full potential. Several independent programs and regulations are in place to increase the use of renewable energy and improve energy efficiency in the building sector. [154] The share of electricity was highest of all end-use sectors in the combined residential, commercial, agriculture, and public sector, at 29 percent in 2021, whereas the share of electricity was 22 percent in the residential sector [155] and 64 percent in the commercial sector, if these are considered separately from the other sectors.[156] There is further potential to substitute liquefied petroleum gas (LPG) and natural gas, which are predominantly used for cooking and heating, with electricity. The most important decarbonization measures for the building sector focus on improving energy efficiency through better insulation and by using more efficient appliances for lighting, cooking, heating, and cooling (the government already has some exchange programs for refrigerators and light bulbs). These measures could be enforced by:

- **Implementing minimum energy performance standards and energy labeling** for appliances (such as refrigerators, air conditioners, heaters, and light bulbs)
- **Rolling out building codes** and labeling for new buildings
- **Gradually retrofitting existing buildings,** starting with major public buildings.

Adopting a holistic view of the transition in cities could exploit synergies across end-use sectors. A transition towards compact cities is essential for reducing energy demand in transport and many urban activities. The World Bank recommends an optimal urban population density of 9,000 inhabitants per square kilometer. Tunisia's national average urban population density is about 2,600 inhabitants per square kilometer (8.5 million inhabitants on 3,201 square kilometers).[157] Denser urban populations allow for a reduction of urban sprawl. In addition to lowering traveled distances, it also fosters the use of collective means, which require three times less energy.[158] Decreasing the time spent in traffic also improves inhabitants' productivity (estimated at 2 percent of GDP).[159] Compact cities further result in lower energy demand for streetlights and better thermal regulation of habitats.

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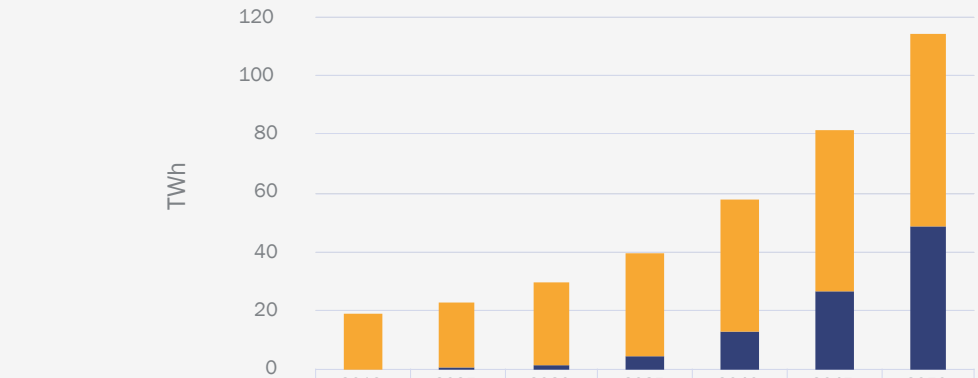
[150] Emissions in the cement sector stem from direct emissions from decarbonizing the raw material (clinker) and indirect emissions from energy consumption (use of fuel to generate heat for clinkers and of electricity for crushing and grinding raw materials and running pumps).
[151] GIZ 2021.
[152] International Energy Agency 2020.
[153] The share is higher among large companies, those owned by foreign investors, or those exporting abroad. Only about 20 percent of smaller companies have such processes in place.
[154] These include the Tunisian Solar Program (PROSOL), established in 2005, which promotes the use of solar water heaters, and PROSOL ELEC, established in 2010, which supports photovoltaic systems in residential buildings. In addition, Article 35 of Circular 87-47 grants an exception for loans to purchase equipment or products under national programs (such as family computers and solar water heaters), for which the repayment period can be up to 5 years.
[155] The share of electricity in the residential sector is 44 percent if biomass is excluded.
[156] Ministry of Industry, Mines, and Energy 2023.
[157] World Bank 2019b.
[158] Pérez-Martinez and Sorba 2010.
[159] World Bank 2019b.

Decarbonize electricity generation

Given the importance of increased electricity penetration and green hydrogen in achieving net-zero emissions in the energy sector, decarbonizing electricity supply by ramping up renewable energy is critical and aligned with the national energy security agenda. To prepare pathways for the decarbonization of the electricity sector, different scenarios were investigated. A capacity expansion model (OPTGEN) and a dispatch model (SDDP) [160] were used to prepare projections of power generating capacity and electricity production by type of technology until 2050 for three scenarios: [161,162]

- **Scenario A:** Least-cost scenario. This is an unconstrained optimized scenario in which the capacity expansion plan is developed with no constraints on emissions. In this scenario, optimization starts in 2026, with projects in the pipeline implemented between 2023 and 2026. Electricity demand grows following a BAU trajectory, without additional energy efficiency and decarbonization of end-use sectors.
- **Scenario B: Green scenario.** In this scenario, constraints are imposed to decarbonize the electricity sector by 2050 (net CO_2 emissions reach zero). Electricity demand is the same as in Scenario A.
- **Scenario C: Green hydrogen and deep decarbonization (net zero) scenario.** This scenario assumes increased electricity penetration and deployment of green hydrogen in the building, industrial, and transport sectors, which displaces the use of fossil fuels through the actions mentioned above.[163] This scenario also assumes that the switch to electricity prompts energy-efficiency improvements because electric equipment is typically more efficient than fossil-fuel-driven equipment. This improvement in end-use efficiency offsets the increase in electricity demand. Electricity demand (excluding electricity use for green hydrogen production) is therefore projected to grow at the same rate as BAU, although the penetration of electricity is 54 percent of final energy demand in 2050 (compared with 29 percent under BAU) (Figure 30).

Figure 30: Total electricity demand under the net zero scenario (Scenario C)



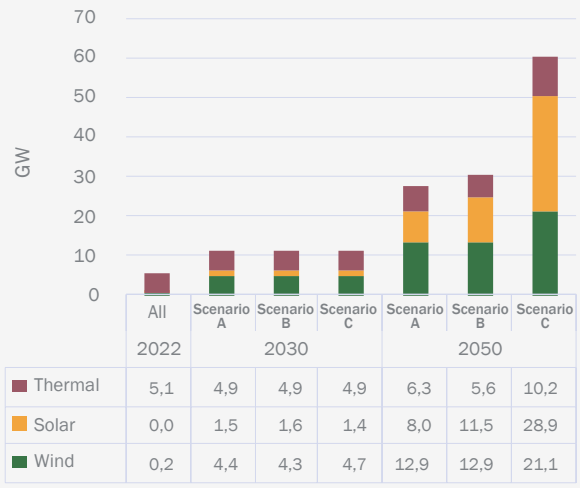
	2019	2025	2030	2035	2040	2045	2050
Final electricity demand	19	22	28	35	45	55	65
Hydrogen production	0	0	1	4	13	27	49

Source: STEG projections.

[160] For more details and model description, see the Energy technical note.
[161] A scenario was simulated whereby the profile for renewable capacity follows the Tunisian Solar Plan rather than the optimum path. Details can be found in the technical note but are not reported here, as results are suboptimal.
[162] The three scenarios were chosen to investigate the cost of decarbonisation in the power sector. The assumptions used do not necessarily match those of the Energy Strategy 2035 or the SNBC. One of the scenarios is a "least-cost solution with no carbon constraint", to be able to compare results with a scenario of decarbonisation of the power generation sector (with and without increased electricity penetration and the introduction of hydrogen). The present analysis focuses on the power sector as a critical sector to reach carbon neutrality and does not assume overall carbon neutrality of the energy sector or the whole economy.
[163] The scenario has been conservative in assuming only green hydrogen production for domestic use. Exports of green hydrogen could develop in the longer term if Tunisian production proves to be competitive on world markets. This possibility requires further investigation.

In all scenarios, there is a massive switch from natural gas to renewable energy because solar and wind are the least-cost solution for producing electricity. In all scenarios, most of the new power generation capacity is based on renewables, which account for 77 percent of total capacity in 2050 in Scenario A, 81 percent in Scenario B, and 84 percent in Scenario C (compared with the government's target of 80 percent). Some natural gas capacity is added for the latter part of the forecast period, at which point some gas plants would have been retired and additional gas-fired generation will likely be needed to enhance the flexibility of the power system, to complement other flexibility measures such as battery storage and increased interconnections. In Scenarios B and C, the new gas-fired units are equipped with CCS to respect the net-zero emissions target. Because of this target, Scenario B has slightly lower gas capacity than Scenario A. This is offset by higher renewables capacity, particularly from solar. Given the higher electricity demand for hydrogen production in Scenario C, the installed capacity is double that of Scenario B. It also favors solar PV energy due to lower investment costs and the possibility of shifting hydrogen production to hours with available sunlight. Natural gas accounts for an even smaller share of generation (less than 10 percent in Scenario B and less than 2 percent in Scenario C). The Elmed interconnection could initially be used to import electricity until the renewable energy potential is sufficiently developed. Towards the end of the forecast horizon, Tunisia would become a net exporter of electricity under all scenarios. Exports are highest under Scenario C, since the development of green hydrogen supports the higher installation of solar PV and provides flexibility during the summer months, freeing some solar generation for export. To ensure power system flexibility to accommodate renewables, there is a need for battery and pumped storage in all scenarios. The need for battery storage is lower under Scenario C because some of the storage needs are provided by green hydrogen.

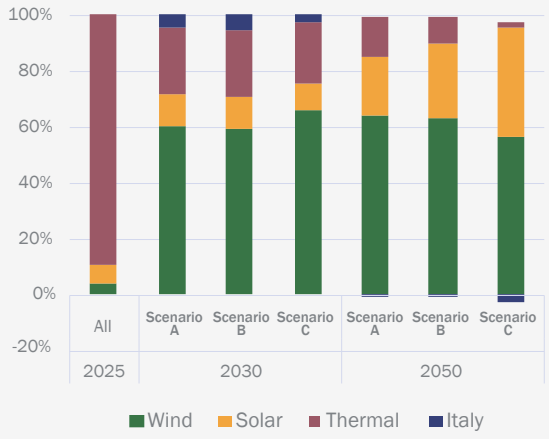
Figure 31: Installed capacity (Gigawatts)



	All	Scenario A	Scenario B	Scenario C	Scenario A	Scenario B	Scenario C
	2022	2030			2050		
Thermal	5,1	4,9	4,9	4,9	6,3	5,6	10,2
Solar	0,0	1,5	1,6	1,4	8,0	11,5	28,9
Wind	0,2	4,4	4,3	4,7	12,9	12,9	21,1

Source: World Bank staff estimation.

Figure 32: Power generation mix



Source: World Bank staff estimation.

The reduction in thermal generation reduces the need for natural gas, with positive outcomes for energy security and the trade balance. From 4 million tons of oil equivalent today, natural gas consumption decreases to 1.8 million in 2050 in Scenario A; 1.3 million in Scenario B; and 0.4 million in Scenario C. Therefore, the CO2 emissions are already considerably reduced under Scenario A (to 3.7 million tons in 2050 from 8.3 today). By definition, they fall to zero in Scenarios B and C.

Due to the large penetration of renewables (which are cheaper than thermal generation) and the improved efficiency of power plants, it is expected that the average cost of electricity generation will decrease significantly, from the average cost of thermal generation today to the average cost of renewable generation in 2050. The average cost in Scenario B is slightly higher than in Scenario A due to the use of costly technologies such as batteries and CCS. With higher penetration of solar and lower use of thermal power plants (hence CCS), the average cost of Scenario C is comparable to Scenario A. This overall reduction would have important benefits for the financial viability of the

sector and the affordability of electricity, improving the welfare for households and competitiveness for businesses. Chapter 4 explores the impact of the decarbonization scenarios in more detail.

Decarbonizing the electricity sector will require mobilizing significant investments in developing renewable energy projects and integrating these projects into the grid. The sooner these investments can be secured, the sooner the country will be able to kick-start its journey towards carbon neutrality and economic health, which in turn would enable it to attract further investment to decarbonize its economy (a virtuous circle). There has been substantial progress in terms of government policies and regulations since 2015, but the development of new renewable energy projects remains limited and the current level of 467 MW installed is very far from the government target of 4,800 MW and the optimal of 5,900 MW by 2030. The following additional measures would support the rapid expansion of renewable energy projects:

- **Macro fiscal:** Restore the financial viability of the sector, including reforms and the financial restructuring and performance improvement of STEG. Provide payment guarantees as needed.
- **Coordination:** Put in place an interministerial committee and designate focal points at relevant ministries to expedite and facilitate the necessary approvals along the procurement and development phases. Assign a STEG team to support the Ministry of Energy.
- **Procurement and project development procedures:**
  - **For all regimes:** Limit the number of permits required along the value chain. Establish clear procedures for land access. Issue a renewable energy code including fiscal incentives for projects completed within agreed timeframes.
  - **Concession regime:** Improve the procurement documents to enhance project bankability.
  - **Authorization regime:** Secure financing by better risk-sharing and assistance programs with local banks.
  - **Self-generation regime:** Initiate corporate power purchase agreements for direct sales between a private generator and an industrial or commercial customer. Introduce the concept of an aggregator for easier financing, but also to better manage variability in load. Simplify the process and establish transparent tariffs for wheeling.
- **Regulations:** Establish an independent regulator to ensure cost-efficiency and issue licenses for private generators.

It is important to rapidly improve the flexibility of the power system to better accommodate the integration of renewable energy. This could be done through interconnections with neighbors, battery and pumped hydro storage, and demand-side response (which is virtually non-existent at present). In addition, market design needs to ensure proper renumeration of flexibility services. Plans are already in process to integrate the Tunisian power system with that of Europe via Italy through the Elmed interconnector, which is expected to be commissioned in 2028. Throughout the forecast horizon, the interconnection is expected to contribute significantly to the flexibility of the Tunisian power system, as indicated by daily exchanges on the interconnector, which will change direction according to time of day and season according to the supply/demand situation on both sides of the interconnector. The interconnector could thus contribute to reducing renewable energy curtailments, accelerating decarbonization in a cost-effective way.

Ensuring integration and coupling between sectors would be key for efficient decarbonization in the country. Sector coupling (the interlinking of energy supply and energy demand) is essential because end-use sectors could contribute to balancing the electricity system through demand-side management. In some cases, end-use sectors could also provide storage services, for example by using the batteries of electric vehicles when they are not in operation or being charged. Sector integration (a coordinated approach to the gas and electricity systems) is already a practice in Tunisia because the national operator is the same for both systems.

Tunisia could develop into a clean energy hub both for decarbonized electricity and green hydrogen. The development of a green hydrogen industry is complementary to renewable energy, and hydrogen is an important energy carrier for decarbonization. However, as Scenario C shows, this would require Tunisia to scale up renewable energy projects even faster than its targets to be able to produce large volumes of green hydrogen before the end of the decade. Some immediate potential actions include:

- Setting up an multisectoral Green Hydrogen Council that includes representatives from all relevant ministers and

key players in the private sector to steer the preparation and validation of the green hydrogen roadmap.

- Identifying demand clusters and key infrastructure to establish special green hydrogen zones with special incentives.
- Establishing a regulatory framework and preparing certifications, norms, and standards for green hydrogen, which is particularly important for exports.
- Securing financing.

Compressed gaseous hydrogen could be mixed with natural gas (at a proportion of 15 to 20 percent) and exported via the existing Transmed gas pipeline to Italy, or in pure form via a dedicated pipeline to be built in future. The first solution is the most likely and least expensive. If the cost of production in Tunisia is sufficiently competitive, then the country could supply, through Italy, markets in Germany and Austria with a strong appetite for green hydrogen. Several studies [164] and a roadmap (which is in preparation) see the export market for green hydrogen expanding rapidly after an initial market catalyst through the local market in replacement for grey hydrogen[165] (mostly for ammoniac replacement in the phosphate/fertilizer sector).[166]

An integrated approach to energy and water management could help reduce risks on both fronts. As the country increasingly relies on desalination of seawater and brackish water, the carbon intensity of the water sector could increase. Massive development of renewable energy may then alleviate the water sector's carbon footprint. Generating power from renewable energy would reduce water stress as renewable energy requires much less water than conventional thermal power generation because it does not need water for cooling. The development of green hydrogen could be a source of additional water stress because it is produced through the electrolysis of water. However, if using desalinated water, the development of a green hydrogen market could result in economies of scale in water desalination, leading to cost reductions that would ultimately benefit water users. In addition, technologies that produce green hydrogen through electrolysis of seawater or brackish water are being developed.

[164] GIZ 2021b.
[165] Grey hydrogen is created by reforming natural gas or methane and is emissions intensive. Green hydrogen is produced by electrolysis of water using renewables-based electricity.
[166] See the Background Paper for more details on export potential.

Box 9: Strengthening workforce capacity to develop renewable energy and improve efficiency

The shift towards clean energy has come with increasing demand for a qualified labor force in this field. The new Energy Strategy for 2035 uses a general equilibrium economic model to forecast the cumulative creation of 70,000 additional jobs between 2021 and 2035. In addition, a green hydrogen roadmap (in preparation) foresees the creation of an additional 65,000 jobs in the hydrogen sector by 2035, and another 400,000 by 2050. These jobs include project managers, engineers, technicians, and workers who can design, build, operate, and maintain renewable energy infrastructure.

Improving energy efficiency in buildings, industrial processes, and transportation will create a growing need for professionals who can conduct energy audits; design and implement energy-efficient systems; and provide energy management services. People should ideally be equipped to take advantage of these new job opportunities at all levels. Highly skilled jobs like renewable energy engineers, electrical engineers, and other specialties are critical for the development and innovation of renewable energy technologies. Medium-skilled jobs (like technicians) and low-skilled jobs are also important for installing and maintaining renewable energy systems and energy-efficient technologies.

At present, Tunisia's university and technical and vocational education and training (TVET) institutions have relatively higher capacity to provide higher-skilled degrees than those relevant for medium- and low-skilled jobs. Across 48 universities and TVETs, staff self-reported that the skills identified for relevant engineering and other higher education degrees are well covered by their degree programs. Twenty-eight programs resulted in 4,460 graduates per year, with more female than male graduates across these disciplines. However, coverage varies. For example, 328 graduates are qualified in electrical engineering each year compared with only 14 in renewable energy. A mere 37 electrical technicians are qualified each year. About 2,321 students graduate from technical-level training programs per year. A notable gap at the technical level is in sales agents with specialized energy knowledge. Of the TVETs surveyed, there were only 20 graduates in sales in the previous year.

Taken together, these provide a foundation of skilled people across the jobs needed for the energy transition. However, the number of students graduating each year does not yet match the need.

To facilitate the development of a green workforce to meet the growing demand, it will be important to establish common governance and planning across relevant stakeholders (for example, sectoral skills councils) and strengthen linkages between the private sector and education or training institutions. These linkages could involve:

- Developing a common database to identify gaps between skills supply and demand
- Involving industries in preparing clean energy education or training curricula
- Arranging internships and practical skills training with industry for students
- Expanding training of trainers' programs and certification to grow the pool of skilled workers.

Source: World Bank (Forthcoming). Jobs and Skills Survey, Climate Change and Human Capital in Tunisia.

3.3.3. Summary

The following table summarizes the investment and operational costs of producing and transmitting electricity to meet national demand. Scenario A, as least-cost, serves as the reference scenario and shows that following BAU and maintaining the current dependence on gas-based generation would be more costly. Although scaling up renewables will likely require more upfront investments, it will save on operational costs. The costs of Scenarios B and C, compared with Scenario A, can be seen as the cost of decarbonizing electricity supply for BAU demand and additional demand from increased electricity penetration and green hydrogen. There is limited difference between the three scenarios up to 2030. However, by 2050, the need for achieving net-zero emissions increases the need for more renewables and CCS for the remaining gas power plants, which increases the costs for Scenarios B and C. The costs of Scenario C are larger given the higher electricity demand.

Table 7: Costs of investment and operations to decarbonize energy sector (in US$ million) until 2050

Engagement dimension	Public or private	Up to 2030	2030–2050	Total costs
Decarbonizing energy supply in the electricity sector [167]	Public	Scenario A: 4,457 Scenario B: 4,439 Scenario C: 4,427	Scenario A: 5,904 Scenario B: 6,962 Scenario C: 8,683	Scenario A: 10,362 Scenario B: 11,401 Scenario C: 13,110
	Private	Scenario A: 6,793 Scenario B: 6,792 Scenario C: 7,383	Scenario A: 9,417 Scenario B: 11,169 Scenario C: 14,183	Scenario A: 16,210 Scenario B: 17,961 Scenario C: 21,567
	Total	**Scenario A: 11,251** **Scenario B: 11,231** **Scenario C: 11,810**	**Scenario A: 15,321** **Scenario B: 18,131** **Scenario C: 22,867**	**Scenario A: 26,572** **Scenario B: 29,362** **Scenario C: 34,677**

Source: World Bank staff estimations.

[167] The costs include capex and operating expenditure for generation and transmission (including storage, CCS for thermal power plants, and grid extension and reinforcement), discounted at 6 percent, for the three scenarios. For Scenario C, the investment includes the cost of electrolyzers for green hydrogen production, but not the cost of infrastructure for green hydrogen transport. The numbers only cover the costs in the electricity sector, not the investments or savings in end-use sectors. It is assumed that, per the government's plan, two-thirds of the generation investments will be carried out by the private sector, and the remaining generation and transmission grid investments will be made by the public sector.

4. Building Macroeconomic, Financial, and Human Capital for Climate Resilience

This chapter quantifies the macroeconomic and fiscal impacts of the climate stresses detailed in Chapter 3 before analyzing to what extent the policies and investments proposed to offset these stressors would affect macro estimates. It then looks at the role of both the public and the private sectors in financing and incentivizing the climate actions needed to place the economy on a sustainable path. Finally, it discusses the challenges posed by climate change to financial stability.

4.1. Macroeconomic Impacts of Climate Inaction

Modeling tools enable us to tease out the macroeconomic and fiscal impacts of the costs and benefits of climate inaction versus climate action identified in Chapter 3. This analysis combines different modeling frameworks to better capture the complexity of climate stressors and provide as precise an estimation of impacts as possible (Box 10). Building on the findings in Chapter 3, it first estimates the extent to which water shortages could affect the economy overall if not addressed. The estimated cost of inaction does not include decarbonization as this is not determined by climate stressors. However, failing to decarbonize would result in a large opportunity cost, as highlighted by the estimated impacts of climate action in Section 4.2.

Box 10: Combining models to estimate the economic impacts of climate change and climate action

The CCDR combines the World Bank's macroeconomic and fiscal model (MFMOD) with a state-of-the-art multisectoral open economy model following Baqaee and Farhi (2021) that accounts for elasticities of substitution and reallocation between different intermediate inputs. This framework helps provide a more realistic characterization of the macroeconomic impacts of microeconomic shocks, such as energy and water shortages (Bachmann et al. 2022), which are crucial to model climate shocks.

In the context of this CCDR, the Baqaee and Farhi model is used to compute the macroeconomic impacts of the water shortage in non-agricultural sectors and of the energy shortage stemming from the external constraint (both illustrated in Chapter 3). The impacts are measured in terms of a percentage reduction in sectoral as well as aggregate real outputs. These losses are then used to feed the sectoral production functions in MFMOD by adjusting their total factor productivity parameter to replicate the output losses. These changes produce shocks to the MFMOD, which in turn generate the macroeconomic and fiscal outcomes.

4.1.1. The economic costs of inaction

The climate-induced water shortages projected in Chapter 3 are likely to have substantial detrimental impacts on Tunisia's economy and macro-fiscal balances. Compared with a baseline that draws on past trends, water shortages would reduce real GDP by between 4.1 percent (in the RCP 4.5 scenario) and 4.6 percent (RCP 8.5 scenario) (Table 8). A sizable portion of these losses could materialize by 2030, when the economy is expected to shrink by between 2.0 percent and 2.7 percent relative to the baseline, equivalent to between TD 2.7 billion and TD 3.8 billion (US$0.9 billion and US$1.3 billion) per year. These losses are driven by the agriculture sector, which could see its value added fall by between 10.3 percent and 19.3 percent by 2030, and between 24.0 percent and 27.3 percent by 2050. Water shortages could also affect the industrial sector, whose GDP contribution may fall by as much 5.2 percent by 2050. A decline in agricultural production would reduce net exports because imports would increase to bridge the resulting supply-demand gap. As a result, the current account deficit would deteriorate by between 6.6 percent and 13.2 percent by 2030 (with the deterioration of the current account balance growing to between 20.7 percent and 24.8 percent by 2050). This would exacerbate Tunisia's already fragile external balance. Nearly all key macro and fiscal indicators would deteriorate, exposing the economy to an unprecedented and protracted crisis.

Sea-level rise and flooding could generate significant economic losses, although their magnitude may be lower than losses due to water shortages. Simulations suggest mild losses from floods and sea-level rise for the RCP 4.5 scenario (0.1 percent of GDP by 2050). For RCP 8.5, this figure increases to 0.8 percent of GDP by 2030 which, if not addressed, would grow to 1.7 percent of GDP by 2050 (Table 8). These losses are driven by loss of land, infrastructure, and buildings due to inundation (see Chapter 3) and could drive proportionate reductions of investments and consumption. The former is likely to be slightly more affected due to a reduction in capital stock. All sectors would be affected, with industry and services slightly harder hit than agriculture because capital losses are expected to be concentrated in those sectors. The current account balance would improve slightly because imports are projected to compress a little more than exports as demand falters. Similarly, the budget deficit would improve as expenditure is expected to fall more than revenues in the medium-to-long term.

These effects combined would cause the economy to shrink by 3.4 percent of GDP by 2030 (close to TD 5.6 billion a year in net present value). Together, water shortages, coastal erosion, and flooding shocks would reduce real GDP by 3.4 percent in 2030 (RCP 8.5 scenario) compared with a baseline that is derived from past trends. The annual losses would grow to 6.4 percent of GDP by 2050, or TD 10.4 billion (US$3.4 billion) in net present value terms (Table 8). A large portion of these losses is driven by the impacts of water shortages. The agricultural sector would be particularly affected, with its value-added declining 15 percent by 2030 (and 29 percent by 2050). A decline in agricultural production would reduce net exports because imports would increase to bridge the resulting supply-demand gap. As a result, the current account deficit would deteriorate by more than 6 percent in 2030.

Table 8: The macro and fiscal impacts of climate damage scenarios (percent deviation from baseline)

	Water shortages				Flood and sea-level rise				Combined	
	RCP 4.5		RCP 8.5		RCP 4.5		RCP 8.5		RCP 8.5	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Real GDP	-2.0	-4.1	-2.7	-4.6	0.0	-0.1	-0.8	-1.7	-3.4	-6.4
Private consumption	-1.5	-2.1	-1.9	-2.2	-0.1	-0.1	-0.9	-1.6	-2.4	-3.8
Government consumption	-2.4	-2.6	-3.0	-2.7	-0.1	-0.1	-1.0	-2.1	-5.6	-9.0
Private investment	-1.1	-3.2	-1.1	-3.5	-0.1	-0.1	-1.2	-1.9	-1.8	-5.4
Government investment	-2.2	-3.6	-2.7	-3.9	-0.1	-0.1	-1.0	-2.1	-5.6	-9.0
Net exports	-8.1	-34.4	-19.6	-41.7	-0.4	-0.2	-6.4	-1.9	-7.5	-19.6
Agriculture	-10.3	-24.0	-14.3	-27.3	0.0	-0.1	-0.5	-1.0	-14.9	-28.6
Industry	-2.1	-4.6	-2.8	-5.2	0.0	-0.1	-0.9	-1.9	-3.4	-7.1
Services	-0.8	-1.1	-1.1	-1.2	0.0	-0.1	-0.8	-1.8	-1.8	-3.0
Current account balance*	-6.6	-20.7	-13.2	-24.8	0.2	0.2	3.2	1.7	-6.5	-9.4
Fiscal revenues	-1.7	-2.9	-2.2	-3.2	0.0	-0.1	-0.8	-1.7	-3.0	-5.4
Fiscal expenditures	-1.8	-3.2	-2.3	-3.6	0.0	-0.1	-0.8	-2.0	-5.0	-10
Budget balance*	-2.9	-6.2	3.6	6.9	0.0	-0.3	-0.1	-4.9	-22.8	-48.8
Public debt#	-3.6	-7.0	-5.0	-7.8	0.0	-0.2	-0.8	-2.6	-7.4	-22.2

* Positive numbers signal an improvement of the balance (that is, a reduction of the deficit), while negative numbers signal a deterioration of the deficit.
# Positive numbers signal an increase in the public debt (in percentage points of GDP).

Source: World Bank staff estimations.

4.1.2. The economic and welfare benefits of actions to mitigate and adapt

The high costs of climate change demonstrate the importance of not only adapting the economy but also of bringing it to a sustainable path. Chapter 3 identifies a wide array of actions—both policies and investments—to address water shortages and inundation from flooding and sea-level rise. Many of these actions are likely to be needed in the short term, which could provide rapid relief for an ailing economy. The chapter also discusses options for decarbonizing the energy sector, which would bring benefits through multiple channels. This section combines the macroeconomic and fiscal (MFMOD) and Baqaee and Farhi models to quantify the impacts of these actions.

Decarbonizing the energy sector would allow the country to largely address the external imbalance, while generating large emission reductions and significant economic gains. As discussed in the preceding chapters, external financing constraints have started to limit Tunisia's ability to import. It is plausible that this constraint will become tighter if no action is taken to redress external imbalances.[168] Energy imports account for almost three-quarters of the trade deficit. By replacing natural gas with renewables to generate electricity, the contemplated decarbonization scenarios allow for enough of a reduction in energy imports to relax this external constraint.[169]

Table 9 presents the output response (relative to the baseline scenario) for the three decarbonization scenarios described in Chapter 3: the least-cost scenario (Scenario A); the green scenario, which entails net-zero emission within the electricity sector (Scenario B); and the green hydrogen and deep decarbonization scenario, which entails developing green hydrogen technology and increased electrification and energy efficiency in end-use sectors (Scenario C). All scenarios lead to economic gains relative to inaction, with the economy expected to be larger by between 1.1 percent (least-cost scenario) and 1.75 percent (deep decarbonization) by 2030. The GDP impact of Scenario C is largest in the short term (GDP 1.75 percent larger by 2030) because end-user sectors are likely to benefit from enhanced decarbonization policies, resulting in lower energy costs.[170] While all sectors benefit, industry and agriculture perform particularly well given their greater energy dependence compared with services. Scenario C entails a reduction in net exports as import demand increases due to the large real income effects of declining production prices (linked to lower energy costs). Public debt increases in all scenarios, but not significantly because most decarbonization investments are expected to be shouldered by the private sector.

[168] Modeling suggests imports should be reduced by 7 percent to maintain foreign reserves at a minimum level of two months of import cover. This rationing is considered in the reference scenario and generates economic losses compared to a baseline of no external constraint.

[169] This also involves an increase in capital investments, which are assumed to be funded by foreign direct investment and that would lead to an increase in electricity imports as the current large-scale IPP tariff is indexed up to 80 percent to foreign currency. However, this import increase would be considerably smaller than the reduction in gas imports to produce electricity.

[170] The model assumes that investments by end-user sectors are equivalent to 120 percent of the expected energy cost savings from decarbonization of production (for example, energy savings technology or shifting away from fossil energy towards renewables). The 120 percent reflects the penalty of credit market frictions, which do not allow to borrow fully against future profits realized through savings.

Table 9: Macro impacts of decarbonization scenarios (percent deviation from baseline)

	Scenario A: Least-cost		Scenario B: Green		Scenario C: Deep decarbonization	
	2030	2050	2030	2050	2030	2050
Real GDP	1.06	1.45	1.11	1.40	1.75	1.40
Private consumption	0.5	1.2	0.9	0.9	3.1	7.9
Government consumption	-0.6	-0.1	-1.0	-0.1	-1.3	0.0
Total investment	-1.4	1.9	-1.1	1.1	0.1	-1.8
Net exports	28.7	-6.4	21.8	-2.0	-12.8	-89.9
Agriculture	0.3	0.9	0.3	0.8	3.2	5.6
Industry	1.2	1.7	1.3	1.7	1.8	1.2
Services	1.1	1.4	1.2	1.4	1.5	0.9
Current account balance*	-0.8	-5.3	-3.9	-7.0	-28.2	-84.9
Fiscal revenues	0.7	1.3	0.9	1.1	2.4	4.1
Fiscal expenditure	1.3	2.9	1.1	3.5	2.4	4.5
Budget balance*	-6.9	-16.4	-3.6	-23.7	-2.5	-8.4
Public debt#	1.0	2.7	0.9	2.9	1.5	1.7

Notes:
Scenario A: the capacity expansion plan is developed with no constraints on emissions and optimisation starts in 2026, with projects in the pipeline implemented between 2023 and 2026. Electricity demand is assumed to follow business as usual (BAU), without energy efficiency and decarbonization of end-use sectors.
Scenario B: Constraints are imposed to decarbonize the electricity sector by 2050 (net CO2 emissions reach zero). Electricity demand is the same as in Scenario A.
Scenario C: Increased electrification and deployment of green hydrogen in the building, industrial, and transport sectors, which displaces the use of fossil fuels, through the actions mentioned above.
* Positive numbers signal an improvement of the balance (that is, a reduction of the deficit), while negative numbers signal a deterioration of the deficit.
# Positive numbers signal an increase in the public debt (in percentage points of GDP).

Source: World Bank staff estimations.

Reforms and investments to address climate change are also expected to yield huge benefits to the economy, particularly the agricultural sector. The actions envisaged to fight water shortages have particularly high returns because they allow both an increase in the availability of water and substantially reduce the amount of water per unit of output, particularly in agriculture. This would facilitate the increase of production and exports, effectively accelerating economic growth. The gains from reconstruction after flooding and for adaptation to coastal erosion are also important, but more limited. If all actions to adapt to water shortages, flooding, and coastal erosion were implemented, GDP would be 7.7 percent larger than in the RCP 8.5 inaction scenario (the "Combined" scenario in Table 8) already by 2030, and a full 9.9 percent larger by 2050 (Table 10, Scenario D). More than half of these gains are accounted for by growth of the agricultural sector, which is the main water user and beneficiary of actions to address water shortages. Boosted by the increase in agricultural and, to some extent, industrial production, exports are expected to increase faster than imports so that net exports account for between 25 percent and 32 percent of the economy's growth. In the absence of compensatory fiscal measures, public debt is expected to increase by between 25 (by 2030) and 54 percentage points of GDP (by 2050) as the large investments associated with this scenario are assumed to be shouldered by public expenditures. That could be well beyond Tunisia's borrowing ability, but the scenario is indicative of the huge potential gains from addressing climate stressors.

Combining the adaptation measures with the most ambitious mitigation policies yield similar economic impacts while achieving the net-zero goal. Adding the mitigation policies of the deep decarbonization scenario (Scenario C) further accelerates economic gains. As a result, GDP would be almost 9 percent larger than in the inaction scenario already by 2030 (Table 10, Scenario E). The acceleration is mainly driven by net exports because the decarbonization policy reduces energy imports in the short term, even as increased domestic demand (due to decarbonization) is mainly covered by domestic supply buoyed by the adaptation policies. At the same time, exports are expected to increase (relative to Scenario D) as the productive sectors benefit from lower energy costs. Eventually, these effects are likely to peter out and, by 2050, net exports would be at the same level as in the inaction scenario in Table 8. The public debt increase is slightly higher than Scenario D because part of the decarbonization strategy is financed by debt. The key benefit of adding mitigation to adaptation is the massive reduction in emissions already by 2030 (-78 percent), which eventually reach zero by 2050. This could entail additional economic benefits in terms of lower negative externalities from pollution and in terms of direct earnings, should an effective international carbon credit market materializes. None of these benefits are considered in the results, which can therefore be viewed as lower-bound estimates.

Table 10: The macroeconomic impacts of adaptation and mitigation (percent deviation from RCP 8.5 inaction scenario unless otherwise indicated)

	Addressing water shortage, floods, and coastal erosion (Scenario D)			Addressing water shortage, floods, and coastal erosion + deep decarbonization (Scenario E)		
	2030	2040	2050	2030	2040	2050
Real GDP	7.7	8.0	9.9	8.8	7.9	9.1
Private consumption	4.0	2.9	5.3	3.8	2.8	8.2
Government consumption	14.4	13.5	15.3	4.5	8.1	9.8
Private investment	1.7	6.5	9.2	1.1	1.7	2.4
Government investment	5.9	8.2	9.8	-4.3	9.5	18.9
Net exports	60.8	47.1	33.1	164.2	73.1	0.6
Agriculture	53.4	68.2	83.8	55.0	68.0	82.3
Industry	6.9	9.1	11.2	7.3	8.8	10.1
Services	2.6	1.0	2.0	3.9	1.0	1.3
Current account balance (GDP p.p.)*	2.8	2.4	1.5	5.9	2.1	-2.9
Fiscal revenues (GDP p.p.)	1.5	1.5	2.0	1.5	1.6	2.3
Fiscal expenditure (GDP p.p.)	4.9	5.2	5.5	4.7	6.0	6.5
Budget balance (GDP p.p.)*	-3.5	-3.7	-3.5	-3.2	-4.4	-4.1
Public debt (GDP p.p.)#	24.7	44.2	54.3	19.8	45.0	57.8
CO_2 emissions	1.0	1.3	2.7	-78.1	-93.5	-98.3

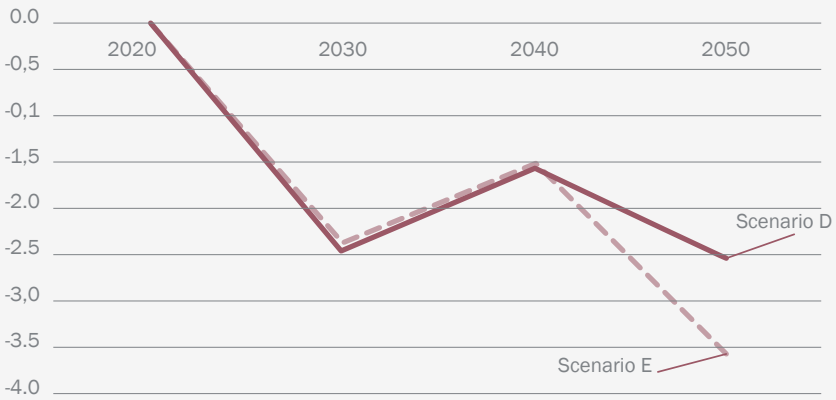
Notes:
- GDP p.p. indicates deviations from inaction scenario in percentage points of baseline GDP.
- Scenario D models all the climate damages (water shortage, sea-level rise, and flooding) included in the combined scenario in Table 8 along with the full set of interventions to address these damages discussed in Chapter 3.
- Scenario E models all the climate damages (water shortage, sea-level rise, and flooding) included in the combined scenario in Table 8 along with: (i) the full set of interventions to address these damages discussed in Chapter 3 and (ii) the actions to achieve the full decarbonization of the economy as per Scenario C in Table 9.

* Positive numbers signal an improvement of the balance (that is, a reduction of the deficit), while negative numbers signal a deterioration of the deficit.
# Positive numbers signal an increase in the public debt (in percentage points of GDP).

Source: World Bank staff estimations.

The large gains of the combined adaptation and mitigation actions translate into a significant reduction in poverty. Inserting the macro results into the poverty simulation model ClimSim allows for a simulation of the poverty impacts of climate actions. The results suggest that adaptation measures have significant poverty-reducing effects due to higher private consumption growth and greater output in all sectors. As a result, poverty is lower (by between 2.5 and 3.6 percentage points) by 2050 in the case of both adaptation measures (Scenario D) and adaptation plus deep decarbonization (Scenario E), when compared to the inaction scenario (Figure 33).

Figure 33: The distributional impacts of adaptation and mitigation measures



Source: World Bank staff estimations.

4.2. Financing Climate Action

While the economic and environmental benefits of climate actions are clear, identifying how the investments underlying these actions might be financed is crucial given Tunisia's limited access to international financing. A significant share of the funding for adaptation will need to come from public investments, while decarbonization investments will likely stem from public and private sources, as highlighted in Chapter 3. The Tunisian government struggles to finance investments, given large recurrent expenditures in the budget (which equal 112 percent of revenues and grants) and constrained access to international financial markets. As a result, public debt financing is unlikely to enable the investments needed for the climate transition. Similarly, Tunisia remains a marginal destination for foreign direct investments and portfolio flows are virtually nonexistent. This section discusses potential fiscal, financial, and private sector policies to address these gaps.

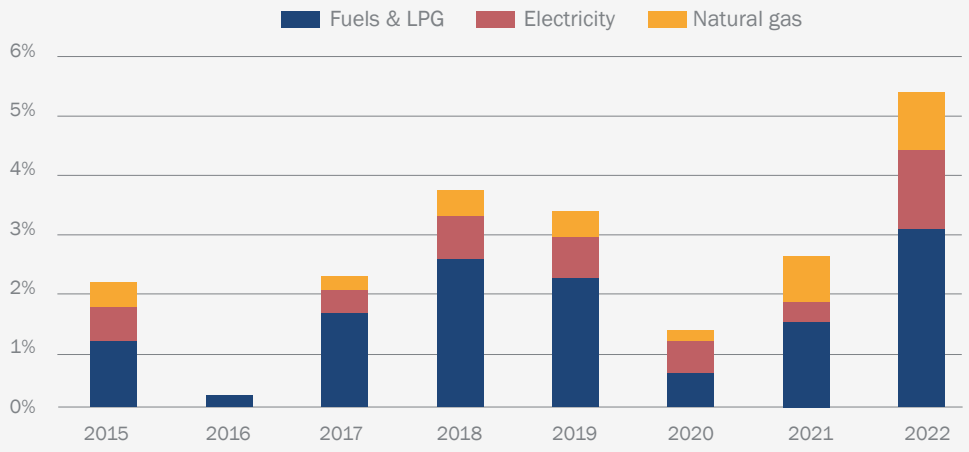
4.2.1. Fiscal policies

Given constraints to debt financing, fiscal policies—especially those that aim to reduce expenditure—could help finance the public investments needed for Tunisia's climate transition. Reducing expenditure, including energy subsidies, represents a significant opportunity to leverage Tunisia's own resources. These subsidies (which target fuels, LPG, electricity, and natural gas) account for a large share of GDP (5.3 percent of GDP in 2022). They are also largely regressive, generate negative environmental externalities, and keep energy consumption artificially high. At the same time, the current Tunisian context makes it difficult to leverage additional tax revenues to fund adaptation needs. Tax revenues are already high (as a share of GDP) and any additional taxes or tax-rate increases are likely to have limited short-term impacts as they may affect demand if not well targeted. To the extent that additional taxes could be considered, carbon tax, capital income tax, and property tax would be the most promising. Taxing production on the basis of carbon intensity is an efficient way to internalize pollution externalities and could be effective at raising revenues, given the relatively low administrative complexity of production taxes. The adoption of a carbon tax is also aligned with the GoT's broader objective of developing carbon pricing instruments, notably through a carbon tax system on energy consumption and a crediting system for GHG mitigation in the electricity and the cement sectors. Taxing capital income is also a potentially useful tool to raise revenues and increase the equity

of Tunisia's tax system, which currently weighs considerably more on labor than on capital.[171] Recurrent property tax could be another effective way to increase the equity of the tax system (given its inherent progressivity) and would enable targeting of a significant portion of the wealth of high-income individuals. Relieving macro-fiscal constraints would also enhance investor confidence and the business environment, so facilitating private sector investment.

Tunisia's current fiscal structure is at odds with the need for climate action because it does not sufficiently tax polluting activities while subsidizing carbon-intensive consumption. The large energy subsidy is driven by fuels and LPG, which account for almost 60 percent of total subsidies (Figure 34). Even before the 2022 increase, Tunisia had one of the highest levels of energy subsidies relative to GDP in the world and was one of the very few countries that does not export energy while having energy subsidies of above 3 percent (Figure 35). At the same time, the country has a relatively low level of environmental taxes. The pre-COVID (2018–2019) average net balance of tax-explicit subsidies was 1.8 percent of GDP, equivalent to US$850 million in 2022 GDP terms. Although the country does tax polluting activities, rates are relatively low and are subject to many exemptions and relief. For example, while the general value-added tax (VAT) rate is 19 percent, diesel, kerosene, and heavy and light fuel oil benefit from a reduced rate of 13 percent. Low-voltage electricity for residential use also benefits from this reduced VAT rate.[172]

Figure 34: Tunisia's energy subsidies (as a percent of GDP)

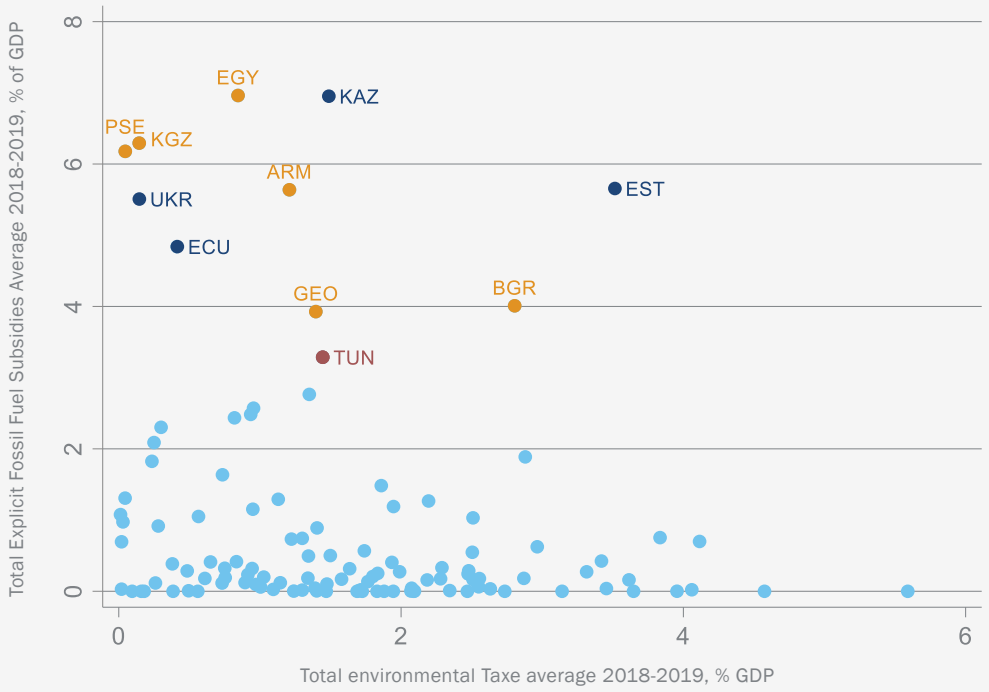


Source: Ministry of Finance

[171] Tunisia is the developing country with the largest difference between effective labor and capital tax rates, according to data from Bachas et al. (2022).

[172] Specific taxation exists to finance the Energy Transition Fund, which replaced the National Fund for Energy Efficiency in 2014. However, the rate is very low. The following energy products are exempted: bottled LPG, natural gas for social tranche (monthly consumption <300 thermal units), and electricity for social tranche (monthly consumption <100 kWh). Other products are also subject to an energy transition tax (for example, there is a lump sum on cars, air conditioning, lamps, or used engines). However, the rate of taxation is low and not able to sway consumer behavior.

Figure 35: Comparison of fossil fuel subsidies and environmental taxes: Tunisia versus global (percent of GDP in 2019–2018)



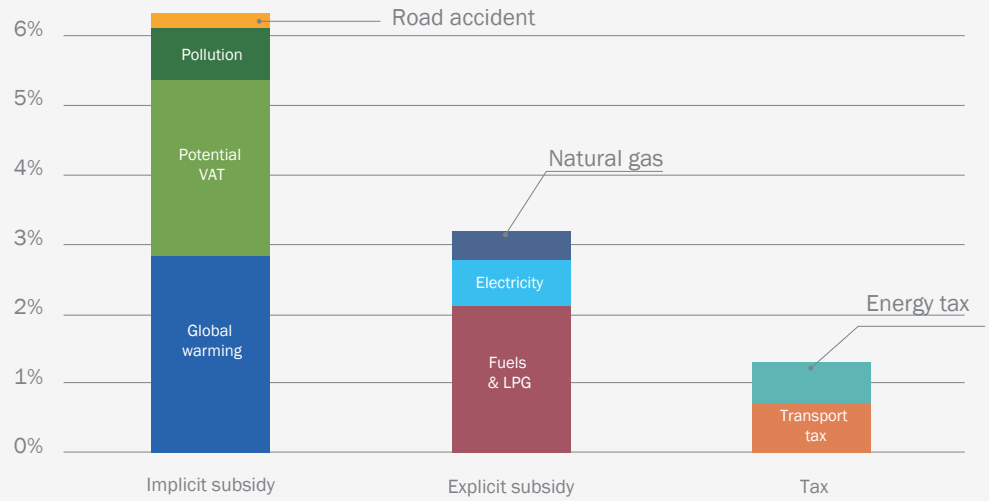
Note: Orange dots indicate net energy exporting countries with average energy subsidies above Tunisia's value. Green dots indicate net energy importing countries with average energy subsidies above Tunisia's value.

Source: Parry et al. 2021.

Tunisia's energy subsidy policy generates more negative environmental externalities than those it internalizes through taxation. The local consumption (and production) of fossil fuels generates negative externalities such as local pollution and global warming, which are not explicitly valued in monetary terms. When considering the implicit economic losses that these externalities generate, the net environmental balance of Tunisia's fiscal policy worsens considerably. The externalities associated with energy subsidies (implicit subsidies) are estimated at 7.4 percent of GDP for 2021–2022 (around US$3.7 billion), and 6.5 percent of GDP in the pre-COVID period. These reflect the impacts of global warming (2.9 percent of GDP), foregone VAT revenues (2.6 percent), local air pollution (0.8 percent), and increased road accidents (0.2 percent) (Figure 36).[173] In 2019, the latest year for which both environmental tax and energy subsidy estimates are available, the cost of implicit and explicit energy subsidies amounted to 9.8 percent of GDP, which dwarfed the revenue from environmental taxes (1.4 percent). The negative net fiscal balance incentivizes polluting activities at the expense of more environmentally friendly investments.

[173] The estimates are based on the data of the Climate Policy Assessment Tool (CPAT) with the following underlying data and assumptions. **Global warming costs:** Based on the damage per ton CO_2 (set at a social cost of carbon fixed at US$75 in 2030) together with the level of Tunisia's CO2 emissions. **Foregone VAT:** Based on the supply cost augmented by all externalities (assuming the general VAT rate of 19 percent). **Local pollution:** Based on the averted mortality using the value of the statistical life, a measure of the rate at which individuals are willing to exchange money to reduce small risks of death within a certain period of time, and the average ambient air pollution-attributed mortality per µg/m3 with ambient PM2.5 (contributed by one unit of fuel used). **Road damage:** Based on fuel price elasticities of vehicle kilometers traveled.

Figure 36: Implicit and explicit fossil fuel subsidies versus environmental taxes (as a percent of GDP)



Note: Explicit subsidy is a monetary cost for the state aimed to reduce the price of a fossil fuel for its users. Implicit subsidy is the economic costs associated with the externalities generated by the additional consumption of fossil fuels due to the explicit subsidy. These externalities include: increased global warming; reduced VAT; increased local pollution and road accidents.

Source: World Bank staff calculations; Climate Policy Assessment Tool (CPAT); Parry et al. 2021.

The structure of environmental taxes and subsidies also contributes to reducing the fiscal space needed to invest in mitigation and adaptation. Environmental taxes represent a mere 6 percent of total tax revenues, contributing little to create the needed fiscal space.[174] On the other hand, energy subsidies account for 15 percent of expenditures (and 19 percent of revenues), so shrinking the fiscal space for alternative investments. Just bringing the environmental net fiscal balance to zero would add around US$1.1 billion annually, part of which could finance mitigation and adaptation investments.[175] Reducing subsidies to zero—while keeping environmental taxes as they are—would increase the available annual government budget by around US$2 billion.[176]

Phasing out energy subsidies while protecting the affected vulnerable groups and raising environmental taxes are crucial for Tunisia from both an economic and an environmental point of view. Chapters 1 and 3 have made the case for more sustainable energy public expenditure particularly by gradually phasing out energy subsidies. Such reform would have to be accompanied by compensation for the vulnerable groups affected by the higher energy prices due to the reform. Environmental tax reforms are desirable for at least three reasons.[177] First, they ensure that market prices reflect the costs of environmental externalities, so generating efficiency gains. Second, by realigning price incentives, environmental taxes can minimize the economic costs (or raise economic activity) of reducing pollution in the economy. A carbon tax would reinforce incentives for behavioral changes and energy-efficiency improvements. Third, environmental taxes can raise domestic revenues at a lower cost than other taxes. [178]

[174] Figures are based on pre-COVID (2018–2019) averages, which are the latest available.
[175] The calculation is based on the report's estimates of energy subsidies and environmental taxes for 2023.
[176] Part of this additional budget could be used to incentivize the development of renewable energy generation, including by shouldering some of the costs involved in such development.
[177] Pigato 2019.
[178] OECD 2018.

Modeling results suggest significant gains from lowering recurrent public expenditures and the increasing in taxes on carbon and capital income. The simulations presented in Table 11—which are based on the MFMOD and Baqaee and Farhi model (Box 10)—show that both a carbon tax and an energy subsidy phaseout, along with direct capital income taxes, yield economic gains by avoiding the need for the country to resort to costly debt financing of adaptation and mitigation investments.[179] This is reflected in Scenario F, which is based on a full adaptation policy addressing water shortages, floods, and coastal erosion risks.[180] This yields the largest economic gains of all scenarios by 2050 as the Tunisian economy is expected to be 10.8 percent larger than in the inaction scenario. Public debt still grows, but much less rapidly than in the corresponding scenario in Table 11. Given the massive economic gains, this growth appears sustainable from a financing point of view. As in Table 10, even in this scenario (Scenario F), net exports are a key driver of growth, along with government consumption boosted by additional fiscal revenues. On the other hand, higher taxes and lower recurrent expenditure reduce private consumption. In Scenario G, where decarbonization is added to adaptation, this effect neutralizes the import-demand effect of decarbonization on end-user sectors. As a result, net exports continue to increase throughout the period with a sustained improvement in the current account balance. As in Table 10, the second scenario yields more rapid growth by 2030. However, the higher tax burden funding both adaptation and mitigation weigh on consumption, eventually moderating the gains relative to the first scenario and risking adverse impacts on poverty. Even in Scenario G, however, the economic gains remain very significant (8.8 percent GDP growth by 2050). In addition, debt growth appears relatively sustainable while maintaining the goal of net-zero emissions by 2050.

[179] A capital income tax appears more beneficial than other forms of revenue-generating taxes because they would rebalance the tax burden, which is currently skewed in favor of capital.

[180] This scenario assumes a gradual subsidy phaseout over five years and a carbon tax that grows from zero to US$20 by 2030. After 2030, the models assumes that a direct income tax commences to cover the remaining financing gap of public investments in adaptation and (for the second scenario) mitigation.

Table 11: The impacts of financing climate action through fiscal policy (percent deviation from RCP 8.5 inaction scenario unless otherwise indicated)

	Addressing water shortage, floods, and coastal erosion (Scenario F)			Addressing water shortage, floods, and coastal erosion + deep decarbonization (Scenario G)		
	2030	2040	2050	2030	2040	2050
Real GDP	7.1	8.4	10.8	8.2	7.4	8.8
Private consumption	-6.1	-13.9	-19.8	-1.6	-4.9	-2.9
Government consumption	27.2	34.3	47.6	23.8	23.7	24.0
Private investment	7.4	12.7	18.3	0.5	2.8	5.6
Government investment	6.5	7.8	8.9	-3.8	10.0	19.2
Net exports	182.4	193.4	225.6	187.9	125.7	85.9
Agriculture	53.4	68.2	83.8	55.0	68.0	82.3
Industry	6.3	8.9	10.8	7.0	8.4	9.8
Services	2.8	1.1	2.2	4.1	1.2	1.4
Current account balance (GDP p.p.)*	8.6	12.8	16.3	6.9	5.6	3.1
Fiscal revenues (GDP p.p.)	6.9	7.7	8.6	4.8	5.4	6.7
Fiscal expenditure (GDP p.p.)	6.5	7.9	9.9	5.5	6.9	7.8
Budget balance (GDP p.p.)*	0.4	-0.2	-1.3	-0.7	-1.4	-1.2
Public Debt (GDP p.p.)#	5.4	12.1	24.2	8.5	20.1	26.6
CO_2 emissions	-1.8	0.4	6.4	-78.1	-93.5	-98.3

Notes:
- GDP p.p. indicates deviations from inaction scenario in percentage points of baseline GDP.
- Scenario F models all the climate damages (water shortage, sea-level rise, and flooding) included in the combined scenario in Table 10 along with the full set of interventions to address these damages discussed in Chapter 3
- Scenario G models all the climate damages (water shortage, sea-level rise, and flooding) included in the combined scenario in Table 10 along with: (i) the full set of interventions to address these damages discussed in Chapter 3 and (ii) the actions to achieve the full decarbonization of the economy as per Scenario C in Table 9.
- All scenarios assume additional taxes and public expenditure cuts to finance the additional investments to address the damages and decarbonize the economy.

* Positive numbers signal an improvement of the balance (that is, a reduction of the deficit), while negative numbers signal a deterioration of the deficit.
# Positive numbers signal an increase in the public debt (in percentage points of GDP).

Source: World Bank staff estimations.

4.2.2. Promoting public investment

Ideally, a large share of the estimated required investment would come from the private sector (with appropriate incentives). However, several areas will probably still depend on public investment. These relate to investment in public infrastructure (for example, water provision, coastal management, the transmission network for integration of renewable energy, the public transport and railway system, and efficient and resilient public buildings) and social expenditures needed to support the poor and vulnerable (see Section 4.4).

Tunisia is taking steps to better integrate climate indicators into public financial management. The MoE, in coordination with the Budget by Objective Unit (Ministry of Finance), has initiated preparatory work to integrate climate indicators emanating from national climate policies and targets into the performance indicators of all objective management units in key sectors. This would improve ownership and monitoring and evaluation of priorities.

Developing a climate project database would promote public finance for adapting to climate change. Sectoral priorities (for example coastal protection and disaster risk management for agriculture, water, tourism, industry, and transport) are often mentioned in national climate policy documents, but these orientations are not reflected in sectoral strategic documents. Neither are they followed in terms of development of investment portfolios and project requests. Instead, climate change budgeting and accounting at the Ministry of Finance has mostly been on a project-by-project basis. Additionally, there is no legal or institutional framework for climate-sensitive accounting. A comprehensive public financial management framework that captures climate change planning and actions (from budgeting to execution to reporting) would support informed and transparent decision-making.

There is no methodology to prioritize climate projects in the current budget allocation system (such as the "tartib" system). The 2021 and 2022 budget circulars by the head of government mention that priority should be given to climate change-related projects. However, specific guidelines on this process are yet to be developed. Tunisia's legal framework does not require climate change screening and evaluation for proposed infrastructure projects. Rather, this is done on a project-by-project basis, depending on donor requirements for projects that are externally funded.

Mainstreaming climate change objectives in public procurement would have a significant positive impact. Public procurement in Tunisia accounts for about TD 15 billion (US$5 billion) annually, which is nearly 13 percent of GDP and 40 percent of the state budget. Given the size and scale of public procurement, green public procurement could contribute substantially to net-zero emissions by 2050. Despite a few initiatives such as requiring feasibility studies for the construction sector and the elaboration of an action plan for sustainable public procurement (2019), implementation is lagging. The legal procurement framework mentions sustainable procurement as a key objective but does not provide additional guidelines. In particular, the integration of evaluation and award criteria for public contracts related to sustainable development (life cycle cost and environmental factors) are not yet developed, and the online public procurement system does not yet allow for the disclosure or tracking of green procurement.

SOEs such as STEG and SONEDE are key to Tunisia's adaptation and mitigation objectives and could spearhead the adoption of sustainability standards in their operations, and of climate-related disclosure in their annual reports. Tunisia's regulatory framework does not require climate reporting, and research carried out for a forthcoming World Bank report found no mention of climate impacts, risks, or mitigating measures in the most recent annual reports of state-owned banks, Entreprise Tunisienne d'Activités Pétrolières (ETAP, the Tunisian Company of Oil Activities), SONEDE, or ONAS. Climate change reporting is an emerging opportunity in corporate reporting, both globally and in Tunisia. STEG is developing an action plan for climate governance that aims to improve its capacity to track its investments in renewable energy, the climate resilience of its assets, and other metrics. The action plan also aims to identify physical risks in STEG's operations for its customers, the regulator, and the electricity market.

Municipalities have a key role to play in leveraging finance for climate adaptation. Tunisian cities, which are poised to play a critical role in ramping up climate action, often lack technical expertise and financial resources to develop collaborative and integrated climate action plans. Opportunity exists to reinforce the capacities of Tunisian cities, support existing initiatives (such as the Municipality of Tunis' upcoming climate action plan), and facilitate their access to climate adaptation finance by raising awareness and creating linkages with global trust funds that focus on city-level climate resilience (such as the City Climate Finance Gap Fund, the City Resilience Program, and the Resilient Cities Network).

4.2.3. Green finance

Even with decisive government action, attracting private, bilateral, multilateral, and international market financing remains key to meeting Tunisia's large climate investment needs. These needs are recognized in the NDC and could take the form of concessional lines of credit, grants, foreign direct investment, and innovative financing via carbon markets. Private actors are expected to finance a significant share of NDC actions, mainly through climate investments. Adopting ambitious green finance policies would support these investments.

Cognizant of these needs, Tunisian authorities have been pledging to develop green capital markets since at least 2016. The Tunisian capital market authority signed the so-called Marrakech Pledge in 2016, a continental coalition of African Capital Markets Regulators and Exchanges committed to "act collectively in favor of fostering Green Capital Markets in Africa". In 2021, the securities regulator Conseil du Marche Financier published the "Guide for Green, Social and Sustainability Bonds". The guide aimed to disseminate best practices for the selection, evaluation, and reporting of bond issuances so that reasonable assurance could be given on the use of their proceeds. Also in 2021, the Tunisian Stock Exchange published an ESG reporting guide intended for listed companies.[181] The Ministry of Finance has further communicated its intention to launch a national sustainable banking framework in the coming years and to formulate a climate finance policy.

These commitments have translated into little progress so far, and Tunisia's climate and green finance market remains nascent and underdeveloped. As of January 2023, no outstanding ESG-linked debt instruments were recorded in Tunisia, according to the International Institute of Finance's Sustainable Debt Monitor.[182] This is in contrast with regional markets where, as of October 2022, Turkey, Egypt, and Morocco had about US$25.4 billion, US$3.2 billion, and US$268 million in outstanding sustainable debt, respectively.[183] This gap is consistent with the Sustainable Banking and Finance Network's assessment that Tunisia is in the earliest development stage for sustainable finance (at "commitment"), as indicated in its 2022 Country Progress Report. Progress has also been limited on the concessional financing front. Between 2009 and 2020, Tunisia secured about US$5.3 billion in climate financing commitments from bilateral, multilateral, and philanthropic partners, of which only 11 percent was provided as concessional funding through grants.[184] Because actual disbursements have been low in Tunisia, investments stemming from these sources is likely to have been limited thus far too.

The challenging macro-financial environment is a key barrier to the development of Tunisia's green finance market. Tunisia's macroeconomic crisis and debt sustainability concerns have limited the country's access to international capital markets. This has increased concerns of capital outflows, which have further limited the convertibility of the local currency. As a result, local players have been hindered from accessing (concessional) funding from development banks. New foreign investment has also been stifled due to high-risk perceptions relative to other destinations. Tunisia's bank-dominated financial sector is highly exposed to the state, making it vulnerable to debt repayments. Capital markets (debt and equity) are small and shallow, restricting diversification of funding and access to long-term finance. Institutional investors are few, pension funds have debts (instead of reserves to invest), and there is virtually no life insurance. The small private equity market is dominated by the subsidiaries of commercial banks, and there is a lack of financial instruments for risk management, with an underdeveloped insurance sector. Equity capitalization is relatively small: Tunisia's stock market provided 9.1 percent of corporate financing in 2019, and financial institutions still dominate market capitalization with a share of 42.3 percent, according to the Financial Market Council annual report. These issues, both conjunctural and structural, will probably not be solved in the short term. While access to financing remains limited and expensive for both the public and private sector, it may be necessary to increase the availability of concessional and grant funding for priority sectors.

Tunisia's public and private sectors have developed limited instruments to unleash green finance and there is a lack of eligible, bankable projects. Tunisia lacks a national climate finance strategy to accurately measure its climate investment needs and provide the market with certainty around regulatory changes. Both the state and businesses have failed to develop a substantial pipeline of bankable projects that can meet investors' financing requirements. The absence of a national sustainable taxonomy in Tunisia adds to the challenge because potential investors are

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[181] The ESG Reporting Guide covers the principles of the Sustainable Stock Exchanges Initiative of the United Nations and the usefulness of the corporate social responsibility approach and ESG reporting. It also provides practical recommendations for their implementation. The guide is based on the Global Reporting Initiative standard, the recommendations of the World Federation of Exchanges, the SDGs, and its national version, the National Governance Framework.

[182] The sustainable debt monitor is based on Bloomberg data and covers 141 emerging and frontier markets. ESG- or sustainability-linked financing typically refers to the use of financing instruments tied to the sustainability performance of the issuer, such as sustainability-linked loans and sustainability-linked bonds, including green bonds.

[183] These figures only include the issuances captured by Bloomberg data. The actual level of green financing might be higher. Measuring the value of green finance remains a common challenge, as the absence of consistent standards or certifications makes it difficult to establish the global "ESG" asset size, with estimations ranging from US$3 trillion (J.P. Morgan 2019) to US$35 trillion (Global Sustainable Investment Alliance 2020).

[184] Initiatives include the Sustainable Use of Natural Resources and Energy Finance (SUNREF) project, supported by the French Development Agency, which is enabling the development of a green loan offering by commercial banks. While this is still nascent (18 projects financed so far), it is a positive first step towards developing the green loan market.

unable to incorporate sustainable principles into their capital allocation processes. As a result, projects are not being promoted as "green" with investors.[185] Moreover, there are few financial instruments and mechanisms in place to lower Tunisia's investment risks, and no government-sponsored financing schemes to support the investment risk linked to financing the green transition.

It would be useful and relevant to explore the real potential of compliance and voluntary carbon markets in Tunisia and identify the preconditions that would enable sound, structured, and sustainable growth of such markets. Key barriers that limit their development include the lack of a proper system to monitor and evaluate mitigation and adaptation actions carried out at the national and sectoral levels; challenges linked to ensuring environmental, financial, and markets' integrity; and the inherent pricing complexity of voluntary carbon markets. The capacity of banks requires development to scale up bond issuances in general, and green bonds in particular.[186] These factors compound the already high-risk perception of green investments to further constrain private sector climate and green financing. [187]

Addressing these issues requires concerted and decisive efforts by both the government and the financial sector. These efforts should ideally focus on the following objectives:

- Develop a national sustainable finance strategy, coordinating policies, and regulations for sustainable finance goals
- Deepen skills and local capacity to support efforts to meet domestic climate goals and scale up sustainable finance
- Develop a national sustainable taxonomy classification of economic activities that can be considered environmentally sustainable to support transparency and disclosure in reports
- Introduce and test new green finance instruments
- Create an enabling platform to aggregate projects into bankable portfolios and provide technical assistance to project owners
- Increase access to concessional and grant fundings for priority sectors
- Channel resources from multilateral development banks and international financial institutions through, for example, concessional finance, credit guarantees, securitized products, hedging, or risk-sharing arrangements
- De-risk investment through well-established and stable legal and regulatory frameworks for adaptation and decarbonization investments.

4.2.4. The role of the private sector

Besides providing financing, the private sector is crucial for developing the required technologies and skills to implement climate action. This highlights the need to tackle constraints blocking its potential. The private sector could be instrumental in making production processes more climate-friendly; developing and maintaining activities that are resilient to new climate conditions (see Chapter 3); and developing the skills and inputs needed for the transition to a more sustainable path. Yet, despite many strengths—an educated and trained workforce, investment in high-quality infrastructure, and Tunisia's strategic location—the country's private sector appears to lack dynamism. Since 2011, investment and company entry rates have fallen, while foreign direct investment and productivity growth declined and companies became less export-oriented. As noted in the forthcoming Country Private Sector Diagnosis, the presence of regulatory distortions, widespread state presence, and protected domestic markets are key contributors to lacklustre performance of the private sector.[188] These factors are further compounded by political and macroeconomic uncertainty that together discourage foreign direct investment at the needed levels, underscoring the importance of blended finance and guarantee instruments to crowd in this important source of capital.

Steep restrictions to investments and competition need to be addressed to revitalize the private sector and unleash the climate transition. Tunisia attempted several economy-wide reforms in recent years, including reducing barriers

[185] For Tunisian potential issuers, this implies relatively higher costs for launching green bonds, given that non harmonized reporting and external review requirements are more complicated and expensive (BIS 2021).
[186] The Tunisian Central Bank is part of an initiative on "Capacity building and development of a roadmap for the use of green bonds in Tunisia", in collaboration with ANME and GIZ.
[187] Uncertainty about future climate policies, technological costs (with lack of track records for new technologies), high transaction costs, long payback periods for green investments, and high upfront costs often result in insufficient returns for existing risks, which increases the real and perceived risks of green projects overall.
[188] World Bank Group (Forthcoming).

to foreign investment, simplifying business registration, reducing subsidies, and signing performance contracts with state-owned enterprise. However, SOEs still often compete against private companies from an advantaged position.[189] This is especially the case for infrastructure sectors, which are important for the climate transition. While competition in typical infrastructure sectors is limited by high fixed costs and other natural entry barriers, Tunisian regulations make it difficult for energy, transport, and communications companies to enter market segments where competition would be viable. Entry is further hampered by excessive technical requirements, direct restrictions on investment, and regulations for interconnectivity and access to infrastructure. Conditions for new entrants are made more difficult by the absence of tariff regulations in upstream markets. In the energy sector, access to infrastructure by third-party operators is not legally guaranteed, and there is no requirement to unbundle production, infrastructure, and retail. Beyond infrastructure, other restrictions block the emergence of a more vibrant private sector. Import tariffs and non-tariff barriers stifle competition in domestic markets, while interest-rate caps and heavy dependence on collateral reduce access to finance for small businesses, women, and youth. The intent of many regulations—such as those supporting SOE participation in commercial activities, administered prices, and command-and-control measures—is to promote greater equity and protect the population's welfare. In some ways, these goals have been achieved. However, these measures are often second- or third-best responses. By implementing policies that do a better job of targeting the problems that they aim to resolve, it would be possible to preserve welfare without repressing private activity.

Decarbonizing key export sectors and integrating them into green value chains would be important for ensuring future international competitiveness.[190] Tunisia possesses pockets of competitive export industries that can be integrated into green value chains. An analysis of Tunisia's competitive strengths associated with products in green value chains highlights, for example, that the electronics sector is well poised to tap into these drivers of growth. Understanding the area in which each extensively traded industry and sector is carbon-competitive is critical for tapping into opportunities stemming from the global decarbonization agenda. Lowering the carbon content of such export sectors would ensure future competitiveness in the global trading system. Tunisia could turn the implementation of the European Union's CBAM into an opportunity to expand its exports.[191]

The new PPP framework could help the private sector partner with the state to develop the infrastructure needed for the climate transition. Given the limited financial viability of SOEs, private sector involvement is likely to be crucial for filling the investment gap in the utility sectors. Recent developments in Tunisia's PPP framework, coupled with the fact that the NDC has indicated that a large share of climate investment should be directed to the energy sector,[192] suggests that the country is open to greater private sector participation in the energy transition. This would require a more open market with flexible arrangements for the sale of electricity and ancillary services between public and private actors. This also applies to the water sector, where PPPs could help secure non-conventional water resources. This is reflected in Tunisia's PPP project pipeline, which includes several desalination and wastewater treatment plants. The private sector investment potential in the water sector is estimated at between US$2.9 billion and US$3.4billion. [193] Most of this will probably be used to develop large-scale desalination plants for the agriculture sector.[194] Public sector and international financing could be leveraged in blended finance approaches, such as through guarantees with subsidies, to encourage further private sector participation.

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[189] This is despite some recent positive steps towards improved transparency and governance, and benefit from support that is not available to private competitors (such as state aid, preferential treatment, or restrictive entry regulations for new entrants).

[190] The Green Value Chain Explorer referenced above assesses countries' competitive strengths and potential opportunities in products associated with the solar, wind, and electric vehicles value chain. For more information, consult Mealyl and Rosenow (forthcoming).

[191] While the commodities under the proposed CBAM coverage comprise less than 2 percent of Tunisia's exports to the European Union, decarbonizing production could help Tunisia expand its range of exports to the region.

[192] In the case of the updated NDC, 82 percent of climate investment should go to the energy sector, of which 40 percent would be needed for energy efficiency measures, 30 percent for renewable energies, and 11.5 percent for strengthening the electrical infrastructure.

[193] United Nations Development Program 2020.

[194] United Nations Development Program 2020.

4.3. Financial Stability in the Face of Climate Risks

While a shift toward decarbonization policies and investments is likely to yield benefits in the long term, there are financial stability risks during the transition process. These risks fall into two broad categories: physical risks (stemming from the impacts of climate change) and transition risks (financial risks resulting from the decarbonization transition). For the financial sector, transition risks could materialize through various channels. For instance, the global shift away from a carbon-based economy raises the risk of stranded assets. The significant exposure of Tunisia's financial sector to the public sector, along with high macro-financial risks and elevated financial sector vulnerabilities, exacerbates the potential impact of extreme climate events for the financial system.

Almost a fifth of lending in Tunisia is concentrated in areas with high flood risks, although the impact of flood damages on the banking sector is expected to be low. Although more than 40 percent of credit exposures are concentrated in Tunis, which has a relatively low flood risk, about 18 percent is located in the six governorates with the highest flood risk.[195] Of the six governorates with the highest flood risk based on modeled damage ratio (Manouba, Jendouba, Beja, Bizerte, Ariana, and Medenine), Ariana has the highest concentration of lending exposures (12 percent of total end-2021 exposures), while lending exposures in the other governorates is lower (between 0.2 percent and 2.7 percent). A micro-level banking-sector vulnerability assessment indicates that the impact of direct damages due to floods on the banking sector are likely to be relatively modest. Across the banks modeled, the impact of a 1-in-100-year flood in all governorates on non-performing loans is relatively small (increases of less than 0.3 percentage points, though with substantial variability between banks), as is the estimated bank-level capital adequacy rating impact (decreases of less than 0.15 percentage points). [196]

Coastal flood and erosion risks may be transmitted to the financial sector via several channels, including via the impacts on tourism in coastal areas. Based on data from Banque Centrale de Tunisie (BCT, Central Bank of Tunisia), in 2021 about 85 percent of productive lending was located in coastal governorates. Loans to the tourism sector (accommodation and food services) constituted approximately 6 percent of total productive lending in Tunisia and were also concentrated in coastal governorates (95 percent of tourism sector loans). For some banks, this percentage was as high as 13 percent. Not all exposures in coastal governorates were in areas that are likely to be directly impacted by coastal flooding and erosion. Nonetheless, the initial analysis of banking sector exposures indicates potential for considerable risk from coastal flooding and erosion.

The portfolio of Tunisian banks includes multiple sectors that could be directly or indirectly exposed to drought and water scarcity risks, although the severity of potential impacts may be relatively modest for agricultural lending. This is due to the low proportion of lending to agriculture, which is one of the sectors most directly at risk from drought. Based on data from the BCT, agricultural loans constituted about 3 percent of productive lending in 2021, with no bank exposed to more than 8 percent. However, banks may also be affected by droughts and water scarcity directly through other water-intensive sectors and indirectly through effects on the economy.

Banks' exposure to transition-sensitive sectors is potentially material in Tunisia, representing 38 percent of total lending. Transition-sensitive sectors (industries that are large carbon dioxide emitters relative to their production, that is, they have high emission intensity) [197] include electricity, transport, and utilities, while manufacturing, agriculture, and mining and quarrying are regarded as moderately transition sensitive. The manufacturing sector accounts for the bulk of exposure (35 percent), while exposure to highly transition-sensitive sectors is limited (4 percent). Exposure to the electricity sector—which may be the most transition-sensitive of all the sectors considered—is negligible, at 0.3 percent. Consistent with these figures, individual banks' exposure to transition-sensitive sectors ranges from 32 percent to 52 percent. Some banks are more exposed to certain transition-sensitive sectors, which could be a source of risk should transition policies target a particular sector.

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[195] Data from the Central Bank of Tunisia indicates that more than 42 percent of lending exposures (end-2021) for which location is reported are in Tunis. However, this could be partly due to lending companies being headquartered in Tunis, while production facilities may be located across the country.

[196] While these initial modeled estimates may be seen as non-material, it is important to note that the analysis relies on substantial assumptions and does not consider flood impacts beyond the direct damages modeled using a flood catastrophe risk model.

[197] Sectoral GHG emission intensity data is extracted from the World Bank's Prototype Emissions Intensity and Trade Exposure Country Comparison Tool, which uses 2014 Global Trade Analysis Project emissions and production data.

The potential impact of climate-related physical and transition risks on the Tunisian banking system calls for a solid regulatory and supervisory framework. The Central Bank of Tunisia could conduct a more granular assessment of the financial sector's exposure to climate risk than what is offered here to raise awareness and build capacity, both internally and within the financial sector. This assessment would inform dialogue between stakeholders and support the improvement of risk-management practices, with the objective of integrating climate-related financial risks into the supervisory framework in the longer term. This work could be considered in the broader context of the multiple challenges faced by the financial sector, also noting the potential for climate-related risks to compound other risks to which the banking sector is highly vulnerable.

4.4. Empowering and Protecting People in the Climate Transition

Preparing people for the jobs needed to realize a green economy and building people's resilience to new climate realities will be of paramount importance in future. Alongside educational reforms, strong health and social protection systems are critical cross-cutting priorities for the adaptive capacity of Tunisia's people. Ultimately, the well-being, livelihoods, and aspirations of individuals and communities are at stake.

Emergency preparedness, including prepared health systems, helps maintain access to basic services while minimizing the negative impacts of quick-onset climate shocks. Tunisia's emergency financing, management policies, and health response systems to climate stress were all ranked as "developing" in a joint 2023 analysis by the GoT and the World Bank.[198] While the national budget has a line item for "unforeseen and unallocated expenditures", to which about 1.6 percent of annual expenditure is allocated, health is not explicitly mentioned and the processes for determining and allocating these funds at the sectoral level are not clarified. The Ministry of Health also faces substantial constraints in terms of epidemiological surveillance and early warning systems. Public financial management and procurement policy bottlenecks at the Ministry of Health further restrict a rapid response to climate disasters. Even though the Ministry of Health has agreements with 14 other ministries within the International Health Regulations framework, the focal points of these ministries have no decision-making power. Collaboration is largely for monitoring, and the multitude of decision-makers across different functions without the presence of coordination mechanisms has hindered effective and timely decision-making. Health system preparedness would build resilience to the direct and indirect health risks of climate change.[199]

Developing appropriate skills is another imperative. Having the right skills and capacity across skill levels could contribute the success of the climate transition itself. This starts with integrating climate change education into the national curriculum and raising public awareness about climate change to empower individuals to make informed decisions, act, and foster a culture of resilience and sustainable development. Without concerted effort across education and training institutions—which would benefit from being closely linked to private sector demand—Tunisia will not have a qualified workforce to do the jobs its climate goals require. The GoT has made important strides in buildings its research and development capacity and has committed to prioritizing investment in human capital for green jobs, including through a proposed Center of Excellence for Renewable Energy, which is envisioned as a hub for training and skills development for the African continent that meets international quality standards.[200] To further support evidence-based climate change solutions through research and development, Tunisia could scale activities such as climate modeling and forecasting, studying the impacts of climate change on vulnerable sectors like agriculture and coastal areas, developing climate-resilient technologies and practices, exploring renewable energy options, and assessing the effectiveness of climate change mitigation and adaptation strategies.[201]

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[198] World Bank (Forthcoming). The "Tunisia Pandemic Preparedness Assessment" methodology looks at 99 indicators of health system preparedness and ranks them on a four-tier scale as "beginning", "developing", "emerging", or "mature".

[199] Flooding can impact human health directly through drowning or traumatic injuries and ecological health risks due to increases in vector- or water-borne diseases, and indirectly by affecting mental health, access to nutrition, and food security. These disasters can directly affect the health system's ability to respond to the existing disease burden by damaging health infrastructure.

[200] In 2022, Tunisia was ranked 12th out of a total of 132 countries in terms of quality scientific production and placed 5th globally in terms of graduates in STEM. Tunisia's research capacity on climate change is reflected in the establishment of dedicated research centers and laboratories, collaborations with international institutions, and the engagement of universities in climate-related studies. Chapter 3 (Boxes 6, 8, and 9) outline remaining skills gaps for the transition.

[201] Such research and development is already taking place at the National Center for Research in Materials Sciences, the Biotechnology Center of Sfax, and three centers of Borj Cedria (Centre for Research and Water Technologies, Center for Energy Research and Technologies, Biotechnology Center), to name a few. Scaling support to such research centers will be important in the short and long term.

The measures discussed above could play a crucial role in mitigating distributional impacts. However, it is imperative to prioritize vulnerable groups and women. Strengthening social protection systems and ensuring equitable access to resources, health systems, and education could provide a strong foundation for those who are likely to be most affected by climate change. Policies that prioritize these vulnerable populations and provide targeted support to regions and groups facing the greatest climate risks are needed. This includes recognizing and addressing the gender-specific impacts of climate change and promoting gender equality by ensuring women's participation in decision-making processes and providing equal access to resources and opportunities.

Finally, transparency for non-state actors can help realize the "whole of society" paradigm for climate action. This could entail: (i) organizing iterative outreach campaigns on climate change tailored towards the information needs of respective stakeholders, including vulnerable groups; (ii) setting up a resourced, national-level multistakeholder network to collaborate on climate change policy planning and monitor climate change commitments, targets, and financing; and (iii) providing support for program investments and technical assistance for community-based interventions for climate change mitigation and adaptation.

5. Summary of Solutions

Tunisia is a country with tight fiscal space, numerous development gaps, and jarring climate impacts. This report identifies the costs of inaction while highlighting the huge potential benefits of addressing climate impacts and decarbonizing the economy. Tackling climate challenges will decrease the costs for the economy, resulting in massive economic gains and enabling Tunisia to achieve its development goals. The recommendations highlighted would allow the country to focus its public expenditure on investments with high economic and social returns while leveraging the private sector for additional investments, so creating jobs and increasing fiscal space. As an example, a profound structural transformation of the energy sector is expected to have significant additional benefits in terms of new jobs relating to the clean energy value chain while spurring innovation and entrepreneurship and opening new export opportunities. Achieving the goals of this report would allow for the more sustainable use of water, land, and energy resources, while reducing wastage and leveraging Tunisia's large renewable resource potential.

In light of Tunisia's current macro-financial constraints, the CCDR also proposes a condensed package of urgent actions that are affordable while delivering high impacts in the near term. The package is built around two key, urgent objectives for the Tunisian economy: addressing water shortages and transitioning the energy sector from fossil fuels to renewables. Because Tunisia cannot currently expand its debt, the country would also need to urgently pursue a third objective: creating the right macro-financial conditions for public and private investments to fund these objectives (Figure 37).

Figure 37: Recommended high-impact actions with near-term benefits for a green, resilient, and inclusive transition

Table 12 summarizes all actions identified in this report, creating a roadmap to sustainable development while rationally managing climate change-related physical, transitional, and financial risks. This Country Climate and Development Report presents three key objectives to pursue and describes an enabling macroeconomic and institutional framework. Each objective is underpinned by engagement dimensions that, if pursued, could support the country in shifting onto a climate-resilient development pathway. To highlight the impact and feasibility of the identified recommendations, they were assessed along six dimensions.[202] The ones in bold are considered high-impact actions that could be pursued in each of these objectives in the short-term.

Table 12: Recommendations for a green, resilient, and inclusive transition

Recommendations	○	○	○
Development impact (DI)	Very high	High	Moderate
Climate benefits (CB)	Very high	High	Moderate
Financial feasibility (FF)	Affordable	Moderate	Costly
Political economy (PE)	No/little resistance	Moderate	High resistance
Readiness (RE)	Very high	High	Moderate
Urgency (UR)	Very high	High	Moderate

Recommendations	DI	CB	FF	PE	RE	UR
1. Address water scarcity						
1.1. Increase water supply and enhance water management						
Control water demand through pricing (tariff review and enforcement) and metering method.	○	○	○	○	○	○
Modernize, rehabilitate, and extend water networks to reduce water losses and waste, and improve network monitoring and management through digitalization of the water sector.	○	○	○	○	○	○
Expand and improve the quality of the supply and distribution of non-conventional water sources such as treated wastewater and desalination, including through the promotion of PPPs.	○	○	○	○	○	○
Protect water (including groundwater) against misuse and agricultural pollution, including by establishing safeguard zones and by revising, approving, and implementing the new Water Code.	○	○	○	○	○	○
Improve water management by developing action (contingency) plans during drought period and by carrying out a water withdrawal inventory.	○	○	○	○	○	○
1.2. Increase the resilience and efficiency of the agricultural sector and leverage nature-based solutions						
Incentivize (for example through subsidies and tax incentives) and invest in protection and rehabilitation of ecosystems, especially watersheds, oasis ecosystems, forests, and wetlands.[203] Implement widespread sustainable land-use planning, water management practices,[204] and agroforestry.	○	○	○	○	○	○
Develop and promote[205] usage of, and research in, climate smart agriculture and animal husbandry, including innovative irrigation technologies[206] and agricultural drainage (notably oases).	○	○	○	○	○	○
Fight against food loss and waste all along agriculture, fisheries, and livestock value chain segments, including at distribution and consumer stages.	○	○	○	○	○	○

[202] The assessment was based on professional analysis by team members.
[203] For instance, establishing forest belts can protect dams from siltation and enable the recharge of aquifers, and incentivizing afforestation and reforestation through subsidies and tax incentives can increase surface water and foster carbon sinks.
[204] Including soil and water conservation techniques (such as contour farming, terracing, and mulching), the use of native species, and so on (see Chapter 3).
[205] This includes raising farmers' awareness of water scarcity and training them in new irrigation practices.
[206] Examples include irrigator helplines for irrigation management to enhance irrigation efficiency.

2. Enhance the resilience of urban and coastal areas						
2.1. Defend coastal zones against sea-level rise and flooding						
Prepare and implement participatory integrated coastal zone management plans and protect coastlines through soft (for example, beach nourishment or installation of ganivelle fencing)[207] and nature-based defense solutions.	○	○	○	○	○	○
Freeze construction in affected natural space/urbanized areas and, if needed, protect urbanized areas through additional sustainable hard defense solutions (breakwaters).[208]	○	○	○	○	○	○
Preserve ecosystem services in coastal areas by developing a sustainable coastal tourism and diversified tourism offering	○	○	○	○	○	○
2.2. Protect people and infrastructure						
Transfer governance of disaster risk management to municipalities and identify infrastructure of critical importance (such as schools and hospitals) for retrofitting or upgrades.[209]	○	○	○	○	○	○
Develop asset-management systems and plans for essential infrastructure that incorporate climate risks and optimize operations and maintenance lifecycle costs.	○	○	○	○	○	○
2.3. Enhance social protection and develop risk-based insurance themes						
Further advance disaster risk financing (DRF), including: capacity building, formalizing a DRF strategy, implementing a public fi-nance mechanism,[210] and expanding the scope of financial protec-tion by enabling the local private insurance sector to supply cov-erage (including index insurance).	○	○	○	○	○	○
Strengthen targeting arrangements for ensuring improved access to financial risk protection and ensure linkages between social registry and insurance eligibility. Maintain enough emergency contingency resources to quickly respond to climate-related shocks.	○	○	○	○	○	○
Strengthen early warning systems and conduct a functional re-view of coordination mechanisms for emergencies to prepare an emergency preparedness and response plan[211] and streamline emergency response.[212]	○	○	○	○	○	○
3. Decarbonize the energy sector						
3.1. Decarbonize demand in the end-use sectors						
All sectors: Enforce the existing legal framework for energy efficiency/conservation[213] and implement energy conservation/efficiency programs with demonstrable effects (for example, in public buildings, public lighting, and public transport). Encourage the use of renewable energy in all sectors (for example, solar pumping in agriculture).	○	○	○	○	○	○
Transport: Promote alternatives to road and private vehicle transport and reduce congestion. Enforce emission standards, retire aged fleet, and establish incentives and infrastructure for electric vehicles.[214]	○	○	○	○	○	○

[207] Beach nourishment is the addition of sand and sediment. Ganivelles are wooden fences installed to preserve dunes.
[208] Hard defense measures need to be sustainable coastal protection investments that do not cause further coastal erosion elsewhere.
[209] This requires adequate human, financial, and operational resources.
[210] The design and operationalization modalities of the potential public mechanism are to be defined as part of the DRF strategy. As part of a dual public/private approach, the public mechanism would complement the private natural catastrophe insurance regime to support financial protection against disasters and climate-related shocks, including for poor and vulnerable populations.
[211] The plan should define a set of actions to be taken in different crisis situations, from flooding to drought to health emergencies.
[212] A functional review can identify potential duplication in effort and help improve coordination across different emergency response functions.
[213] Examples include the issuance of minimum energy performance standards and a compulsory energy labeling system for appliances or building codes.
[214] Develop regulations, standards, incentives, and infrastructure to develop the electric vehicles market, with a focus on the public transport fleet.

Industry: Enforce and scale up energy audits, energy manage-ment programs, and energy certification for energy intensive sec-tors, accompanied by capacity building and financing mecha-nisms (including the Energy Transition Fund). Pilot the use of innovative decarbonization technologies (for example, green hy-drogen or sustainable bioenergy) and accelerate the self-generation and cogeneration program.	○	○	○	○	○	○
Buildings: Scale up the Prosol Elec and Prosol thermique (rooftop solar PV and solar water heating) and the appliance replacement and retrofitting programs.	○	○	○	○	○	○
3.2. Decarbonize electricity generation						
Enhance coordination and streamline the develop-ment of renewable energy, including coordinating approvals at the Council of Ministers level, limiting the number of authorizations required, establishing clear procedures for land access, securing financing and guarantees for better risk-sharing, and restoring the financial viability of the sector.	○	○	○	○	○	○
Develop adequate technical and market conditions to promote flexibility services to facilitate renewable energy integration, including storage, demand-side response, regional electricity market integration, and transmission network reinforcement where required.	○	○	○	○	○	○
Prepare a roadmap for green hydrogen and set up an intersectoral Green Hydrogen Council for its implementation.	○	○	○	○	○	○
Invest in and promote traceability-testing-certification systems, including green hydrogen and electricity for exports.[215]	○	○	○	○	○	○
Adopt a whole-system approach for planning and operating the electricity system, including sector integration and coupling.[216]	○	○	○	○	○	○
4. Build macroeconomic, financial, and human capital						
4.1. Enhance human capital						
Expand skilling, re-skilling and up-skilling short-term programs, apprenticeship, and on-the-job training, especially on the energy transition.[217]	○	○	○	○	○	○
At the higher education and vocational training level, expand cli-mate-related programs (renewable energy, water resource man-agement, and so on). Involve industries in the development of the curricula to ensure relevance and quality, raise awareness about climate change and green practices in the national curricu-lum, and train teachers and educators.	○	○	○	○	○	○
Strengthen the capacity of primary-level health facilities, given their role in local service delivery and the implementation of inte-grated surveillance systems and electronic medical records to improve climate responsiveness.	○	○	○	○	○	○

[215] The systems help to verify conformity with carbon-related requirements of buyers in overseas markets.
[216] Sector integration refers to coordination between electricity and gas systems, while sector coupling refers to linking of energy supply and energy demand. Integrating these considerations in planning and policies could enable end-use sectors to contribute to electricity system flexibility to integrate intermittent renewable energy.
[217] Programs can leverage existing training centers and platforms, notably the inter-enterprises training center hosted by UTICA or the Alliance of Communities for Energy Transition.

4.2. Improve institutions and engagement						
Establish an intersectoral National Climate Council[218] chaired by the head of government and adopt climate change legislation to cover existing gaps.	○	○	○	○	○	○
Adopt climate indicators to measure adaptation progress for pub-lishing on the government's climate portal. Starting with SOEs, adopt international best practice on reporting and disclosure standards.[219]	○	○	○	○	○	○
Establish climate focal points and provide support for community-based program investments in municipalities.	○	○	○	○	○	○
Engage with affected stakeholders, including by organizing itera-tive outreach campaigns on climate change and establishing a national-level multistakeholder network on climate change public policy planning and monitoring.	○	○	○	○	○	○
4.3. Create the right macro-financial conditions for public and pri-vate investments						
Repurpose recurrent public expenditures (including expenditures on fuels and electricity) towards the most urgent public investments in adaptation while compensating vulnerable households. [220]	○	○	○	○	○	○
Leverage public mechanisms by including climate-related criteria to evaluate public investment projects, greening public procure-ment, adopting methodology to integrate climate indicators in program budgets, and launching a green taxonomy process.[221]	○	○	○	○	○	○
Enhance private sector entry for green activities, including eliminating prohibitive authorizations, sec-toral specifications (cahier de charges), capital out-flow restrictions and non-tariff barriers; simplifying investment authorizations,[222] especially around clean energy; and reducing the regulatory power of sectoral incumbent.	○	○	○	○	○	○
Prepare financial institutions by assessing the sector's exposure to climate risk through the Central Bank of Tunisia and build ca-pacity to diversify funding sources.[223]	○	○	○	○	○	○
Create an enabling platform to accelerate procedures for climate investments and aggregate projects into bankable portfolios for concessional funds and blended finance, and provide climate finance offering for vulnerable groups.[224]	○	○	○	○	○	○
Increase and integrate private participation, including by develop-ing a PPP framework (water, energy, waste) and a regulatory framework for adopting new technologies and the commercializa-tion of related products.[225] Incentivize green certification.	○	○	○	○	○	○

[218] This has been proposed as part of the draft Environmental Code, submitted to the Office of the Prime Minister for review on August 2023 ,3.
[219] Sustainability standards for SOE operations and climate-related disclosure in their annual reports could, for example, be implemented through a pilot with STEG. The adoption would serve as an example for businesses.
[220] This includes compensating vulnerable households and businesses in conjunction with efforts to consult with consumer groups to adopt a systematic and socially inclusive approach.
[221] Develop a national green taxonomy classification of economic activities with inputs from civil society, academia, and other stakeholders.
[222] It is important to respect environmental regulations in the process.
[223] This includes aligning and coordinating various financial policies and incentives with sustainable development or climate goals by creating a taskforce on sustainable finance; developing a national sustainable finance strategy or roadmap aligned with national climate targets; developing skills and local capacity to meet domestic climate goals; and scaling up sustainable finance. The sector could also test and build capacity on new green finance instruments (through risk-sharing mechanisms, securitized products, and compliance with voluntary carbon offsetting mechanisms to de-risk and incentivize private sector participation).
[224] Possible interventions for vulnerable groups include micro-credits and targeted subsidies.
[225] For instance, to reduce water, land, and energy resources usage, Tunisia could produce animal proteins such as bacterial or fungi fermentation and allow for their commercialization.

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