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Climate Change in the Middle East and North Africa: Mitigating Vulnerabilities and Designing Effective Policies

Joy Arkeh and Amr Hamzawy, editors

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This publication can be downloaded at no cost at CarnegieEndowment.org.

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Introduction

Joy Arkeh and Amr Hamzawy

Policy awareness about the challenges of climate change in the Middle East and North Africa (MENA) region has been on the rise, especially with Egypt hosting the 27th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP27) in 2022 and the United Arab Emirates (UAE) hosting COP28 in 2023. The previously dominant narrative in MENA public and political spaces—that addressing climate change is a luxury that cannot be attended to in countries facing constant turmoil—has receded. The devastating impacts of climate change, ranging from high temperatures and extreme weather events in the Middle East to declining water resources and eroded coastal land in North Africa, have imposed their urgency on both citizenries and polities.

Equally emerging as urgent policy priorities have been the correlations of climate change, societal vulnerabilities, and governance deficits. Research has shown that in order to devise climate adaptation strategies that can facilitate equitable political power sharing among relevant stakeholders and address the socioeconomic struggles of vulnerable populations, climate governance must be approached from a political economy perspective, which may pose a problem for MENA countries.

In countries facing long-standing socioeconomic crises—poverty, unemployment, high inflation rates, population growth, and widening gaps between rich and poor population segments as well as between urban and rural localities—the impacts of climate change have exacerbated societal vulnerabilities. The weak, the needy, the unprotected, and the marginalized in the MENA region all have been greatly affected. According to the World Bank report on the impacts of climate change on poverty, poor and socioeconomically disadvantaged population segments are mostly at risk should governments fail to adequately tackle climate mitigation and adaptation.

Meanwhile, chronic governance deficits have made it difficult for MENA countries to mitigate and adapt to the impacts of climate change. These deficits include the persistence of undemocratic policymaking processes; the systematic exclusion of wide segments of MENA populations in favor of consolidating power and influence in the hands of the ruling establishments; the lack of transparency and accountability in resource and financial allocation matters and in policy implementation; and the restrictive nature of public spaces, which undermines the free flow of information and freedoms of expression and associations. Moreover, climate-change-induced societal vulnerabilities have also aggravated governance deficits in the region.

Several key questions have driven the research work that led to this series on climate, vulnerability, and governance:

How has poor governance in MENA countries contributed to a lack of inclusivity and action, as well as structural deficiencies in countries' declared commitments such as those related to resilient infrastructure, economic opportunity, and human security?

What are the most significant short-term and long-term impacts of climate change at both institutional and individual levels that allow for an exploration of the relationships between climatic hazards, slow-onset hazards, governance, and vulnerability? Which are preexisting and therefore exacerbated by climate change, and which are new vulnerabilities that are a direct result of climate change and poor governance?

What is the role of civil society in driving climate change action at the country and regional levels? How does the lack of engagement between governments and civil society actors in MENA limit climate adaptation efforts and undermine the representation of vulnerable communities, specifically women, minorities, and low-income individuals, in policymaking processes?

How do different risks, climatic and nonclimatic, that MENA governments face impact governance models? How do governance and climate change impact each other?

How do preexisting vulnerabilities—particularly poverty, water and food insecurity, and health issues—exacerbate climatic effects on vulnerable societal groups? Are governments considering vulnerable societal groups in their climate policies, and to what extent are these policies effective? How do government policies decrease or increase vulnerability? How do governance deficits, intensified by climatic hazards, create new vulnerabilities?

How do different political and economic governance models in the region inform countries' climate policies, especially in regard to sustainable resource sharing?

This series seeks to engage ongoing popular and policy debates addressing the correlations of climate change, vulnerability, and governance in the MENA region. The contributions were written by regional and international scholars, and their findings are based on empirical research conducted mostly in 2023.

Traditionally, the map of vulnerable population segments in the MENA region has included poor and impoverished communities; religious and ethnic minorities; members of rural, coastal, and urban populations, especially women and children; and migrant communities. In a first methodological step to examine the impacts of climate change on vulnerability, the collected pieces disaggregate preexisting vulnerabilities related to poverty, gender inequality, deteriorating public health and educational services, lack of social safety networks, and oppressive political conditions. The second methodological step analytically links the relationship between climate change and preexisting vulnerabilities to newly created vulnerabilities such as water scarcity, desertification, and the decline of farmer communities. As framed in this collection, these two methodological steps yield an updated and realistic map of vulnerable communities in the MENA region. Through this process, the authors' research benefits the poor, the marginalized, and the underrepresented by giving voice to their legitimate concerns in order to seek an end to poverty and discrimination.

Contributors also analyzed the impacts of climate change on governance. State capacities may vary radically across the MENA region, but governance challenges remain almost identical. Eradicating poverty, improving the quality of key services, addressing gender inequality, ending human rights violations, empowering underrepresented population segments, and getting rulers and governments to abide by the principles of the rule of law during a climate transition are key governance challenges that unite countries such as Jordan, Libya, Morocco, Oman, Tunisia, and Egypt. The authors of the different contributions shed light on how climate change, on the one hand, has given social and political urgency to these governance challenges and how, on the other hand, it brings to the fore new challenges such as the loss of costal resources, rising water scarcity and food insecurity, and the widened map of societal vulnerability.

The research design, questions, and outcomes of these pieces have been undoubtably enriched by engagement with vulnerable communities in the region. The authors' knowledge, awareness, and activism all helped guide the research and ensured that it supports local empowerment and inclusion.

Country-Specific Realities

In his piece on climate adaptation plans in the region, Saber Osman primarily characterizes the MENA region's vulnerability to climate change as an economic loss: Dust storms alone have cost the region $13 billion annually. The MENA region is particularly dependent on climate-sensitive agriculture for food security and livelihood, yet it is one of the world's most water-scarce and drought-prone regions. Such conditions have already enabled instances of social unrest that could spin off to conflicts. The excessive urbanization of economically vital coastal areas in cities like Alexandria, Abu Dhabi, Doha, Dubai, and Benghazi, and the largely costal countries of Tunisia and Morocco, increasingly is threatened by sea level rises and flooding that have aggravated infrastructure crucial to economic development,

transportation, and tourism. Osman further points to women and youth as one of the most marginalized groups as a result of preexisting social disparities and forced migration in the form of men seeking employment in urban areas and consequently abandoning their households.

Osman outlines the institutional, legislative, and policy deficits of Egypt, Jordan, Morocco, Tunisia, and the UAE in response to climate change based on their Nationally Determined Contribution and National Adaptation Plan reports. Climate change has revealed common threads linking the governance gaps, such as the lack of coordination mechanisms and methods for streamlining climate policies and plans between relevant national and local stakeholders, sectors, and institutions; financial restraints; and technical insufficiencies in assessing climate risks. Because of insufficient technical expertise and political turmoil, Algeria, Iraq, Libya, Palestine, and Syria all struggle to consistently report climate goals and policy updates to the United Nations Framework Convention on Climate Change. An integrated approach to climate planning, consistent reporting via technical assistance, and (as Osman emphasizes) the mobilization of climate financing by the international community through partnerships with donors and the private sector are all necessary to build climate-resilient mitigation and adaptation systems across the region. Algeria, Egypt, and Morocco suffer from the largest climate financing gaps in North Africa; Osman also identifies Jordan and Tunisia as significantly weak in terms of climate financing.

In the second piece on the water crisis, Mohammed Mahmoud argues that a country's access to water and the specific type of water resources used, whether freshwater or nonconventional—such as desalination and water recycling—are crucial determinants of a country's ability to alleviate climate pressures and to adapt to climate change. Historically, the MENA region has relied on groundwater owing to its limited surface water systems. This is especially the case in the Arabian Peninsula and in the Gaza Strip in Palestine. As groundwater is a finite resource and demands for it have led to excessive pumping and extraction methods that are harmful to the environment, overreliance has heightened the MENA region's vulnerability to climate change.

The region's surface water systems—namely the Nile River, the Tigris-Euphrates River System, and the Jordan River—depend heavily on higher-elevation precipitation and snowpack, which continues to decrease as the earth's temperature rises. Because of this shortfall, some of the region's most fragile countries, including Sudan and Yemen, are receiving less water to supply their agricultural sectors, therefore intensifying preexisting vulnerabilities. Urban water use also is inhibited, further disadvantaging fragile countries that are experiencing the highest rates of urban population growth, namely Iraq, Palestine, Sudan, Syria, and Yemen.

According to Mahmoud, a large share of the region's climate governance challenges stems from unresolved transboundary conflicts, along with excessive groundwater depletion between riparian states that fail to collectively regulate shared groundwater aquifers. Mahmoud warns that competing water needs between riparian states in the MENA region have allowed for the monopolization of water flows, further underlining the urgency to

establish sustainable water management mechanisms at the regional level. Specifically, upstreaming by Türkiye has limited Iraq's water sources from Tigris-Euphrates River System, Ethiopia's construction of the Grand Ethiopian Renaissance Dam has strained Egypt's and Sudan's utilization of water from the Nile, and water supplies to Jordan via Lake Tiberias and the Dead Sea have significantly diminished in quantity. In all these cases, waterways have also worsened in quality owing to insufficient regulations on pollution, solid waste discharge, and irrigation runoff from nearby farms. Similarly, effective adaptation to climate change calls for reduced reliance on the energy-intensive process of desalination, mainly in the Gulf and through Libya's Great Man-Made River project.

Adopting a more localized perspective, Dina Zayed also homes in on the intersection of climate vulnerability and governance. In a journalistic piece on a major flooding that occurred in Alexandria in 2015, Zayed portrays how Egypt remains one of the world's most vulnerable countries to climate change. This can be demonstrated by its continued heavy exposure to floods, where a one-meter sea-level rise scenario is projected to affect 10 percent of Egypt's total population and to wipe out nearly 15 percent of its agricultural land. As a country with an agrarian economy and economic activity highly concentrated in coastal areas, which also ranks second in the world in terms of coastal populations affected, Egypt's population writ large is highly vulnerable to climate change.

Zayed strongly advocates for the mobilization of civil society groups in Egypt to facilitate government efforts to collect and track climate-related data. Currently, this approach is not a streamlined and developed part of climate adaptation plans in Egypt. She further argues that more participatory governance mechanisms, which both are inclusive of all relevant stakeholders and sectors and also win the approval of the public through transparent policies, are needed to achieve more effective and equitable climate protections. These sentiments are echoed in a draft for a new climate strategy. However, Egypt's legal restrictions on nongovernmental organizations (NGOs) will have negative implications for climate adaptation. In particular, NGOs have undertaken robust fundraising efforts, both locally and from abroad, that have proven to advance climate capacity-building mechanisms, but since 2017 these ambitions have been minimized in response to fears of surveillance and harassment. Zayed believes NGOs have the ability to inform more accurate and inclusive decisionmaking on climate change and to fortify government officials' understanding of climate risks facing Egypt. Thus, she argues that climate change has revealed deficits in policy decisionmaking stemming from a lack of accurate information, data, and input from subnational governments and municipalities and that NGOs can fill this gap if Egypt can depoliticize the roles of these organizations.

On another hand, Shada El-Sharif and Marwan Muasher point to the economic losses associated with climate change. El-Sharif and Muasher argue that Jordan's severe water scarcity problem has made the country's economic development highly vulnerable to climate change, particularly for older adults, migrants, and those living in poverty. Jordan's agriculture sector is likely to suffer further declines in economic productivity owing to reduced water availability, given that Jordan's per capita renewable freshwater resources

already fall well below the United Nations' severe water scarcity threshold of 500 cubic meters per year (m^3/year). The authors explain how water scarcity, exacerbated by climate change, has enabled forced rural to urban migration in the farming community and depleted water resources for subsistence farmers who depend on rainfed agriculture. On a national level, this is also concerning for the 53 percent of Jordanians already vulnerable to food insecurity.

In addition to rising operating costs in Jordan's tourism and water sector, mostly from electricity demands, Jordan's trade structure is also highly vulnerable to climate change. Its five largest export sectors—textiles, chemicals, fertilizers, pharmaceuticals, and rare minerals—either rely on intensive extractions of water and energy or are sensitive to water and energy tariffs. El-Sharif and Muasher emphasize that climate change, beyond worsening vulnerabilities in national economic terms, will have unfavorable impacts on traditionally vulnerable groups especially regarding health. Malnutrition is rampant in refugee camps in Jordan, particularly in the eastern Badia area, as increasing temperatures have given rise to water-, food- and vector-borne diseases. Asthma and lung diseases brought about by temperature rises and dust storms are also infecting refugees, consequently worsening their high vulnerability to socioeconomic and health challenges.

El-Sharif and Muasher use the Intergovernmental Panel on Climate Change (IPCC) climate adaptation frameworks to make the central argument that the most effective way a country can address climate-induced vulnerabilities is through strengthening its adaptive capacities. Their article calls for actors to mobilize toward sustainable development through a multilevel global governance framework that promotes multisectoral and multistakeholder involvement and collaboration between regional, municipal, and city-level governments and between the water, health, agriculture, and urban development sectors. Jordan has made strides in better aligning its executive and legislative branches on climate projects and policies and has prioritized multidisciplinary governance in climate-sensitive sectors by creating a Water-Energy-Food-Environment Nexus Council (though this has yet to be institutionalized).

However, El-Sharif and Muasher revert to the point that the state's focus on creating new policies is holding Jordan back from streamlining existing policies and realizing its optimal governance capacity. Moreover, regulatory obstacles at higher levels of government continue to stifle local empowerment toward climate resilience. Climate change has forced local farmers to give up their land: many have reported being ill-prepared for climate hazards like frost and drought owing to (what they consider to be) a lack of access to communication with national authorities and early-warning systems. As stressed by El-Sharif and Muasher, to safeguard economic livelihood at the micro level, more coordination between national local actors is needed. At the macro level, El-Sharif and Muasher reinforce that a "just economic transition" that ensures job opportunities in all climate-sensitive sectors while generating revenue for the state should be at the forefront of Jordan's climate strategy. To reach its emissions reduction target in particular, Jordan will have to attract more investments.

In a case study on Amman specifically, Reem Halaseh argues that a combination of burgeoning urbanization (rate of 97.2 percent) and aging infrastructure has meant that climate change significantly heightens preexisting social and economic vulnerabilities in Amman, Jordan—a city already suffering from a 24 percent unemployment rate and a continuous influx of refugees. Amman struggles with limited green spaces, which otherwise could help alleviate the city's rising heat island effect, and with strained water and electricity consumption that causes more frequent blackouts and vehicle inefficiencies.

In Amman, those disproportionately impacted by climate change include refugees living in overcrowded camps as well as lower-income groups with a comparable lack of access to sufficient resources and economic opportunities. Both groups are more exposed to heatwaves and outbreaks of vectorborne and airborne diseases. Al Qweismah, Abu Alanda, Al Jwaydah, and the western district of Wadi As Seer are particularly vulnerable. Droughts that further limit access to water also disproportionately affect vulnerable groups, including youth, the elderly, women, city workers, and people with disabilities—all of whom are primarily concentrated in residential and commercial areas. Affected areas include Basman, Abdali, Badir, Zahran, Ras Al Ein, Tlaa' Al Ali, Um As Summaq, and Khalda. Lastly, Halaseh raises the issue of flash flood occurrences as a driver of exacerbated vulnerabilities jeopardizing schools and residential and commercial spaces in Al Madinah district and outlines how poorly built infrastructure has contributed to unsafe conditions.

Halaseh asserts that establishing urban climate resilience in Amman will hinge on upgrading critical physical infrastructure in a way that utilizes energy efficiently and equitably, to ensure that all will have adequate access to city resources. Amman's various local climate strategies and action plans—including the Amman Resilience Strategy, the Amman Green City Action Plan, and the Amman Smart City Roadmap, as well as the Green Amman Municipality—promote sustainable city development through energy resource diversification. Possible approaches include turning to renewable energy; expanding green spaces; and improving management of solid waste, water, and wastewater. Implementing these plans will improve successes with future emergency responses to climate hazards. Yet as Halaseh argues, the escalated magnitude of climate risks in Amman's most vulnerable urban communities has underlined the need for the consistent monitoring of disaggregated climate data that are measurable, scientific, and evidence-based, as part of greater climate governance efforts. Although air- and vector-borne diseases in the context of climate change remain understudied in Amman, Halaseh asserts that further research could help reduce climate-induced inequalities, especially for the health-related consequences of climate change. Halaseh also highlights how district-level city plans, especially Amman's "data hub," the Amman Urban Observatory, generally must be better aligned with broader IPCC recommendations and the United Nations' Sustainable Development Goals. Both resources contain thoroughly and accurately studied environmental indicators that can yield better guidance and results for effective climate adaptation in Amman. Improvements in coordinated national- and city-level planning in Jordan also could make progress in Amman's climate action goals.

Beyond centralized governance, the MENA region's vulnerability to climate change also can be framed as a hydrocarbon dependence issue, according to Manal Shehabi. Shehabi's piece focuses on Morocco, a hydrocarbon importer state, and Oman, a hydrocarbon exporter state, as case studies. Along with other Gulf states, Oman unduly relies on hydrocarbon exports with inherently volatile prices for government revenue, which has heightened its economic vulnerability, as seen following the 2014 oil price collapse. Similarly, Morocco's dependence on energy and energy-intensive imports has heightened the country's economic vulnerability through energy and food import inflation following hydrocarbon price hikes. Additionally, both countries, especially Oman, face high levels of water stress that have deprived their citizens, especially farming communities, of adequate water supplies, a situation that is exacerbated by climate change impacts such as floodings in Oman and droughts in Morocco. Water scarcity is especially challenging in Oman, and the country will have to increasingly rely on additional energy-intensive water desalination projects to secure its water needs, including for its planned energy transition projects. In Morocco, already vulnerable Indigenous groups in Noor Ouarzazate have been displaced from their land, which was used for renewable projects, while the cleaning and cooling down for solar panels depleted potable water resources.

Shehabi advocates for MENA states to prioritize protecting the environment in their economically motivated energy transition plans to manage substantial trade-offs of those plans and to make them just and climate-resilient, benefiting people and the environment. The importance of managing those trade-offs is evident in regional acceleration of green hydrogen plans (which require water and renewable electricity). In Morocco, the government has established some renewable energy projects in agricultural-rich regions that have depleted water resources, harming potable water levels, agricultural products, farmers, and consumers of water-intensive agricultural products. Similarly, even though green hydrogen use is more sustainable than hydrocarbons, MENA governments—particularly in the Gulf states and Jordan—are ambitious in their plans for exporting green hydrogen, the production of which is costly and water-intensive and, therefore, will further strain water resources and local demands in some of the world's most water stressed countries.

Oman has announced plans to reduce emissions to net zero by 2050 in its National Strategy for Orderly Transition to Net Zero. Yet Shehabi argues that Oman's strategy yields a substantial reduction of emissions—approximately 97 million metric tons of carbon dioxide equivalent (MTCO2e)—which is still insufficient to reach net zero. In addition to expanding renewables, Oman will need to substantially decarbonize both its oil and gas operations and industries and utilize expensive carbon capture, utilization, and storage technologies. In Morocco, by contrast, the gap between targets and transition plans is less pronounced; Morocco emits significantly less emissions than Oman and has a more-established renewables sector. Although Morocco has emissions reduction plans for its forestry, land use, waste, and agriculture sectors, decarbonizing its agriculture sector using costly future output of green ammonia (a derivative of green hydrogen) could economically harm local farmers and consumers through the price surge of agricultural goods, absent subsidies or other measures. In this way, energy transition projects' effects on vulnerable

sectors could undermine a just transition, which further highlights the need for Morocco to implement energy transition plans that are climate-resilient and benefit all groups. Lastly, Shehabi states that an effective, just transition plan cannot be achieved without adequate access to finance, especially for middle-income countries (especially hydrocarbon importers).

In Libya's case, Frederic Wehrey approaches vulnerability to climate change as a condition exacerbated by political turmoil that perpetuates the marginalization of already vulnerable socioeconomically disadvantaged communities and ethnolinguistic minorities, especially when it comes to access to water and energy infrastructures. Wehrey claims that on a national scale, Libya's economic reliance on revenues from oil exports will undermine its decarbonization transition, risking continued exposure of its population to oil price fluctuations along with exposure to food supply shocks due to excessive imports of agricultural goods.

In terms of climate risks sharpening vulnerabilities, the arable and farmer-concentrated towns of Jabal Nafusa in Libya (such as Yifren, Nalut, Jadu, and Qala'a) continue to experience disrupted harvesting cycles, decreasing yields, and heightened food insecurity conditions as a result of climate change. Worsening sandstorms in the south have spiked transportation costs for farmers transporting crops to northern markets. Limited water access coupled with temperature spikes have led to frequent electricity outages in areas like Fezzan, Libya's poorest region concentrated with farmers and displaced persons. Consequently, water supplies crucial for irrigating staple products like wheat and barley in Fezzan, are progressively declining in output; vandalism of wells in Fezzan has diminished output by 30 percent. Similarly, in socioeconomically vulnerable areas like the western Jafara Plain and in the eastern Jabal Akhdar, access to land and resources already threatened by climate impacts like reduced precipitation and rising temperatures has been further threatened by political instability, namely the Libyan Arab Armed Forces' monopolization of key agriculture and energy infrastructure.

Wehrey argues that the socioeconomic hardships experienced by Libya's most vulnerable communities as a result of climate change are exacerbated by the lack of decentralization in Libya's governance strategy. The insufficient power of local governance has allowed for the escalation of corruptive measures that deprioritize sustainable policies and goals, further disadvantaging Libya's most fragile groups. Wehrey explains how the government's diversion of water supplies away from Libya's poorer minorities, such as the non-Arab Tabu, Tuareg, and Amazigh people, and toward richer northern communities is the product of a deficit of regulated control on the centralization of resources, which will further jeopardize Libya's climate goals and widen socioeconomic inequalities. Similarly, the state-owned monopolies that heavily influence Libya's energy sector have sidelined renewable energy plans. Wehrey refers to this state of affairs to call for greater decentralization in governance to help both national and local actors develop capacities for a more effective response to climate-induced vulnerabilities.

Wehrey further argues how, at the governance level, climate disasters such as the catastrophic flooding in Derna in 2023 have exposed Libya's lack of qualified personnel, insufficient technical capacities, and poor local data collection mechanisms. Libya's future climate governance plans will rely on greater expertise and collaboration with universities to develop potential solutions. Wehrey also claims that the regulatory exclusion of local grassroots actors and foreign companies in climate planning will only derail adaptation strategies that safeguard the most affected vulnerable minorities. As part of this greater argument for decentralization in climate governance, Wehrey points to municipal leaders in Nafusa and an agricultural research center in the coastal city of Misrata as models for effective climate governance through their introduction of economical adaptive capacity tools that locals have continued to use.

As for Tunisia, Sarah Yerkes and Joy Arkeh argue that climate change has widened preexisting socioeconomic inequalities that further harm struggling populations in the rural, coastal, and fragile urban sectors. On a national level, Tunisa's overdependence on food imports (especially grain, at 95 percent) has rendered Tunisia structurally inept to weather climate shocks, such as droughts, that lower agricultural yields. At a sectoral level, Tunisia's persistent struggles over water and food scarcity, both made worse by rising temperatures, have further harmed groups that are economically dependent on agriculture and fishing and therefore are subject to food and price energy shocks. Yerkes and Arkeh demonstrate how Tunisians' poverty status is positively correlated with their chances of being exposed to climate risks; in the poorer southern region, for instance, residents are more likely to work in jobs associated with climate stress, like agriculture. Additionally, rural Tunisians exposed to climate change have been forced to migrate to highly concentrated urban areas, which raises their vulnerability to climate-induced health and socioeconomic risks among already vulnerable groups, especially as women and children are left behind while men seek urban employment.

Yerkes and Arkeh argue that Tunisia's centralized governance structure plays a major role in imperiling climate adaptation efforts and further exacerbating preexisting and climate-induced socioeconomic vulnerabilities. According to the authors, divided government coalitions and the prevalence of a rent economy and related particular interest groups have created a weak institutional setup for climate action in Tunisia's Ministry of Agriculture, Water Resources, and Fisheries. More critically, the absence of a functional local government infrastructure has prevented municipalities from adequately addressing local climate challenges, which require a distinct set of strategies (from the national agenda) that cater to differing local bioclimates. In Tunisia's energy sector, centralization has led to the deprioritization of climate plans intended to protect vulnerable rural communities that are suffering disproportionately from water scarcity. In addition, agricultural land continues to be seized to build land for solar and wind projects that require significant water usage.

Similarly, Yerkes and Arkeh examine the implications of the water sector's lack of participatory governance, advocating against the privatization of the water and renewable energy sectors. As is the case with Tunisia's energy sector, Yerkes and Arkeh argue that in addition to alleviating public budgetary pressures and expanding financing measures for climate projects, private sector involvement as a function of decentralization can immensely improve resource security in Tunisia. Major benefits include healthier water quality and more abundant water supplies, especially in areas disproportionately experiencing water scarcity, by allowing for more efficient project implementation processes. Such processes include operations, maintenance, regulation, and enforcement.

Conclusions

In summary, as long as social and economic justice continues to be excluded from climate governance frameworks, climate change will deepen the region's socioeconomic problems. Major adaptation projects across the region that are dubbed as "sustainable" are acquired through unchecked land seizures resulting in displacement and are the same projects to degrade the quality and quantity of already scarce resources. Costly techniques like desalination and green hydrogen are prized for being renewable yet fail to critically assess the impacts of their use—through a demographic and sectoral-inclusive lens—before implementation. The urban poor will face a distinctive set of climate, health, and resource access challenges compared to commercial farmers versus subsistence farmers; so will consumers versus producers of agricultural products. The MENA region's centralized governance framework will have environmental consequences. The monopolization of resources by political powerhouses—in addition to a lack of concerted governance between local grassroots actors and foreign entities, especially regarding fundraising—remains one of the biggest roadblocks to honing capacity building and self-sufficiency. Policymakers must seriously consider how siloed emergency responses set back climate resilience goals and must begin to treat micro-level local and municipal issues with national urgency through established communication channels with state-level stakeholders.

CHAPTER 1

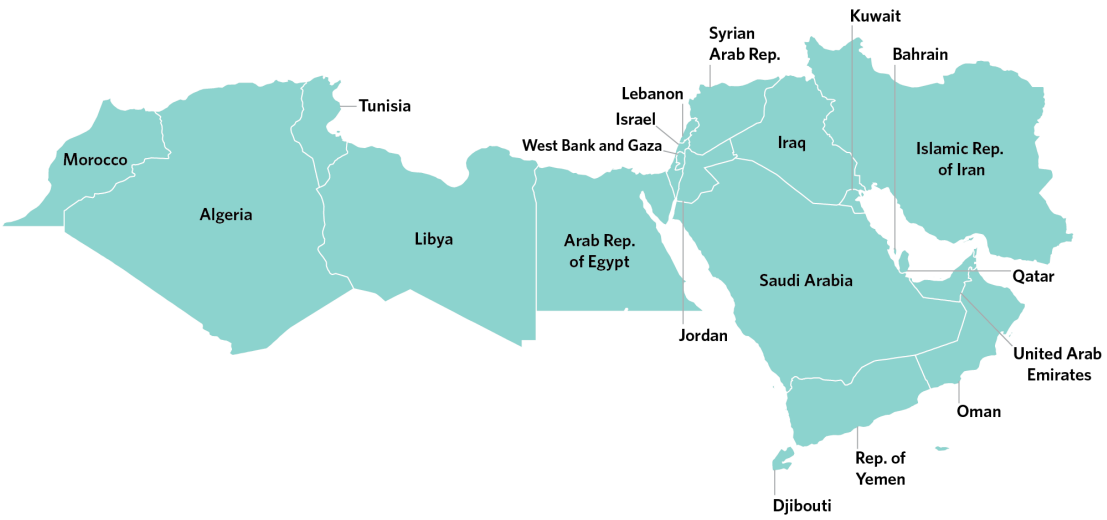
Assessing Climate Adaptation Plans in the Middle East and North Africa

Saber Osman

Introduction

The Middle East and North Africa (MENA) region is a complex and multifaceted geographical entity with a distinctive identity (see figure 1). It extends across two continents and encompasses a diverse array of terrains, ranging from arid deserts to fertile plains, though it is characterized by a predominantly arid and hot climate. It boasts significant natural resources, most notably abundant reserves of oil and natural gas, which wield considerable influence over the economies of some countries in the region. Owing to the unique amalgamation of its climatic attributes, its geographical positioning, and the intricate interplay of geopolitics and socioeconomic conditions within the majority of its constituent nations, the MENA region is one of the most susceptible regions to the physical repercussions of climate change.

Figure 1. Map of the Middle East and North Africa (MENA) Region



The region's vulnerable populations and ecosystems face an array of severe hazards, including drought, heat waves, and other extreme meteorological phenomena. Moreover, the MENA region relies heavily on climate-sensitive agriculture, with a substantial proportion of its populace and economic activity concentrated in coastal zones that are susceptible to flooding. In the forthcoming years and decades, the infrastructure, economy, and demography of the region will face mounting stress as a consequence of the swift escalation in global mean temperatures, erratic precipitation patterns, and rising sea levels. These stressors will disproportionately affect vulnerable groups—such as marginalized communities, women, and youth—exacerbating social disparities, affecting migration trends, and potentially precipitating conflicts. Some scholars have linked the conflict in Syria to the devastating drought caused by climate change impacts. Therefore, climate change adaptation and resilience efforts are imperative for the MENA region to address unique regional vulnerabilities, protect its people and resources, and ensure long-term stability and sustainability in the face of climate challenges. National adaptation plans (NAPs) are highly important to help countries within the region identify medium- and long-term adaptation needs, based on the latest climate science, to enable governments and societies to face climate challenges and develop strategies to address them.

In this context, this article thoroughly examines climate adaptation plans in the MENA region, with a specific focus on Morocco, Tunisia, Egypt, Jordan, and the United Arab Emirates (UAE), using a desk review approach. The assessment aims to respond to the following questions:

- What are the current statuses of NAPs in MENA region countries?
- What challenges, weaknesses, and threats are countries facing in the development of these plans?
- What opportunities can they benefit from in order to implement the NAPs?
- Finally, what are the entry points for mainstreaming adaptation within national planning and budgeting?

The answers to these questions will help in understanding how regional efforts in adaptation planning could be aligned with global efforts to reduce loss and damage, achieve global goals for adaptation, and work toward sustainable development goals.

The Current Status of Climate Change Adaptation Plans in the MENA Region

Countries in the MENA region have made efforts to address challenges arising from climate variability and demographic shifts, such as the construction of dams in Morocco to combat drought, the optimization of irrigation water usage in Egypt to accommodate population growth and increased demand for reclaiming arable land, and the construction of centrally

air-conditioned towers in Gulf Cooperation Council (GCC) countries to cope with their hot and humid climate. These countries also will need to respond to future events like rising sea levels as well as recent extreme weather events such as heat waves. Despite these proactive measures, MENA countries have not yet crafted comprehensive climate adaptation plans.

The origins of climate change vulnerability and adaptation efforts in MENA countries can be traced back to countries' responses to the mandates outlined in Article 4 and Article 12 of the United Nations Framework Convention on Climate Change (UNFCCC). MENA countries have prepared diverse reports aimed at exploring national susceptibility to climate change, planned adaptation measures, and associated requirements. One significant report is the national communication submitted to the UNFCCC, which each MENA country periodically compiles and presents to the Conference of the Parties (COP). This document provides comprehensive insights into a country's vulnerability; ongoing or required adaptation measures; and necessary means of implementation, including financial, technological, and capacity-building components.

Similarly, the Paris Agreement, as detailed in Article 4, paragraph 2, mandates each participating party to prepare, communicate, and continually update their nationally determined contributions (NDCs), outlining the specific actions they intend to undertake in response to climate change. Furthermore, it calls for the formulation of a NAP to identify medium- and long-term adaptation needs, along with the development and implementation of strategies and programs to address these needs. The reporting framework also includes the Biennial Update Report (BUR), Technology Needs Assessment (TNA), Adaptation Communication (AC), and national strategies, each offering insights into how a country addresses climate change, spanning from assessment to implementation, monitoring, and evaluation.

Current Status

Under the UNFCCC framework, all countries in the MENA region are categorized as Non-Annex I Parties (developing countries), have no historical responsibility for human-made climate change, and have the right to benefit from the means of implementation provided by the UNFCCC financial mechanisms. Table 1 presents the status of reports submitted to the UNFCCC by MENA countries, including the distinct stages and circumstances among MENA region countries. These countries can be categorized into the following groupings under each reporting scheme.

National Communications to the UNFCCC

- Lower-income MENA countries, exemplified by Jordan, were the first to submit their Initial National Communications (INCs) in 1997, followed by Egypt and Lebanon in 1999. Conversely, wealthier countries in the MENA region, particularly those reliant on oil exports, such as Saudi Arabia and Oman, presented their INC reports considerably later, in 2005. In contrast, countries grappling with political instability, such as Syria, Iraq, and Palestine, reported their INCs in 2010, 2015, and 2016, respectively.

- Certain countries, particularly Egypt, Jordan, Lebanon, Morocco, and Tunisia, exhibit a pattern of frequent reporting. This proclivity can be attributed to various factors, including political determination, the existence of established institutional structures, the availability of qualified experts, and a willingness to capitalize on the financial support for reporting provided by the UNFCCC's financial mechanism, the Global Environment Facility, coupled with technical assistance from the United Nations Development Programme (UNDP).

- In contrast, other nations, including Algeria, Iraq, Libya, Palestine, and Syria, face challenges related to a lack of capacity and internal political turmoil. Consequently, they encounter difficulties in consistently reporting to the UNFCCC.

- Libya has yet to submit its INC; according to Libyan officials, it is currently in the preparatory phase.

- Specific oil-exporting nations, with Qatar as a notable example, have chosen a cautious, wait-and-see approach to reporting, primarily because of concerns about potential consequences. Qatar's 2011 INC submission—the only one it has provided—contains data on greenhouse gas (GHG) emission sources and quantities, GHG mitigation measures, and climate adaptation. Countries such as Qatar appear to be influenced by ongoing allegations from certain nations, including those of the European Union, which attribute the escalating GHG concentrations in the atmosphere to the activities of oil-exporting nations, thereby endangering oil exporters' primary revenue source. Moreover, these countries do not currently require access to climate finance, a fact that sets them apart from other developing countries that frequently update their reports with the aim of facilitating their access to climate-funding mechanisms.

Nationally Determined Contributions Reports

- All MENA region countries, with the exceptions of Libya and Yemen (owing to their political situation), have submitted their NDCs. The significance attached to these reports, which serve as the primary vehicles for the Paris Agreement, by countries in the region can be attributed to the global consensus on the agreement's importance. Strong support from major nations like the United States and China has accelerated its adoption, making it one of the fastest multilateral agreements to gain worldwide recognition. This widespread support has fostered trust among the majority of countries, encouraging their active participation and commitment to reporting under the agreement.

- To date, the political situations in Libya and Yemen have prevented these countries from making progress in developing their NDCs.

National Adaptation Plans

- Although all MENA region countries have emphasized the priority of adaptation in their climate change responses since they commenced the reporting process in 1997, only a few have actually developed their NAPs. Notably, Kuwait is the sole country that has submitted its NAP as a standalone document to the UNFCCC.

- Countries like Jordan, which partnered with the German Development Cooperation (GIZ), and the UAE, which funded its NAP through its domestic budget, have employed their updated NDCs as a vehicle to integrate their NAPs.

- Several countries, including Egypt, Morocco, and Tunisia, have started to develop their national adaptation plans using funds provided by the Green Climate Fund. These countries are at different stages of NAP development, and the completion of their plans is expected within the next two or three years.

- Owing to their respective political situations, Libya and Yemen have made no progress in developing NAPs to date.

Table 1. MENA Countries' Status of Climate Change Reporting Schemes

Party	NC1	NC2	NC3	NC4	TNA1	TNA2	BUR1	BUR2	BUR3	BUR4	NAP	NDC
Algeria	2001	2010										2016
Bahrain	2005	2012	2020									2021
Egypt	1999	2010	2016		2001		2019					2023
Iraq	,2015 updated 2017											2021
Jordan	1997	2009	2014		2001	,2016 2017	2017	2021				2021
Kuwait	2012	2019					2019				2021	2021
Lebanon	1999	2011	2016	2022			2015	2017	2019	2021		2021
Libya												-
Morocco	2001	2010	2016	2021			2016	2019	2022			2021
Oman	2013	2019					2019					2021
Qatar	2011											2021
Saudi Arabia	2005	2011	2016	2022			2018					2021
State of Palestine	2016											2021
Syria	2010											2018
Tunisia	2001	2014	2019		2001	,2015 ,2016 2017	2014	2016	2022			2021
United Arab Emirates	2007	2010	2013	,2018 revised 2019								2023
Yemen	2001	2013	2018			2012	2018					-

Source: Author's compilation from "National Communication submissions from Non-Annex I Parties," UN Climate Change, https://unfccc.int/non-annex-I-NCs?gclid=Cj0KCQjwjt-oBhDKARIsABVRB0zOB2Cevmi56hBhtwQmq7dflQqYw6kpKPwWgWrQIlG0k5Hi8zbhmXYaAq3fEALw_wcB; "Technology Needs Assessments: Pathways for Climate Tech Implementation," TTClear, UNFCCC, https://unfccc.int/ttclear/tna/reports.html; "Biennial Update Report submissions from Non-Annex I Parties," UN Climate Change, https://unfccc.int/BURs; "Submitted NAPs From Developing Country Parties," UN Climate Change, https://napcentral.org/submitted-naps; and "NDC Registry," UN Climate Change, https://unfccc.int/NDCREG?gclid=CjwKCAjw69moBhBgEiwAUFCx2DWCkMwQWbTS-pGgPAYIh3L77R4nY0Sg6KWVnnpJge6lWxCyFJxuUBoCLQkQAvD_BwE.

Challenges

MENA countries face several critical external challenges in their efforts to adapt to climate change impacts. These challenges will be discussed in the subsequent sections. They are reported by the countries of the region in their national reports or through the international organizations such as the World Meteorological Organization, the Intergovernmental Panel on Climate Change (IPCC), and World Bank. Table 2 presents a summary of these challenges.

Table 2. Challenges, Weaknesses, and Opportunities of Climate Change Adaptation in Selected MENA Countries

	Challenges				
Country	**Main climate change impacts**	**Vulnerable sectors**	**Required finance**	**Weaknesses**	**Opportunities**
Morocco	• Extreme weather events • Severe droughts • Floods • Wildfires • Heat and cold waves • Snowstorms and storms • Sea level rise • Marine submersions • Landslides	• Water resources (−25 percent) • Agriculture (−3 percent to −39 percent) • Fishing • Forestry • Biodiversity • Coastline and coastal zones • Habitat • Health • Housing • Locust invasions	• Around $16 billion until 2030	• Lack of institutional coordination • Absence of a monitoring and evaluation system for adaptation and a dedicated learning framework • Climate-related data are fragmented, incomplete, and challenging to access • Multiple methodologies and procedures have been tested, resulting in incompatible outcomes • Limited engagement from the private sector	• NAP is currently being prepared to establish a policy framework for integrating the private sector and mainstreaming adaptation policies within planning and budgeting • Availability of existing experts • Increased awareness among policymakers after hosting COP21 • Potential for cooperation with numerous donors and countries in the region
Tunisia	• Extreme weather events, mainly drought • Sea level rise	• Agriculture • Water resources • Health • Ecosystems • Coastal zones • Tourism	• $4.3 billion for adaptation	• Lack of effective coordination mechanisms and an institutional anchoring of adaptation • Lack of awareness and engagement of high-level decisionmakers, both at central and local levels • Gap in cross-sectoral and macro level information and analyses relevant to high-level decisionmakers • Gaps in technical capacity, knowledge, and tools for adaptation planning • Lack of sustained financial resources	• NAP is in preparation, targeting development of a policy framework for integrating the private sector and mainstreaming adaptation policies within planning and budgeting • The government and consultancy firms and NGOs such as GIZ have well-qualified experts in different aspects of climate change covering adaptation and mitigation

	Challenges				
Country	**Main climate change impacts**	**Vulnerable sectors**	**Required finance**	**Weaknesses**	**Opportunities**
Egypt	• Extreme weather events • Heat and cold waves • Increased humidity • Flash floods • Sand and dust storms • Sea level rise • Coastal erosion • Fertile land salinity • Inundation	• Agriculture • Water resources and irrigation • Coastal zones • Human health • Urbanization and infrastructure • Tourism • Biodiversity (coral reefs bleaching)	• Conditional finance for adaptation $50 billion	• Limited availability and accuracy of climate change risk assessments • Limited institutional coordination and capacity to undertake advanced adaptation planning • Insufficient financial resources and budget allocations dedicated to adaptation planning • Lack of a holistic approach to adaptation planning	• NAP is in preparation, focusing on developing a comprehensive national risk assessment and the integration of adaptation policies into national planning and budgeting • NAP emphasizes the cobenefits of mitigation • Leveraging the expertise of existing specialists, policymakers' awareness has notably increased, especially after hosting COP27 • The potential for collaboration with numerous donors and countries in the region is on the horizon
Jordan	• Warmer summer and heat waves • Drier autumn and winter • Reduction of precipitation in autumn and winter	• Agriculture • Water • Health • Coastal zones • Agriculture, water, urban systems, biodiversity, and ecosystems, coastal, health, and socioeconomic	• $329,445,830	• Fragmented institutional framework; weak governance, policies, strategies, and legislation • Weak coordination mechanism between public and private community-based organizations and other relevant stakeholders; the need to ensure mainstreaming NAP in their strategies • Lack of knowledge, awareness, and communication tools for an effective NAP implementation process • Absence of dynamic and sustainable funding instruments for NAP implementation • Insufficient research and capacity building programs in the climate adaptation field • Unavailability of data management system for climate change adaptation	• NAP has been developed, and the required policies and projects regarding climate adaptation priorities were identified. • The government, consultancy firms, and NGOs such as Friedrich Ebert and GIZ have well-qualified experts in different aspects of climate change covering adaptation and mitigation

	Challenges				
Country	**Main climate change impacts**	**Vulnerable sectors**	**Required finance**	**Weaknesses**	**Opportunities**
UAE	• Extreme weather events • Heat waves • Heavy rains • Increased humidity • Sand and dust storms • Sea level rise • Coastal erosion • Fertile land salinity • Inundation	• Energy • Infrastructure • Health • Environment • Insurance	• The UAE is deploying policy measures to enable the private market to deliver the required financing (alongside the government) and as such is not expecting to require additional international support to deliver on these targets	• Country reports do not highlight any weaknesses owing to their high adaptive capacity, attributed to the increased national income resulting from rising oil prices and global demand for petrochemical products	• NAP has been formulated, and the necessary policies and projects have been identified • Domestic funding is available for investment in adaptation • There is potential for supporting other countries in the region, particularly North African nations. An announcement has been made regarding support for renewable energy in Africa through a $4.5 billion investment program. A similar program could be initiated for adaptation, with a particular focus on investment in the agriculture sector

Source: Author's compilation from "Supporting the Foundations for Sustainable Adaptation Planning and Financing in Morocco," Green Climate Fund, https://www.greenclimate.fund/document/supporting-foundations-sustainable-adaptation-planning-and-financing-morocco; "National Adaptation Plan: Advancing Risk-Informed Development and Land-Use Planning in Tunisia," Green Climate Fund, https://www.greenclimate.fund/document/national-adaptation-plan-advancing-risk-informed-development-and-land-use-planning-tunisia; "Formulation and Advancement of the National Adaptation Plans Process of Egypt," Green Climate Fund, https://www.greenclimate.fund/document/formulation-and-advancement-national-adaptation-plans-process-egypt, "The National Climate Change Adaptation Plan of Jordan 2021," Ministry of Environment, Jordan, https://www.moenv.gov.jo/ebv4.0/root_storage/ar/eb_list_page/final_draft_nap-2021.pdf," National Climate Change Plan of the UAE 2017–2050," The United Arab Emirates' Government portal, updated August 9, 2023, https://u.ae/en/about-the-uae/strategies-initiatives-and-awards/strategies-plans-and-visions/environment-and-energy/national-climate-change-plan-of-the-uae; and "NDC Registry," UN Climate Change, https://unfccc.int/NDCREG?gclid=CjwKCAjw69moBhBgEiwAUFCx2DWCkMwQWbTS-pGgPAYIh3L77R4nY0Sg6KWVnnpJge6lWxCyFJxuUBoCLQkQAvD_BwE.

Climate Change Impacts and Vulnerability

Sea level rise. The MENA region confronts severe vulnerability to rising sea levels, with a confirmed average global increase of 1.7 millimeters annually over the twentieth century, as stated by the IPCC's Fifth Assessment Report (AR5). Approximately 24 percent of the MENA region's coastal gross domestic product (GDP) and 20 percent of coastal urban areas are exposed to sea level rise, double the global averages. Around 100 million people are at risk of coastal flooding by 2030; this vulnerability extends to forty-three port cities, including Alexandria, with projections aligning with IPCC reports.

A global mean sea level rise of 29 to 110 centimeters by the end of the century, combined with storm surges and saltwater intrusion, threatens water quality and agriculture. Capitals like Abu Dhabi, Doha, and Dubai are vulnerable, and Egypt, Libya, Morocco, and Tunisia emerge as the most vulnerable countries.

Water scarcity. The MENA region is globally recognized as the most water-scarce area. Approximately 60 percent of its population already lives in areas under severe water stress and generates 70 percent of the region's GDP. The IPCC projections under a 2°C temperature increase scenario indicate a substantial decline in freshwater availability in MENA, ranging from 15 percent to 45 percent. These climate-induced water scarcity effects are expected to diminish the region's GDP by 6 percent to 14 percent by 2050, posing a grave threat to economic development. The looming water crisis in MENA has the potential to incite social unrest—an issue already unfolding in unstable contexts, exemplified by Iraq.

Some MENA countries have already experienced amplified water scarcity, including severe droughts seen in Morocco in 2022 and Tunisia in 2023. Other countries in the region, such as Oman, Qatar, Saudi Arabia, the UAE, and Yemen, witnessed extreme floods in 2022, further compounding the region's water-related challenges.

Historically, the arid MENA region has experienced cyclical drought periods. For instance, over the past two decades, Morocco has witnessed a surge in both the frequency and severity of drought periods, a shift primarily attributed to the impacts of global climate change. The adverse impact of these challenges is disproportionately felt by women, who bear the brunt of increased household responsibilities, especially in securing water, while men migrate to urban areas seeking employment.

Anticipated increased drought will also result in secondary consequences such as sandstorms due to drying soil and desert dust accumulation in the atmosphere, contributing to land degradation and desertification and limiting solar energy potential. Furthermore, increased erosion and sedimentation affect both water and land-based transportation.

Extreme weather events. In the MENA region, temperatures have surged at 0.46°C per decade from 1980 to 2022, surpassing the global average of 0.18°C per decade. A +4°C global warming scenario could lead to extreme temperatures, possibly reaching 56°C in some areas. A 2°C projection foresees approximately 30 percent of summer months with unusual heat extremes. The IPCC AR5 projects that annual temperatures in East Africa and the Maghreb could rise by over 2°C by 2100, potentially reaching 6°C in extreme scenarios. Climate models anticipate temperature increases of 1.2°C to 2.6°C by the 2046–2100 period. Also, sand and dust storms are recurrent and severe weather events in the MENA region, causing prolonged environmental damage in their source areas.

The MENA region sustains substantial economic losses caused by dust storms, estimated at roughly $13 billion annually, significantly impacting its GDP. For example, in late February 2015, a severe dust storm originating from northern Saudi Arabia, Iraq, and Kuwait reached

the Arabian Peninsula's shores, carried by powerful northwesterly winds. Similarly, in September 2015, the Mashreq region experienced an extended dust storm that affected the Syria and Iraq, extending into Lebanon, Egypt, and Jordan. This storm, unprecedented in recent Lebanese history, resulted in five fatalities and 750 cases of asphyxiation.

Climate Finance

Most of the countries in the MENA region confront considerable financial hurdles in their climate change adaptation efforts. Even though developed nations have pledged $100 billion a year to help developing nations achieve their climate goals, according to Oxfam and the Organisation for Economic Co-operation and Development, the commitments of developed nations remain unfulfilled and the funds mobilized for adaptation even dropped by $4 billion (-14 percent) in 2021. Thus, it will be crucial to ensure fair access to climate finance mechanisms and equitable distribution of funds that consider vulnerability and adaptive capacity. Yet allocating a significant portion of climate finance to adaptation projects poses another challenge, given the region's pressing need in areas like water resource management, infrastructure resilience, and agricultural sustainability.

The Paris Agreement acknowledges the importance of finance, technology, and capacity-building for climate action, emphasizing the need to make financial flows consistent with low GHG emissions and climate-resilient development. Climate action in developing countries urgently needs more support, and climate finance from developed to developing nations has seen some growth. However, a rapid scaling-up, with a focus on adaptation finance, will be required. To play a critical role in building resilience, this approach should avoid funding actions that increase climate-related risks. Furthermore, on the issue of global financial structures reform, debt swaps and efforts to shift financial flows away from maladaptation and toward mainstreaming adaptation both will be essential steps in enhancing climate ambition and action.

As indicated in table 2, numerous countries in the region have determined their financial necessities for climate adaptation. For instance, Morocco estimates that it will require approximately $16 billion by 2030, while Tunisia has identified a need for $4.3 billion. Egypt, meanwhile, is requesting a substantial $50 billion in conditional finance for adaptation, and Jordan has specified a requirement of nearly $330 million. In 2018, the African Development Bank estimated the cost of climate change mitigation and adaptation in North Africa to be around $280 billion by 2030, with an annual financing gap of $10 to $30 billion. The largest gaps are projected to be in Egypt, Morocco, and Algeria. This shortfall can be attributed to the weak ability of the countries in the region to attract the required funding and investments to meet the challenges of climate change. Notably, Tunisia has access to 48.3 percent of its needed annual climate financing, compared to other North African countries. It, along with Egypt (which has 35.8 percent of funding), has relatively the more significant financing flows. In a recent 2023 analysis of the climate financial gap in Jordan, the current climate and nature annual financing gap was estimated at about 1,095 million Jordanian dinars, or 3.4 percent of Jordan's GDP. Hence, these nations are seeking support from international funding agencies and private investments

to implement crucial adaptation projects. Countries in the region that are grappling with political instability, however, have not submitted their national reports and currently lack the capacity to calculate their specific climate financial needs.

In terms of climate finance distribution, data from the Climate Fund Update in 2022 indicate that out of the twenty-one MENA countries, seventeen are beneficiaries of climate finance, with Egypt and Morocco being the primary recipients. The majority of these financial resources are allocated in the form of loans and concessional loans to support mitigation projects. It is worth noting that wealthy oil-producing states like the UAE are among the four countries that do not receive climate finance.

Moreover, the gross public debts of several countries in the region, especially in North Africa, have reached historic highs. The efforts made by these nations to address the impacts of the COVID-19 pandemic have compounded the existing trend of high public debt. Given recent increases in interest rates, persistent inflationary pressures, and conflicts in regions such as Ukraine and Palestine, the burden of servicing this debt is anticipated to rise. Consequently, international climate finance becomes imperative for assisting certain MENA region countries in enhancing their resilience and adapting to the adverse effects of climate change. To ensure the effectiveness of climate finance, both the quantity and quality of financial resources must be considered to adequately meet the region's specific needs.

Weaknesses

The information in table 2, drawn from national adaptation proposals and other information submitted to the Green Climate Fund, can be used to gain insights into the limitations and weaknesses impeding climate adaptation planning in MENA region nations. An all-encompassing analysis of NAP proposals or reports from the selected MENA countries—Egypt, Jordan, Morocco, Tunisia, and the UAE—uncovers a set of shared deficiencies and barriers. These inadequacies include the availability and precision of climate risk assessments, institutional coordination and readiness for advanced adaptation planning, insufficient financial backing, and an absence of climate data and a comprehensive approach to adaptation planning.

One common weakness observed in MENA countries, such as Morocco and Tunisia, is the limited availability and accuracy of climate change risk assessments and risk reduction strategies. For instance, in Morocco, despite the country's investments in climate change adaptation and risk management projects, climate change risks and adaptation needs have not been systematically integrated into regional development planning. This piecemeal approach results in fragmented and incomplete climate-related data, making it difficult to inform sound decisionmaking across various sectors. Similarly, Tunisia grapples with a dearth of comprehensive and up-to-date data regarding the impacts of climate change

on its economy and development path, limiting its ability to set development objectives at larger scales. The inadequacy of reliable climate risk data and the limited access to such information are shared hurdles for both countries, undermining their ability to develop robust adaptation strategies.

Another common challenge is the lack of institutional coordination and capacity for advanced adaptation planning, as seen in Egypt and Morocco. Egypt's policymakers still lack a broad-based understanding of climate change impacts and the technical skills necessary for effective integration of climate change adaptation interventions. This limited capacity at the policy level hinders the NAP process and future long-term climate change adaptation planning. Morocco, by contrast, grapples with a diverse set of challenges linked to the inadequacy of its institutional framework. Among these challenges are the absence of a steering document for the NAP process, limited capacities among key stakeholders at various levels, and insufficient information-sharing. In both Egypt and Morocco, these capacity-related issues are obstacles that hinder efficient and coordinated adaptation planning.

Insufficient financial resources allocated for adaptation planning are yet another shared vulnerability across MENA countries. Egypt, with its high vulnerability to climate change, requires significant investments to address these challenges. However, efforts to mainstream climate change adaptation into national-level sector budgets and policies have been progressing slowly. Public funds are described as insufficient to meet climate change adaptation needs, necessitating the exploration of other funding sources. A similar financial challenge is witnessed in Morocco, where despite various climate adaptation initiatives, private sector engagement remains limited. The private sector's limited awareness of climate change risks hampers its engagement in adaptation activities. In both cases, inadequate financial resources and limited engagement from key sectors represent financial vulnerabilities that hinder effective adaptation planning.

Lastly, the lack of a holistic approach to adaptation planning is a widespread concern. In Egypt, adaptation efforts have focused primarily on specific sectors, particularly agriculture, water resources, and coastal zones. As a result, many areas remain unprepared to handle climate change impacts and extreme weather events. This fragmented approach similarly is observed in Morocco, where climate change adaptation projects have been executed in a disconnected and sector-specific manner. In both instances, this siloed approach to adaptation planning leaves gaps in regions and sectors ill-equipped to address climate change impacts. Egypt and Morocco serve as prime examples of the need for a more comprehensive and integrated approach to adaptation planning, one that considers the broader spectrum of challenges posed by climate change.

The weaknesses and obstacles to climate adaptation planning in MENA region countries like Egypt, Morocco, and Tunisia are strikingly similar, encompassing limited access to accurate climate risk data, inadequate institutional coordination and capacity, insufficient financial resources, and a lack of holistic planning. These challenges hinder the development

of effective adaptation strategies, so it is essential for these countries to address these issues collaboratively and systematically to better prepare for the impacts of climate change. By learning from each other's experiences and focusing on overcoming these shared weaknesses, these nations can enhance their resilience to the ever-increasing challenges of climate change.

Threats

Previous challenges and weaknesses in MENA region countries could pose not only national but also transboundary risks, owing to variations in natural resources and socioeconomic conditions among Arab countries. Examples of adverse transboundary effects of climate change in the MENA region include the following.

Water resource disputes. Extreme climate conditions, such as rising temperatures and increased evaporation, strain water resources. Although the MENA region is home to about 6 percent of the world's population, it holds only around 1 percent of the Earth's total renewable freshwater resources. In 2011, the average per capita share of total renewable freshwater resource base in the region was 819.8 cubic meters, and by 2016 it fell even further, to around 600 cubic meters. By way of comparison, the global average share is about 6,000 cubic meters. Given that a significant portion of freshwater sources in MENA countries originates outside their national boundaries, and fourteen out of twenty-two MENA states share surface-water bodies, climate change may worsen water scarcity and provoke tensions within and between nations that share hydrological resources and geopolitical boundaries. For example, Egypt receives 55.5 billion cubic meters per year of the total rainfall on the Nile River, but this is only part of the total 1,660 billion cubic meters per year on average that falls on the eleven Nile River Basin countries.

Public health concerns. In a region already challenged by extreme temperatures, even a minor temperature increase could expand the habitats of disease-carrying vectors such as those that transmit malaria, yellow fever, and dengue fever, heightening the threat of vectorborne diseases.

Desertification. The expansion of deserts like the Empty Quarter (Rub' al Khali) in Saudi Arabia, Oman, the UAE, and Yemen, coupled with rising temperatures, decreased annual precipitation, water stress, and recurring droughts, together pose significant stress to agriculture and biodiversity. Similar impacts are anticipated from the expansion of the Sahara Desert, which spans about 31 percent of Africa.

Conflict and human security. Resource degradation, especially related to water, can contribute to conflict and insecurity, particularly in weak states and regions already facing conflicts. Climate change can further destabilize these areas, exacerbate conditions on the ground, and lead to forced migration. As seen in the case of Syria, conditions such as drought can lead to or exacerbate conflict.

Opportunities

In spite of the weaknesses and threats mentioned above, the MENA region has a number of opportunities for taking action to address climate change. In particular, the region has made strides in raising awareness of the importance of climate change adaptation efforts. Two consecutive COPs hosted in the MENA region—COP27 in Egypt in 2022 and COP28 in the UAE in 2023—provided a platform for citizens and policymakers to understand the pressing issues related to climate change and its consequences. The MENA region, characterized by its diverse climate challenges, has gained a heightened sense of urgency in addressing these issues thanks to the international attention brought by hosting these conferences. The discussions and commitments made at these events have contributed to increased knowledge and action regarding climate adaptation and mitigation strategies in the region.

In addition, younger people in the MENA region are ready for climate action. More than 55 percent of the MENA population is under thirty years of age, and the role of youth in climate change adaptation is of paramount importance. Young people in the MENA region are not just passive victims of the climate crisis; they are proactive agents of change who are leading innovative, community-based climate initiatives. Even though they face challenges in accessing information and capacity-building opportunities, they remain at the forefront of climate action, working to protect their communities and ways of life. Their active participation in climate governance, policymaking, and climate justice initiatives is essential for ensuring that the region effectively addresses the challenges posed by climate change and benefits from the innovation and energy of its youth.

MENA countries' NDC screenings demonstrate that these countries pay great attention to the role of youth when dealing with climate change. For instance, Egypt is encouraging youth involvement in the green transition through skills training and incentives, aiming to foster green entrepreneurship. The UAE is investing heavily in youth development for climate engagement, with initiatives like the Emirates Youth Climate Strategy 2018–2021 and the UAE Youth Climate Delegates Program (YCDP) 2022–2023, as well as events promoting sustainability. Jordan also is investing in youth as future decisionmakers for climate adaptation, integrating climate change into education and empowering a dedicated national delegation for effective participation in UNFCCC negotiations, alongside supporting youth engagement in global climate networks. The rest of the countries in the region, such as Morocco and Tunisia, have also identified several measures for integrating youth in their climate plans and actions.

Finally, cooperation and the exchange of knowledge among MENA countries, especially those grappling with similar climate challenges, will be instrumental in mitigating the adverse effects of climate change. UAE Minister of Climate Change and the Environment Mariam Bint Mohammed Almheiri has highlighted the country's unwavering dedication to fostering collaboration among MENA nations. The primary focus is on reducing carbon emissions and enhancing climate adaptation, setting an example for the region. Information

and experience sharing is particularly crucial for countries facing delays in climate action, often owing to political or economic constraints. This collaborative approach can act as a catalyst, providing these countries with a pivotal starting point to catch up and align their climate aspirations with global objectives.

In this context, the emphasis on inclusivity in the collective response to climate change, acknowledged by organizations such as the UNDP, underscores the essential nature of shared knowledge and cooperation. The active participation of specific countries and organizations in the region in addressing significant climate challenges, while concurrently working to establish a comprehensive, equitable framework to achieve national adaptation goals, demonstrates leadership in advancing climate resilience and sustainable development.

Conclusion

In the realm of climate change adaptation planning, the MENA region faces challenges, weaknesses, threats, and opportunities. This is of paramount significance in light of the escalating perils stemming from climate change impacts, notably the increasing frequency and intensity of extreme weather events. The policy conclusions reached in ths paper can be summarized as follows.

Enhancing reporting and planning efficiency. Given the critical importance of climate change adaptation, it is imperative for all nations in the MENA region to consistently report to the UNFCCC. Special attention should be directed toward supporting countries currently facing political challenges, like Libya and Yemen, in fulfilling their reporting obligations.

Addressing delayed NAPs. Acknowledging the significance of prioritizing adaptation efforts, there is a need to investigate and address the delays in developing NAPs among some countries in the region. Identifying and overcoming underlying reasons for delays will be crucial for effective climate resilience.

Overcoming external challenges. Sea level rise, water scarcity, and extreme weather events demand immediate attention. Priority should be given to securing and improving the availability, accessibility, and quality of financial resources for effective climate change adaptation.

Mitigating weaknesses in adaptation planning. Efforts should focus on rectifying weaknesses identified in the study, including the absence of NAPs in many countries; the lack of integrated approaches; institutional fragmentation; and insufficient engagement of municipalities, local communities, and the private sector. Addressing misconceptions among policymakers and improving access to information and tools is pivotal for avoiding maladaptation.

Mitigating threats through collaboration. To mitigate threats related to water resource disputes, disease vectors, desertification, and potential conflict, collaborative efforts and knowledge exchange among countries facing similar climate impacts will be essential. Learning from successful models, particularly in the GCC states, can provide valuable insights for weaker nations.

Integrating adaptation with sustainable development. Aligning climate adaptation strategies with disaster risk reduction and national sustainable development objectives will be crucial. This integrated approach ensures a harmonized and comprehensive policy framework that maximizes effectiveness across various sectors.

Defining entry points for adaptation policies. Establishing clear entry points, such as legislative frameworks, institutional capacity building, and public awareness campaigns, will be pivotal for mainstreaming adaptation policies. This approach ensures the effective implementation of climate adaptation measures at national, sectoral, local community, and project levels.

CHAPTER 2

The Looming Climate and Water Crisis in the Middle East and North Africa

Mohammed Mahmoud

Introduction

The Middle East and North Africa (MENA) region is naturally prone to being hot and dry, in stark contrast with the rest of the world. The region's arid climate is the primary contributor to its perennial state of water scarcity. When coupled with the region's limited freshwater supplies and growing demand for water, virtually all MENA countries are facing elevated levels of water stress. The amplifying effects of climate change threaten to increase the gap between water supply and water demand in the region by exacerbating drought conditions. The longer-term consequences of water scarcity that increase this imbalance extend beyond insufficient water availability. Concerns over water quality, critical water infrastructure, and transboundary water cooperation may also compound the region's existing socioeconomic challenges.

The Current State of Water Resources in the Middle East and North Africa

The MENA region has been widely acknowledged as the most water-stressed region in the world. In fact, according to data from 2019, sixteen of the twenty-five most water-stressed countries in the world can be found in this region (with Bahrain ranked as the world's most water-stressed country). In this context, water stress is defined as the gap between water supply and water demand for each given country, meaning that the most water-stressed nations are utilizing nearly all of their available water supplies, and any fluctuations to water supply with respect to meeting water demand could trigger periods of water shortage.

Although the MENA region is generally recognized as water-stressed, different parts of the region experience water stress differently. The differences in water vulnerability between countries in the region are highly correlated to the level of access each country has to a range

of water resources, both from freshwater and nonconventional water supplies. For example, access to renewable supplies from surface water systems (such as rivers) can place nations at an advantage to countries that have limited ability to draw on freshwater sources (which also include groundwater extracted from subsurface aquifers). Conversely, countries that have extremely limited opportunities to leverage the use of freshwater supplies can mitigate this risk by greatly expanding their utilization of nonconventional water resources (such as desalination and water recycling). Being able to do so is contingent on a country's financial and development capacity to invest and build water infrastructure that can augment its existing water sources with nonconventional water supplies.

The mostly arid climate and predominantly flat, desert landscape of MENA is not a naturally favorable environment for large surface water systems borne from high-elevation headwaters, but there are a few major exceptions. The Nile River provides a critical water supply to all of its basin states, most especially its two most downstream arid riparians, Egypt and Sudan (which together account for nearly 90 percent of annual water withdrawals from the Nile). In many ways, the Nile is the lifeblood of Egypt: 99 percent of Egypt's population resides along the floodplain and banks of the river, and the Nile Delta (Egypt's most fertile region) accounts for 63 percent of Egypt's agricultural lands.

Much of the recent tensions in the Nile River Basin have centered on the Blue Nile segment of the river, which originates from highland headwaters in Ethiopia and provides 83 percent of the Nile's annual volume. The construction and subsequent fillings of the hydropower-generating Grand Ethiopian Renaissance Dam has put Ethiopia's energy security goals at odds with Egypt's and Sudan's critical need for the Nile's water resources. The lack of transboundary cooperation among these three nations on how to manage the Blue Nile conjunctively with respect to the Grand Ethiopian Renaissance Dam and other water infrastructure—especially under prolonged drought conditions brought on by climate change—will likely result in further unilateral actions that could threaten the viability of the Nile as a water resource for all riparians.

The Tigris-Euphrates River System is another river basin that suffers from transboundary water-sharing challenges. Originating from the mountains of eastern Türkiye, both the Tigris and Euphrates Rivers travel through Syria and most of Iraq before merging together to form the Shatt al-Arab, which terminates in the Arabian Gulf. Much like the Blue Nile segment of the larger Nile River, the water issues in the Tigris-Euphrates River System are associated with consequences of upstream water-use operations on downstream riparians. Prolonged drought conditions in this basin (which have been exacerbated by warming from climate change) have led to a zero-sum game of competing water management needs among the riparians. Türkiye, where the headwaters of both rivers originate, has been moving forward with its own water development projects to secure as much as possible of this surface water resource for its own water security. These projects have had the most negative impact on Iraq, the most downstream riparian in this basin. As a cumulative effect, Türkiye's dam construction projects have reduced Iraq's water supply from the Tigris and Euphrates Rivers by 80 percent since 1975. Iran, which contributes to the Tigris-Euphrates River System

with tributaries that originate from within its borders, has also pursued dam construction projects that have further reduced the tributary flow into the river system. Future projections estimate that by 2025, the flows of the Tigris and Euphrates Rivers will decrease by 25 percent and 50 percent, respectively. The consequences of this diminished river flow are already detrimental for Iraq, resulting in a lack of sufficient potable water in the city of Basra near the river system's outlet to the Arabian Gulf.

At the root of the water management challenges in the Tigris-Euphrates River System is the lack of binding multilateral agreements between all the riparians of this river system: Türkiye, Syria, Iraq, and Iran. The presence of such a set of agreements that includes all riparians could encourage transboundary cooperation, which would disincentivize the current state of unilateral water operations that disproportionately harm downstream riparians. A number of agreements already have been put into place within this basin, but these have been bilateral in nature between only a couple of the riparians and have had broad stipulations on cooperation. Examples include the 1987 Protocol on Economic Cooperation between Türkiye and Syria (an interim agreement on water quantity to be released at the Syrian-Turkish border) and the 1990 Syrian-Iraqi Water Accord (to allocate the water of the Euphrates between Syria and Iraq). To date, water negotiations between Iraq and Iran on shared tributaries have yielded no tangible agreements. Without cooperation between these riparians—especially between the upstream nations of Türkiye and Iran with Iraq—the water quantity and quality of this basin will continue to decline to dangerous and potentially irreversible levels.

Southwest of the Tigris-Euphrates River System is the Jordan River, a surface water basin with headwaters in the Anti-Lebanon Mountains bordering Syria and Lebanon. The river flows southward through Lake Tiberias and pools into the Dead Sea. Although tributaries from Lebanon, Syria, Jordan, and Israel and the West Bank feed into the river, water-sharing of the Jordan River is primarily a management issue between Jordan and Israel. Increasing aridification as a consequence of drought has been a key driver in the large reduction in flow of the Jordan River, with estimates of current flow being equal to 10 percent of the river's historical average. Less streamflow into the river from the headwaters has translated into shrinking water levels for both Lake Tiberias and the Dead Sea.

But a reduced water supply is not the only factor compromising this surface water basin. The water quality in the Jordan River and of the two lakes that are part of the system (Tiberias and the Dead Sea) has progressively declined to a state that could cause water from this basin to become unusable without extensive and costly water treatment or desalination. Rising salinity and pollution in the Jordan River are byproducts of sewage and solid waste being discharged into the river and irrigation water runoff draining into the river from nearby farms. Irrigation water runoff entering the Jordan River is highly saline because of the salt leached from crops during irrigation, and it contains chemical contaminants from pesticides applied to crops. This contamination not only threatens the water quality of the Jordan River but also is a risk to nearby groundwater aquifers, into which these pollutants may seep and infiltrate.

Though surface water systems are limited, groundwater aquifers are much more prevalent across the region. As such and historically, groundwater has been a key source of freshwater supply in the region, especially in areas with no access to surface water, including the Arabian Peninsula and the Gaza Strip in Palestine. The most prominent example of groundwater utilization and extraction in the region is Libya's Great Man-Made River Project, a large-scale water infrastructure project borne out of Libya's dependency on groundwater and lack of surface water supplies. This historical overreliance on groundwater resulted in the overpumping of coastal aquifers near major Libyan cities in the northern part of the country, prompting the need to transport water from further aquifers in the south. The Great Man-Made River Project would become the means of this water conveyance. Originally, the project was justified as a more cost-effective alternative to desalination, but the scale of the project has made it costly in terms of construction, maintenance, and energy consumption to pump and distribute the extracted groundwater. Furthermore, project expansion and upkeep have been threatened by unreliable financial support and security risks from vandalism and crime. Ultimately, groundwater is a finite resource, which presents the question of what happens to a huge, costly project like the Great Man-Made River Project when the aquifers on which it relies are no longer sustainable.

With the inclusion of alternative nonconventional water supplies across the region, primarily desalination, groundwater has been mainly used to satisfy drinking water and irrigation needs. But even with a diversity of water supply sources available, this resource is still very much at risk of overdraft, as the regional extraction of groundwater far exceeds the natural and artificial replenishment of exploited aquifers. Much of the challenge of managing groundwater is associated with several primary issues. First, there is not sufficient information or adequate quality of data to accurately determine how much groundwater is stored in the region's aquifers. Irregular monitoring and tracking of groundwater extraction, as well as the replenishment of these aquifers, all contribute to this lack of data. This is an issue across MENA, as on-the-ground monitoring networks in this region are not as robust as in other parts of the world, necessitating a greater reliance on satellite information or modeling data. Second, as an extension of the lack of information issue, there is little to no regulation of groundwater aquifers in the region, which makes managing and sharing transboundary aquifers even more difficult. Usually, nations that share mutual aquifers do not have conjunctive management operations.

The most important water augmentation innovation that has buffered the countries of the region against limited freshwater supplies and water stress is desalination. Although most MENA coastal nations have active desalination plants, none of the countries in the region are as reliant and dependent on desalination as the countries of the Gulf Cooperation Council (GCC): Kuwait, Bahrain, Saudi Arabia, Qatar, the United Arab Emirates, and Oman. Nearly half of the world's freshwater desalination (45 percent) occurs in the Arabian Gulf, with several GCC members sourcing nearly 90 percent of their drinking-water needs from desalination.

The use of desalinated water has enabled the GCC and other countries in the region to help bridge the gap in the imbalance between their water supplies and water demands. But the construction, operation, and maintenance of water desalination plants is a costly, lengthy (in terms of design and construction), and energy-intensive enterprise. And while the financial resources of the GCC states, and their dire need for water resources in extremely water-scarce environments, make desalination a palatable water acquisition strategy, other countries in the region may not have the capacity and capital to follow suit. Additionally, concerns have been raised as to the environmental impact of this level of desalination activity in the region—especially in the Arabian Gulf—because of the volume of concentrated brine discharge that is released back into the source water body of the desalinated water. But recent research has indicated that the Arabian Gulf is not under risk of elevated salinity caused by the discharge of brine from the many desalination plants along the Gulf's coast. Even though the research studies denote that this finding may be true in the Arabian Gulf for the coming decades, there is still some uncertainty if this finding could remain valid further into the future with an increased number of and expanded capacity of desalination plants along its coast.

Effects of Global Warming on Regional Climate

According to the Koppen Classification System, most of the MENA climate can be described as a hot desert environment that is consistent with a dry climate zone. Thus, as a region it is naturally prone to aridity, little rainfall, sparse vegetative land cover, and higher average annual temperatures, especially during the summer period where temperature extremes are more pronounced than other parts of the world. These conditions already have put the MENA region in a natural environmental state that increases the likelihood of extreme water scarcity. However, the accelerated advent of climate change has added a layer of complexity when it comes to the region's climate and its water resources.

Over the past decade, the growing impacts of climate change in MENA countries have been adverse, with direct implications for the reliability of the region's water supply and infrastructure to satisfy its various types of water demand. The primary climate impact that drives several implications associated with water insecurity is extreme heat and warming. In recent years, the Middle East, a region already experiencing significantly warmer temperatures than most of the rest of the world, has seen an elevation of daily temperature highs above the historical average for the region. Progressively, during the summer periods in the past several years, a number of countries and cities in the region have broken historical records for daily temperature highs. For example, in July 2023, the Persian Gulf Airport in Iran registered a heat index of 152°F (the heat index being a metric that couples the effect of humidity with air temperature to gauge the perceived heat that humans experience). This extreme level of heat coincided with the hottest month ever recorded, where the global average temperature record was broken and set three times over a span of four days (from July 3 to 6).

Even as climate change has increased air temperatures in the region, a similar effect has been occurring in the surrounding oceans and seas. A corresponding rise in sea surface temperatures has yielded dangerous outcomes with regard to extreme weather. Warmer oceans and seas tend to generate more extreme weather in the form of severe thunderstorms and even cyclones. And while precipitation and rainfall can be considered boons for a mostly dry and arid region like MENA, the intensity of rainfall, winds, and subsequent flooding from these storm events can be catastrophic.

Heavy rainfall events that have produced expansive flooding have been occurring with more frequency in MENA. This is especially the case for the countries of the Arabian Peninsula, an area surrounded by the Arabian Sea and Indian Ocean, two water bodies that experience significant warming during the summertime owing to their proximity to the equator. These heavy thunderstorms and corresponding floods have particularly afflicted the countries in the southern part of the Arabian Peninsula: Oman, Saudi Arabia, the United Arab Emirates, and Yemen. And while these types of storms have been most pronounced along the southern coastline of the Arabian Peninsula, severe weather has even made it as far inland as Mecca, Saudi Arabia.

In extreme cases, these types of storms are intense enough to be categorized as tropical cyclones. Such severe storms can cause catastrophic flooding that results in substantial infrastructure damage and fatalities. The frequency of these types of tropical cyclones forming in the Indian Ocean and making landfall at a high level of severity is relatively low, but they do occur to devastating effect. Both Oman and Yemen have been the primary recipients of these tropical cyclones. In 2021, Cyclone Shaheen made landfall in Oman as a severe cyclonic storm. The heavy rainfall, excessive flooding, and high winds of the cyclone caused serious damage to infrastructure and a considerable death toll. With the likelihood of increased global warming in the future, tropical cyclones may form and make landfall at greater frequency and intensity, with the potential of traveling further inland than the southeastern coastal front of the Arabian Peninsula.

Cyclones have a history of developing from the Indian Ocean in the warmer waters surrounding the equator, but there is growing concern that sea surface temperatures across the globe are rising. Significantly warmer ocean waters will likely produce more extreme weather, even for water bodies that generally are known to produce cyclones and hurricanes (like the Indian Ocean and the Atlantic Ocean). However, an increase in global sea surface temperatures could see extreme weather occur from oceans and seas not historically prone to creating them. This has been the case for the Pacific Ocean, where hurricanes rarely form and make landfall. Historically, the Mediterranean Sea has had similar experiences: it would be unusual for cyclones or medicanes (the term used to refer to cyclones from the Mediterranean Sea) to form and make landfall with severe intensity. But with the amplification of climate change enhancing warming in oceans and seas, both the Pacific and the Mediterranean could see such effects in the future.

An indicator of what a future with extreme weather from the Mediterranean Sea would look like came in September 2023, when Storm Daniel made landfall in eastern Libya. Developing as a medicane and following its trajectory from Greece, Storm Daniel descended into the coastal Libyan city of Derna, causing torrential rainfall and severe flooding. But the tragedy of Derna was not limited to these initial hydrological impacts of extreme weather. The combination of an incredibly large amount of rainfall and the country's aging and neglected infrastructure led to the collapse of two dams upstream of Derna—Derna Dam and Mansour Dam. The outcome of that critical failure of water infrastructure was nothing short of catastrophic. Entire neighborhoods and large parts of the city of Derna literally washed out to sea under the massive release of water from these collapsed dams, further inundating a city already submerged with floodwaters. The death toll from this climate calamity is in excess of 10,000 people, and that figure is expected to rise as an equally large number of missing people are still unaccounted for.

It is clear that the warming of the oceans and seas surrounding MENA has direct implications when it comes to producing extreme weather that can affect the countries of the region. But in conjunction with these short-term, yet intense and potentially more frequent, weather events is another more long-term and incremental impact from the warming of the oceans: sea level rise. The threat of sea level rise will only continue to increase in the future, as the Sixth Assessment Report of the Intergovernmental Panel on Climate Change indicated that sea level rise due to ocean warming from greenhouse gas–driven global warming will continue for centuries. What is equally alarming is that even if global warming is curbed by fully mitigating greenhouse gas emissions, the coastal encroachment resulting from sea level rise at that point in time will be irreversible for further centuries.

Implications of the Climate/Water Nexus on the Middle East and North Africa

The regional climate effects of global warming on both land and sea have direct consequences for managing the region's water supply, water demand, and water infrastructure. Warming is a key driver of drought conditions, especially for surface water systems. Significantly warmer conditions affect surface water systems in several ways. For surface water systems that rely on water being generated from higher-elevation precipitation and snowpack (which is the case for the Nile River, the Tigris and Euphrates River System, and the Jordan River), climate change can reduce the volume of water that is generated from these higher-elevation headwaters. Because warming can lessen the amount and rate of precipitation that occurs in these higher elevations, the smaller snowpack and subsequent snowmelt from the headwaters would reduce the flow of these rivers. A reduction in snowpack can occur primarily when some of that snowpack sublimates (changes into water vapor directly) owing to extreme heat, as opposed to turning into snowmelt. Also, with higher regional temperatures, the rate of evaporation will likely increase, resulting in less water available downstream as the river experiences elevated evaporation along its route

towards its terminus. For countries in the region that utilize a surface water supply source, this reduction in available surface water will cause them to shift more of their reliance on other sources of water supply—placing pressure on alternative sources of water to meet this shortfall.

Warming will also have an effect on water demand in the region. The three broad sectors of water demand are urban or residential water use for human consumption (including for drinking water and sanitation), agricultural water use to support food production, and industrial water use (such as for manufacturing, commercial uses, and energy generation). Rising temperatures in the region have the potential to significantly inflate water demand from these different water consumption sectors as a consequence of their unique water needs.

Agriculture is the largest consumer of water globally, on average amounting to 70 percent of water use. This statistic also holds true for MENA, where most countries' agricultural water use as a percent of total water withdrawals exceeds 50 percent. In Morocco, Sudan, and Yemen, agricultural water use is close to or higher than 90 percent of total water used. With increased warming, the rate of evapotranspiration from irrigated crops also increases. To counteract this evaporative loss of water from crops due to higher temperatures, irrigation requirements per crop type must also increase to ensure sufficient water has been applied during the growing season. The largest sectoral consumer of water thus will require even more water to meet regional food production needs.

Urban water use (which includes domestic and residential water consumption for drinking water needs and sanitation) accounts for a significantly smaller portion of total water demand in the region (on average approximately 8 percent of freshwater use). But as with agricultural water use, urban water use is also influenced by the region's warming climate. Inflated urban water use can be linked to the urban heat island effect, where daytime heat from sunlight and warm emissions from vehicles and air conditioners are trapped by heat-absorbing infrastructure and materials (like asphalt in roads). Urban areas also tend to have less natural and green areas, which help to diffuse some of the absorbed heat. During periods of extreme heat, the urban heat island effect can push urban water consumption to higher levels, as urban residents use more drinking water to cool down from the heat and apply more water to maintain green natural spaces in cities.

Another factor that is progressively boosting urban water use is the rate of population growth in the MENA region. In 2022, the average annual population growth across the region was 1.9 percent, with Syria and Yemen leading the annual urban population growth of individual countries at 4.8 percent and 3.8 percent, respectively. Compared to regional annual urban population growth rates in excess of 4 percent pre-1990, the current figure seems modest, but future population growth projections paint a different picture. By 2050, half of MENA countries will see their total populations grow by over 50 percent compared to their population size in 2015. Three nations in particular—Iraq, Palestine, and Sudan—will more than double their population size from 2015.

Impacts to industrial water use are also expected to occur with enhanced regional warming, especially for water needed for energy generation. Hydropower generation is directly affected, as surface river systems with hydropower plants will see reductions in river flows (at the headwaters) owing to higher levels of evaporation. Additionally, water is a critical component of power generation in thermoelectric plants, primarily for cooling purposes to produce electricity more efficiently. Water scarcity as a consequence of climate change can therefore severely constrain a power plant's ability to efficiently and optimally generate electricity.

Water infrastructure is a critical component of any water management system, as it is the means by which water is transmitted, stored, or treated, to connect the water supply from source to utilization. Unfortunately, several MENA countries do not have reliable and efficient water infrastructure. For example, more than 50 percent of Jordan's drinking water supply is lost because of water leakages and illegal theft of water from the water transmission network. Similarly, Lebanon is experiencing water system losses of 40 percent as a consequence of illegal water connections and inadequate maintenance of its water transmission network.

The region's water infrastructure will be even more vulnerable due to the effects of climate change. Extreme heat, extreme weather, and sea level rise threaten the reliability and durability of water storage, treatment, and transmission infrastructure. As higher temperatures from warming elevate evaporation rates, reservoirs and dams used for surface water storage (such as the Aswan High Dam in Egypt or Atatürk Dam in Türkiye) will lose more of their stored water to evaporation. Prolonged exposure to extreme heat over time can reduce the lifespan of critical water infrastructure such as dams, water treatment plants, desalination plants, and water transmission pipelines and canals, thereby increasing the risk of infrastructure failure if adequate repair and maintenance is not implemented.

Extreme weather is an even more immediate threat to critical water infrastructure. High winds, intense rainfall, and flash flooding from severe thunderstorms and cyclones can cause sufficient structural damages that will either force water infrastructure operations offline for repair or, in an extreme case, lead to their catastrophic and irreparable failure (such as what happened to the dams in Derna, Libya). Other types of extreme weather, like the frequently occurring dust storms of the Arabian Peninsula, can also damage water infrastructure.

The future viability of existing coastal water infrastructure and resources is also at risk from the longer-term ramifications of sea level rise. As sea level rise continues unabated in the span of decades and even centuries (as suggested in the Sixth Assessment Report of the Intergovernmental Panel on Climate Change), encroaching seawater will likely inundate and submerge critical water infrastructure such as desalination and water treatment plants along MENA coasts. The corresponding losses of nonconventional water supplies and the ability to produce drinking water from nonpotable sources would be disastrous for the region. It would hurt the GCC countries in particular, as they rely disproportionately on desalinated water to meet their consumption needs. Incremental sea level rise also propagates seawater

intrusion into groundwater aquifers near the coast and pushes salty seawater into the coastal outlets of rivers—a problem that is already happening in the Nile River Delta along the Mediterranean in Egypt and the Shatt al-Arab outlet of the Tigris-Euphrates River System to the Arabian Gulf in Iraq.

Besides the water management challenges posed by inadequate water supply, inflated water demand, and precarious water infrastructure integrity, the region could contend with a possible public health crisis from the poor quality of much of its freshwater. As water supplies dwindle and drinking water needs increase because of the effects of warming, disenfranchised segments of the region's population that live in rural areas or refugee camps, and cannot financially afford to acquire adequate supplies of drinking water, may make difficult and dangerous decisions when it comes to meeting their water needs. This scenario has played out in Syria, where people who are desperate for water have extracted contaminated water from the Euphrates River and utilized it without proper water treatment. Consequently, rural Syria has seen several outbreaks of waterborne illnesses and diseases, the most recent of which is a cholera epidemic that has caused fatalities in the local population.

Conclusion

When it comes to the climate-driven water security challenges of the MENA region, several key messages are clear.

Water scarcity and water stress. The region is naturally prone to arid and dry conditions, leading to a chronic state of water scarcity. Limited freshwater supplies and growing demand for water have resulted in elevated levels of water stress across MENA countries.

Regional differences in water stress. Water stress varies across the region, owing primarily to differences in access to freshwater and nonconventional water sources. Countries with access to renewable water supplies have some advantage, while others rely heavily on nonconventional sources like desalination.

The importance of desalination. Desalination has become a crucial water augmentation strategy for mitigating water scarcity in the region. GCC countries in particular mostly rely on desalination for drinking water needs. However, this method is cost- and energy-intensive and could pose some long-term environmental concerns.

Water quality challenges. Poor water quality in freshwater sources poses public health risks, especially in rural areas. Contaminated water sources have led to outbreaks of waterborne diseases.

Groundwater depletion. Groundwater aquifers are a significant source of freshwater, especially in arid regions like the Arabian Peninsula. But overextraction of groundwater is depleting these aquifers.

Transboundary water conflicts. Transboundary water management challenges, particularly in the Nile and Tigris-Euphrates River Basins, have strained relations among riparian nations. The construction of dams and reduced river flows have created tensions, posing a threat to regional stability.

Climate change amplifies water issues. Climate change is exacerbating water insecurity by increasing the frequency and severity of droughts. This new climate reality threatens to widen the gap between water supply and demand, compounding existing water scarcity issues.

Climate change and extreme weather. Climate change has brought about extreme heat waves, severe storms, and cyclones in the region. These events have serious implications for water infrastructure, including reservoirs, dams, and desalination plants.

Sea level rise. In the long term, rising sea levels are threatening coastal water infrastructure, such as desalination plants and water treatment plants. Seawater intrusion into groundwater aquifers and coastal river outlets is also a growing concern.

Impact on water demand. Rising temperatures increase evapotranspiration rates, leading to higher water demands in agriculture and urban areas. Population growth will inflate future urban water consumption, particularly in rapidly growing cities.

Overall, the MENA region faces a multifaceted water crisis that is exacerbated by climate change. Desalination has provided some reprieve to the region's water deficit, but it comes with its own set of environmental and economic challenges. Transboundary water disputes, groundwater depletion, and the vulnerability of water infrastructure to extreme weather events are pressing issues that require urgent attention. As the region grapples with these complex challenges, addressing water scarcity and improving water management will be immensely important for ensuring the stability, sustainability, and the well-being of its populations in the face of a changing climate.

CHAPTER 3

On the Margins: Civil Society Activism and Climate Change in Egypt

Dina Zayed

In October 2015, a small Egyptian village, 80 kilometers (about 50 miles) from Alexandria, was swept by an extreme flooding event that killed twenty-seven people and submerged hundreds of acres of agriculture land. The initial hours and days of managing this crisis were ad hoc, and community associations rapidly formed and took the leading role, navigating relief networks and coordinating resources. In the weeks that followed, the Egyptian government committed 35 million Egyptian pounds to a relocation plan to rebuild the shattered community and help move dozens of families away from what was deemed a dangerous flood plain. But by November 2017, an investigative piece in a local newspaper had confirmed that less than half of the 320 families of the village had moved to the new site, named *Qaryat al-Amal*, or "Village of Hope." Al-Amal had no schools, electricity, water pipes, or sewage facilities because of contractor delays. Many of the villagers, unable to afford commuting dozens of kilometers for services, opted to remain on the flood plain, naming it the "grounds of mass destruction" but unable to leave. The investigative piece went on to detail that the villagers who refused to move to the incomplete site were visited by local officials who forced them to sign an eviction form that demanded they leave during the winter season for their safety or accept remaining at their own risk.

Several years on, few of the conditions this small village faced are exceptional. Like hundreds of communities across the Nile Delta facing changing climate conditions, its recourse to civil society support is not self-evident. Egypt is one of the world's most vulnerable countries to climate change: estimates suggest that under the scenario of a one-meter sea-level rise (SLR), up to 10 percent of Egypt's population would be affected and nearly 15 percent of agricultural land could be lost. Egypt's own national communications to the United Nations Framework Convention on Climate Change (UNFCCC) reference analysis that positions the country as the second-most-exposed country in the world in terms of coastal populations affected and third for the proportion of its gross domestic product (GDP) at risk under a one-meter SLR. For a country in such dire straits, a thriving civil society network

of advocates and intermediaries may be expected. Yet, national strategies offering nods of recognition to the importance of civil society, are silent about how to meaningfully enable a strong ecosystem of civil society partners to champion citizen action around climate change and mediate public policy and societal interests.

It is widely understood that civil society advocates can act as an "essential bridge" between the public and the state. They can hold governments accountable to act on "behalf of citizens," facilitate citizen action and advocacy around climate change, and ensure the independent collection and tracking of data. As climate change and its long-term impacts may imply policy shifts or costly investments, participatory planning is proposed to make better decisions, support collective problem-solving, reflect citizen needs, and achieve equitable outcomes. Much of this planning depends on the existence and strengthening of a diverse spectrum of stakeholders that are capable of transparently and fairly sustaining engagement with the public and supporting the tailoring of policy design to meet various actors' needs.

But in a context like Egypt, where restrictions, limited resources, and underdeveloped connections shape the scope of what civil society advocates are capable of achieving, how much of that role can civil society organizations (CSOs) play? When Egypt hosted the UNFCCC's twenty-seventh Conference of the Parties (COP27), the country's human rights record and security engagement with civil society received a huge amount of media attention. In a mainstay of Western press, calls for solidarity with Egypt's "embattled civil society" resounded, alongside analysis that spotted the ways in which discourses around civic space in Egypt threatened the credibility and the image of the COP27 host, dampening faith in the Egyptian leadership's capacity to fully engage key partners in addressing the climate crisis.

Against these concerns and broader lamentations of restrictive civic space, Egypt's comprehensive 2011 Climate Adaptation Strategy, and its latest National Climate Change Strategy 2050, clearly mention vital partnerships with civil society, offering them the particular duty of engaging the public and promoting climate-resilient social behavior. Draft language in the new strategy argues in its introductory pages that the "implementation of the national strategy for climate change in Egypt requires the participation of all sectors of society, including NGOs [nongovernmental organizations] and civil society, not just government agencies." In the earlier 2011 Climate Adaptation Strategy, the "weakness" of civil society and its "resistant" attitudes to "advancement" is critiqued, but these statements declaring the essential role of civic groups nonetheless offer clarity on the Egyptian state's desire to work in alliance and coordination with nonstate actors.

From within this context, this piece explores the challenges faced by Egyptian civil society groups. They operate in one of the world's most vulnerable countries to climate change but appear relatively unable to mobilize public attention and advocate for wide-reaching climate policy change. Yet, while it may seem that civil society groups have little voice and ability to work on climate change in the Arab world's most populous country, in practice both the

restrictions *and* the possibilities for policy and societal engagement are far from uniformly distributed. One must exercise caution in describing a singular, homogenous civil society field. This piece will first contextualize the landscape from which climate-minded civil society actors may operate in Egypt, focusing on a range of legal and security restrictions and long-standing state discourses that question the legitimacy of civil society actors. These dynamics in turn shape the nature of opportunities for civil society mobilization. It will then examine some of the tactics, spaces, and narratives adopted by civil society groups working on climate change by looking at how organizations routinely benefit from the relative policy marginality the climate change issue occupies. In doing so, it will reveal the ways in which local groups may find windows of opportunity in response to local crisis or through policy openings. This piece draws on a variety of civil society responses, dozens of interviews conducted between 2017 and 2022, and the author's own professional and participatory research experience.[1] It further explores the calculated disavowal of combative politics and the tactical ways in which nonstate actors may become embedded in closer, often informal, contact with official policy networks. Through careful effort, some groups may appear to be able to escape the worst of a challenging political and security environment and leave a tangible imprint on policy design, defying what may be assumed about civil society activism under current political circumstances. More research is needed, but the piece argues that much remains to be understood on how disparate and fragmented civil society groups can galvanize grassroots solutions and hold governments to account in different political settings. This is especially important when considering the Middle East and North Africa region, where few works have attempted to understand social and political responses to the climate crisis.

Sanctioned Environment?

Since the 2011 political upheaval in Egypt, the landscape of civil society activism has witnessed fundamental transformations. As the country is home to a rich and expansive number of registered CSOs, there is considerable existing research on Egyptian civil society, documenting numerous organizational inefficiencies, fragmentation, and decades of adapting to challenging political circumstances. Large swaths of Egyptian civil society often have lacked domestic constituencies that support their missions; have operated under an overall environment of restriction; and invariably have depended on foreign funding, which repeatedly has exposed them to attacks that aim to discredit them domestically.

In recent years, international rights group have described "unprecedented" and renewed restrictions on NGOs in Egypt. Civil society groups have been characterized as being on "life support" and facing the risk of "obliteration." Human rights groups describe a landscape in which a combination of repressive tactics, combining legal and bureaucratic restrictions with threats of arrests and crackdown, have constrained the scope of activities and issues on which NGOs can work. Some critics points out that vaguely worded bureaucratic and legal restrictions sanctioning the activities of nonstate groups have hampered the spaces in which CSOs function and interact.

Until recently, Law 84 of 2002 regulated Egyptian civil society. Observers have long noted that its ambiguous language often enabled selective implementation of its provisions. Subsequently, at the drafting of Law 70 of 2017, groups like Amnesty International argued, renewed, deep restrictions on CSOs were once again imposed. Amnesty and others proposed that changes to the law provided the government with "extraordinary powers over NGOs," particularly limiting their independent ability to fundraise.

In the decade since the political upheaval that swept across the Arab region, pressures on civil society have ebbed and flowed, with some moments of escalation and others of relative calm. But for the most part, some Egyptian civil society groups have had to grapple with an array of travel bans, new rules on bureaucratic red tape, arbitrary arrests for interrogation, and a general climate characterized by critics as one of "unpredictable escalation." Observers note an overall sense of fear and, most importantly, uncertainty that has come to define CSO calculations on where the redlines may be, at least for politically focused advocacy. This is especially true if such advocacy is framed around human rights.

The government routinely emphasizes that restrictions are meant to regulate NGOs, rather than prevent their operations. Yet the net result of this environment has largely been that many civil society activists find themselves operating in hostile terrain, with opportunities for mobilization circumvented and fears of surveillance and security harassment shaping their calculations. Most notably, some observers have described restrictions on receiving foreign funding as a tactic of control, encouraging competition and fragmentation among Egyptian civil society actors in a manner that prevents them from building cross-sectional alliances. Although these dynamics are far from static, one long-term activist, interviewed for this analysis, described a "state of sanction of activities unwitnessed before." For him and others, not only are CSOs grappling with the limitations of a restrictive environment—either having to unilaterally retreat or being forced into closure—but also, some large organizations operating out of Cairo and other major urban centers describe security meddling in the events they organize, the partners they collaborate with, and the topics they choose to work on.

Holding this context in mind, the following section will turn to the specific contours of civil society engagement around climate change in Egypt, highlighting the myriad ways in which some groups, aware of the overwhelming pressures facing CSOs, work on the topic—often by adopting alternative operational models and tactics.

Civic Engagement, Climate Engagement

> They may cover the windows with black drapes and block the entrance with a sign that you are not allowed to enter or record. But, if you just walk around the building, you might find a broken window and watch every detail. . . . Maybe even, without them noticing, you can enter the room.
>
> —Pioneering environmental civil society activist

There is limited research on CSO engagement with climate change in Egypt, and efforts to map and understand current patterns of national and regional policy advocacy and public awareness–facing initiatives are nascent at best. The infancy of this research agenda also mirrors the relative lack of knowledge on broader public awareness and engagement with climate change in the country; a series of recent surveys offered mixed and inconclusive results. The largest international survey of public opinion on climate change ever conducted, which included Egypt, showed broad-based support for ambitious climate action—even though the portion of surveyed Egyptians who supported major policy shifts lagged other countries. Against that, an Egyptian survey, conducted by Baseera, in 2022 indicated that only 65 percent of Egyptians had heard the phrase "climate change." The survey indicated that while most Egyptians understood that something is changing for their agricultural systems, water resources, and weather, their articulation of the causes and their understanding of climate change did not seem to match. But equally, all recent surveys seem to indicate an awareness of shifts in weather patterns, crop variability, and broad articulation of the *lived* realities of a changing climate, with another survey even suggesting that 92 percent of Egyptian respondents said climate change was already affecting their everyday life.

Among CSOs, some of these discrepancies are mirrored. One recent mapping, produced by Egyptian environmental organization Greenish in collaboration with the UK-based Climate Outreach, covered 283 CSOs around the country, aiming to identify a climate engagement ecosystem. The study found that a mere 8 percent of organizations referenced climate change in their organizational vision, mission, and objectives, but around 24 percent documented climate engagement work. The latter figure is probably influenced by a burst of activities prior to COP27.

An earlier mapping exercise, produced by the Egyptian Initiative for Personal Rights (EIPR), similarly documented a proliferation of civil society work around environmental issues.[2] Both studies indicate there is a broad-based network of groups with an environmental mission, but they equally identify the extent to which this remains a small and loosely held together network of NGOs, often highly place-based and focused on single-issue environmental matters. It is also clear that observers have no in-depth understanding of the differences between urban-based CSOs and rural associations, and how those two groups may operate.

Despite Egypt's rich history of associational life, environment-focused activists are such a small group that they circle between organizations, and civil society professionals with environmental credentials invariably know one another both socially and professionally. Broadly speaking, public engagement on climate action has limited material budgets. Essentially, Egyptian CSOs face myriad challenges in working on climate change—most centrally, in accessing funding, with smaller and rural CSOs unable to systematically participate in national policy dialogues and tap into funding streams. The longevity of initiatives and their capacity to scale and grow are also limited, with activities routinely being project-bound. For example, comparing EIPR's 2016 mapping against current realities would indicate that roughly two-thirds of the rights-driven environmental advocacy platforms they identified either no longer exist or are largely inactive.[3]

But against that, Egypt's national adaptation strategy and work on the ground together indicate that many CSOs play a role in climate change engagement efforts and in supporting community-led adaptation initiatives and projects. Overall, however, spaces for civil society engagement largely appear atomized and often highly reactive, even though these can materially translate into some nonstate representation in policy dialogues and project programming for donor-funded climate activities. One project, for instance, implemented by the World Food Programme and supported by the Adaptation Fund, focuses on southern Egyptian agricultural zones and adaptation efforts there. According to the World Food Programme's description, the project has been designed and is implemented through a multidimensional stakeholder-driven effort in which national, regional, and local authorities work closely with and rely on community groups and associations to deliver agricultural adaptation programs. It uses participatory appraisal techniques and is dependent on the support of local NGOs and nonstate groups to enable outreach and public engagement.

Interested observers, thus seeking to identify organizations working on the climate agenda at a national level, may find it difficult to assemble a comprehensive list of entities with this focus, and instead they come away with a perception of a fragmented civil society landscape. In many ways, the civil society groups working on climate change in Egypt resemble the government response to the climate crisis, with decision making around climate change distributed across multiple ministries, each holding separate and often competing mandates. This dynamic in turn has consequences for environmental NGOs, which must learn to identify suitable allies across a loose government structure.

It also appears there are numerous models of civil society engagement around environmental and climate issues in Egypt. The first of these models involves working below the radar and often deliberately adopting noncombative forms of advocacy. Many environmentally minded activists in this model choose to reinvent themselves into social enterprise modes, makerspaces, and community hubs. At the same time, they rely on workshops and other convening spaces for dialogue and connection, focusing on networking between atomized groups and building deeper forms of solidarity for learning and knowledge exchange. These groups may rarely, if ever, interact with official policy circles.

A second model of engagement is the one invoked in response to moments of crisis—with civil society groups forming the backbone of relief networks first to respond to incidents like extreme weather events. In those moments of crisis, they can be capable of determining policy approaches to relief. This is not merely a humanitarian response role but one in which associations and local organizations may have strong capacity to influence the government's understanding of the climate issue, helping to shape official analysis of climate vulnerability and potentially steer the direction of resources.

Finally, a third tactic and pattern of climate policy engagement is the one shaped by highly informal modes of cooperation with officials, in response to specific policy windows. In this process, organizations are invited or may find themselves able to contribute their views in drafting key policy outputs. Alternately, they may be supporting officials within government, as consultants and advisers.

One example of the first model is an organization in Alexandria, Egypt's second-largest city, which runs dialogue-driven simulations and debates. By putting Alexandria's issues and its record of environmental governance on "public trials," it draws in volunteers to enact what resembles a collective visualization exercise and offers spaces for public engagement and awareness-raising campaigns. Some of this public engagement–facing work on climate change is routinely led by organizations formally labelled as "social enterprises," but many of the staff members of these organizations see themselves as serving a broader public agenda on climate action and regularly pursue opportunities to find a corner into conversations on the climate agenda.[4] In private, many such social entrepreneurs interviewed for this research would even describe themselves as "civil society activists."

These sentiments echo Yomna ElSayed's exploration of a trend showing social enterprises emerging in Egypt as a "hybrid" space for activists to "transition back to civics," drawing on the revolutionary movement of 2011 but within the current state of sanction. She finds that despite the social enterprise label, few groups successfully generate a real profit. Instead, they maintain the work that allows them to engage in advocacy campaigns, in which the ideas of politics are kept strategically vague and ambiguous to practice "politics by other means" shaping "win(s) without attrition." One entrepreneur rationalized in an interview: "The restrictions are overwhelming. So, I am thinking of it instead as a puzzle, which means I'll work on another part of the piece."

Makerspaces, or groups that offer a community venue equipped with a variety of tools to give people an ability to physically experiment with their ideas, are another modality growing in appeal. One makerspace, housed within a cultural center associated with a local church in Alexandria, worked with a group of youth from an informal area to build emergency lighting units for households. This project was a learning lesson to cope with electricity outages like those experienced after the 2015 flooding across the Nile Delta. "Climate change is here, and the government needs to do its part to protect this city, but with or without them, there will be solutions at the public level," one of the founders described.[5] This initiative is not registered, a purposeful decision that allows them to work in their "individual capacities." By "not existing on paper," the group can "avoid problems."

A subcategory of social enterprises focuses on facilitating workshops and community learning. Founders of this type describe social enterprises as offering the freedom to invert the power dynamic that has forced groups to be dependent on donors and government approvals for this funding. Instead, groups now can be hired to facilitate workshops, with donors becoming their *clients*, and as a result the work no longer requires state authorization. One such group works with rural villages to enable participatory learning around water management and climate adaptation. Another enterprise has in one project toured the country and facilitated dozens of workshops in coastal cities and villages.

In the second pattern identified, civil society groups may find themselves the main responders to localized crises, including around extreme weather events. In repeat episodes across the Nile Delta, and in Alexandria, local charities and place-based NGOs are often the main respondents and distributors of relief packages. This service delivery role can

be in some cases highly depoliticized and reactive, rather than one designed to shape Egypt's climate policies. Many charities responding to climate events have neither policy specialization nor deep understanding of climate change, nor even the lexicon to attribute events to a changing climate. However, in some cases, including one example in Alexandria after the 2015 flood that displaced the villagers mentioned at the start of this piece, one local charity ended up working directly with the city's municipal authorities, building on their credentials and relief networks to review and audit flood management practices in Alexandria. Much of this work is rarely credited, and the CSOs advising municipal authorities on ways to improve practices do not always have visibility of reach of their diagnostics. Nevertheless, local charity groups may have a critical role in forming knowledge and preliminary analysis, which in turn may have influence in determining government understandings of the nature of climate risks in the country, along with ways to address social vulnerability.

In this case in Alexandria, the local charity's analysis helped deliver the message that part of the city's vulnerability to the 2015 flooding incident was caused by poor information exchange and minimal public outreach that meant meteorological models were not circulated to or among other stakeholders, whether in or outside government. In the months that followed, a municipal committee was formed to help coordinate between various local government authorities and to manage drainage through a more coordinated and streamlined committee that involves local CSOs, according to the author's interviews with municipal authorities in Alexandria.

The third and final pattern of civil society tactics seen here relies on targeted informal networking, working directly with officials to support the production of key climate policy documents and strategies. Opportunities for such networking also may exist around key international conferences and multilateral negotiations, like COP27 or COP28, in which individual civil society experts have face time with key government officials and negotiators and can help support their positions and offer technical expertise and advise. Holding banquets and workshops falls on one end of the NGO-led lobbying spectrum, but more widely, individual environmental activists routinely are called upon and recruited into policy circles to help produce key knowledge documents. Examples of such documents include national reviews on climate action or the routine submissions to the UNFCCC, such as drafts of Egypt's Nationally Determined Contributions. Egypt's Sustainable Development Strategy 2030, for instance, provided several opportunities to leaders of the enterprises. For example, when the Egyptian Ministry of Planning began to organize consultations in governorates across Egypt, it worked with NGO partners and social enterprises specializing in workshop facilitation to organize those sessions. As another illustration, the ministry also partnered with a cofounder of one social enterprise focused on environmental education, effectively inviting a civil society partner to "coach" a panel of more than 200 high-level state officials on strategies to incorporate climate planning into their daily work.

With security and political restrictions both shaping what is possible for advocacy and curtailing any ability to work at the grassroots level, a pragmatic resignation that "it's not the right time to mobilize people" has given way to these tactics, premised on what one CSO

project manager described in an interview as "constructive dialogue with the right people."[6] Ties with officials are personality-driven and contingent upon fragmented policy openings. But they also are shaped by a mutual perception across government and civil society dividing lines that climate change occupies a marginal place in national conversations. In this context, specialized government officials, tasked with navigating their own burdensome bureaucratic structures, are aligned with their civil society counterparts on advancing attention around climate action. One environmental justice activist proposes that in a context where a "community of interested parties" around climate change is so small, "allies" within government—specifically mid-level bureaucrats and officials in local government offices—are crucial. Put simply, officials need support to deliver their policy objectives, and well-networked CSOs must identify key leverage points to capitalize on this need.

The challenge, of course, to all these models is that they may have little institutional continuity. CSOs must be mindful of not appearing to be the "competition." Instead, they must show themselves as relevant enough that state actors choose to work with them "because there is no alternative," yet without disrupting an official's desire to not "want someone in the room that understands more than them" or that appears too openly combative and critical of the government's political choices.[7] In allying with government actors, activists also work to strategically and consciously frame their contributions as mere "technical" interventions, a theme to be addressed in the next section.

Practicing Politics in Disguise?

> *Everything is politics.* But when you are working with the government, you must avoid politics or at least pretend to. *You need to play the game.*
>
> —Environmental researcher and advocate

In the current security environment and with concerns around arbitrary restriction, many activists propose that attracting state attention is a risky tactic. Instead, activists purposefully make environmental work look so little like politics that it inspires no security meddling. At the very least, they exploit the ambiguity of climate change issues. Previous sections explored how nonstate actors pursue alternative organizational strategies or are pulled into closer contact with state officials, lobbying elite decisionmakers directly through informal avenues. This section will highlight how both approaches may rest on the perception of climate change as a "scientific" issue, thereby giving activists a framing tool that allows for substantive critiques of political arrangements that are proposed simply as technical advice and not political or contentious condemnation.

This tactic has a long history in environmental activism and mobilization, not just in Egypt but across the region and in a diverse set of political contexts. As Jeannie Sowers puts it, the "rhetorical feint of disavowing political claims while actually revealing

local mismanagement" is a well-recognized strategy in environmental circles. Although environmental campaigns on their own rarely are capable of prompting structural reforms, they have routinely extracted tactical gains from corporations, local officials, and the central state.

In the cases described earlier, maintaining vital networks with officials means that civil society activists purposefully attempt to pick issues that will not put them "in direct and violent confrontation," aiming to focus instead on "confrontation around policies and the ideas they are built on."[8] Not only is there "room for practices to improve," but also, CSOs imagine that government officials or bureaucrats "know they need help to address climate change." The characteristics of an issue that is not "owned by anyone" also endow climate change activism with more "flexibility"—or, at least, "there is no hostility . . . [or] lurking sense of violence" that many may have themselves experienced working in other advocacy spheres.[9] This flexibility is in part shaped by a perception that officials do not have an "opposition to others. On the contrary, they think of climate change as a crisis coming our way." There is thus a window of action and a possibility for NGO leaders to leverage this need.

Climate change politics, environmental leaders propose, "are not honest" as they offer "an indirect point of entry into conversations on power, but the links are not always obvious."[10] In the political, economic, and security environment in Egypt—with inflation reaching an unprecedented 40 percent, an escalating debt crisis, and domestic security volatility—environmental issues may seem like "irrelevant," "trivial," and secondary issues dismissed as mere "privileges" that do not require imminent and immediate attention against critical livelihood matters.[11] But environmental NGOs and activists are not oblivious of the political nature of their work. Instead, they exploit the lack of political clarity as an "advantage that offers the space to work on the issue"—to build alliances, discourses, and make connections.[12] Some argue that being off the political radar is "beneficial because you have more time. You have a buffer."[13] This buffer allows for the technical nature of climate management, and the advocates campaigning on behalf of solutions to be listened to and even "congratulated" by high-ranking officials for "positive engagement" that "gives suggestions based on data."[14] By focusing on the policy issues, rather than the political system at large, CSO activists show that "if you understand the society you are working with, [officials] will listen and won't leave the conversation deciding they never want to see you again."[15]

These tactics are not exceptional to Egypt. In a wide variety of political contexts, numerous works have documented the use of "circumspect" approaches to influence environmental policy or to forge functional cooperation around "depoliticized" activities that may nonetheless "be intensely political despite not being contentious." Examples from Myanmar around supposedly "nonpolitical arenas" allowed groups to affect policies in other spheres, describing activism against dam-building projects that may appear simply about environmental concerns but also provided spaces for contesting ethnic redistribution patterns. In a connected thread, research from Vietnam highlights how a campaign against tree-cutting enabled a platform for rights-driven civic discourses around state-society

accountability. In China, environmental NGOs have used environmental issues as a "way in" to much more contested claims around democratic rights and citizenship. In the case of the charity group in Alexandria, the critique of the government's management of flooding in the city was squarely political and fundamentally about poverty, land use rights, and informality in a growing urban metropolis. However, group leaders never articulated these concerns as political agendas directly to municipal officials. Instead, they hid advice on flood management behind the veneer of depoliticized technical analysis. But in gaining an audience with officials, they managed to convey vital information on land use rights in informal areas in the city.

In conclusion, the political malleability of climate change offers a possibility for CSO groups in Egypt, as it does in a host of similar political settings. The perception that climate change and climate governance are "scientific" matters and technical domains can enable some forms of advocacy. These approaches, however, come with obvious limitations, and there are associated risks: the pretense of depoliticizing environmental work may effectively make it apolitical and unable to successfully advance climate action in the country.

Conclusion

Although Egypt operates in a context of deep climate vulnerability, Egyptian civil society groups appear limited in bandwidth and are working with stretched resources. Few organizations have a clear climate change strategy and focus, and the systematic differentiations between different kinds of associations, across urban and rural divides or around various issue areas, are less than clear. The civil society landscape around climate change in Egypt in all cases appears fragmented and small. Few organizations have the funding and connections needed to make a dent on climate action to support local mobilizations and engage national CSOs on the international front.

Yet the possibilities for policy engagement are available to *some* and are unevenly cultivated. Disparate and fragmented environmental advocates have carved out space to work on a climate change agenda. Many groups have adopted a calculated and rhetorical negation of combative politics and have exploited a perception that climate change and climate governance are merely "technical" and "scientific" matters. In the climate change policy context, the fact that environmental issues do not have an overtly contentious history is likely advantageous and tactically conducive for some civil society actors to adopt alternative organizational formats to remain below the radar. Inversely, they may be pulled into closer relationships with officials, often allowing nonstate actors to critically influence the policy design process and theoretically enable wider participation in what may otherwise be opaque political spaces.

Of course, evading political contestation may mean that self-censorship limits the scope for radical change. But contrary to abstracted global narratives that expect civil society to serve as a democratizing and pluralizing force for climate governance, there are practical and

fundamental constraints shape the feasibility of those efforts. In an environment in which the civil society community at large must navigate immediate concerns like losing funding streams and reacting to arbitrary repression, the lived realities of an under-resourced civil society community should be at the center of deeper analysis.

This piece has argued that activists make the most of the fact that climate change and environmental issues remain below the radar to connect with one another and often with the state establishment. Exclusive attention to large-scale NGOs and visible initiatives, however, may mean losing sight of numerous small-scale initiatives and locally led efforts that carry out important work on the ground and often are not labelled as climate focused. Researchers need to systematically improve the capacity to track and document these efforts. Many groups working around the climate agenda do not always describe their activities in that language, or they may not even appear to be traditional NGOs, with some opting to register as social enterprises. Yet these organizations are part of the mosaic of nonstate voices shaping the climate conversation and the nature of work at the grassroots level.

For those pulled into closer ties with national and municipal government officials, there are real opportunities to influence the framing of climate change in policy circles. In entering key policy conversations, civil society groups can co-construct at least nominally more deliberative spaces and contribute to policy evolution. It is not particularly unusual for strides on climate and sustainability advocacy to be made by highly networked organizations and individuals. Indeed, existing research reveals a "democracy-influence paradox" on an international level, in which actors with the highest capacity to engage repeatedly, and often informally, around key governance processes often are more effective and more likely to influence policy, even while they are rarely representative of global civil society. This may appear to be the case in the Egyptian context. Further research is necessary to understand these trade-offs and to examine whether a simple resourcing of and democratization of civil society spaces is sufficient to increase the efficacy and the inclusiveness of civil society groups in policy processes.

Finally, CSOs have adopted tactics to find supposedly *apolitical* ways to play politics. Through organizational formats like social enterprises, makerspaces, and community hubs, activists work under a label that is sanctioned under current political configurations, allowing themselves to be seen as "partners in development" by officials instead of being labelled as provocateurs. Such intentional depoliticization of the work risks and limits CSO abilities to recruit and retain support and, more fundamentally, to critically track government performance and commitment information. Moreover, by working in nonthreatening ways, local civil society groups also often effectively are unable to build international coalitions or even cross-regional networks, especially with more radical grassroots networks.

Initiatives and research that map and connect civil society actors thus will be vital. As Egypt's vulnerability to climate change increases, the need for deeper civil society engagement will only grow. Those interested in supporting locally led climate action must expand their lens of analysis to incorporate the diverse and complex ways in which civil society actors are *already* connecting with one another and with government officials. A more nuanced understanding also is needed of the tactical ways in which civil society advocates operate in diverse institutional settings, without layering unrealistic expectations on local groups—especially in the absence of fundamental transformations to their ability to access resources and material support. Egypt's 2011 National Adaptation Strategy stressed the role for civil society and community participation in climate change risk reduction and management, arguing that to adapt to climate change, "the state cannot certainly assume this role on its own without full support of these groups." It appears overdue to turn these words into reality.

CHAPTER 4

Vulnerability and Governance in the Context of Climate Change in Jordan

Shada El-Sharif and Marwan Muasher

Compared to neighboring countries that continue to wrestle with political instability, natural disasters, conflict, and mass migrations, Jordan is a relatively small and stable nation. Yet today it faces serious economic challenges, with youth unemployment at around 50 percent and a debt ratio that is around 114 percent of its gross domestic product (GDP). Climate change compounds an already dire economic situation; impacts key sectors of the economy, particularly water, agriculture, food, and health; and influences low-carbon policies in other sectors like energy and transport. Partly in response to these challenges, Jordan developed an economic plan in 2022: the Economic Modernization Vision (EMV) ambitiously targets the creation of 1 million jobs and the attraction of $41 billion in investments by 2033. Jordan is also among the first countries in the region to issue a National Adaptation Plan and update its Nationally Determined Contributions (NDCs).

However, in order to realize these economic targets while addressing its climate vulnerability, Jordan needs to strengthen its climate governance framework to achieve the adaptation and mitigation goals in line with its NDCs. Jordan has strategically identified "sustainable resources" and "green growth" as two of its key economic growth drivers under the EMV to ensure a sustainable economic development environment conducive to growth. These drivers are set to function alongside other areas of historical comparative advantage such as tourism and information and communications technology. However, climate must be embedded within the governance and planning frameworks across all sectors. In doing so, it will be an enabler for investment, jobs, and development, rather than a threat multiplier that exacerbates existing vulnerabilities and jeopardizes the security of precious resources that could derail these economic development aspirations.

The linkages between climate change vulnerability, governance, and economic development may not be entirely evident from the onset. This piece aims to shed light on Jordan's climate vulnerability and adaptation contexts, challenges of the current climate governance framework from the perspective of diverse stakeholders, and conclusions for the way forward. The key findings are summarized below:

- Jordan is expected to witness a warmer, significantly drier climate, with shifting rainy seasons and more extreme weather events like drought and frost. These changes in weather patterns are already exacerbating hardships faced by vulnerable communities, particularly farmers, refugees, and those in poverty pockets. This reality should inform the prioritization and implementation of adaptation actions, nationally and locally, across the country.

- Despite progress at the regulatory, policy, and project levels, the climate change governance framework in Jordan has not yet delivered the type of transformative impact the country needs in terms of resource security, climate resilience, jobs, investments, and financing.

- A holistic governance approach that tackles climate concurrently across all sectors is needed, particularly in water, health, agriculture, and urban development. Climate change also impacts key economic considerations related to trade, water and energy tariffs, unemployment, the real economy, and the financial services sector. These linkages need to be better articulated in sectoral policies by applying a climate lens to all national and local planning and implementation processes.

- Synergies and trade-offs between key resource-focused sectors (water, energy, food, and environment) need to be addressed through a nexus-based governance approach, backed by a neutral, science-based centralized policy function. Such a system will target overall economic benefits to the country in the medium to long term, rather than allowing for only short-term gains for a particular sector.

- In general, any national government should lead the delivery of "ambitious climate policies," supporting other layers of government (regional, municipal, city, or village level), engaging globally, and articulating economic cobenefits through a multisectoral approach.

- There is a need to strengthen Jordan's Ministry of Environment (MoEnv) as the national entity mandated to drive climate policy and action. Similarly, there is a need to build capacities at municipalities, as well as at the Aqaba Special Economic Zone Authority and the Petra Development and Tourism Regional Authority, to adopt the same direction in their jurisdictions, institutionalizing frameworks for meaningful and regular engagement with civil society and the private sector.

- The focus needs to shift from generating additional policies and strategies to examining and streamlining existing laws, policies, strategies, and national committees. A clear regulatory framework should serve as the backbone to an institutional, sustainable, and systematic governance model.

- There is also a need to enhance national capabilities to attract and mobilize climate finance nationally and internationally, leveraging the existing pipeline of climate-responsive projects and investments. Such efforts could include the multibillion-dollar projects and public-private partnership opportunities embedded within the EMV, NDCs, Climate Investment Mobilization Plan, and Green Growth National Action Plans (GG-NAPs).

- There are indications of growing alignment between the executive and legislative branches on the importance of climate policies and projects, which bodes well for Jordan's climate change governance and its effectiveness in delivering economic benefit to all Jordanians.

- Key dimensions—vision, regulations, policies, institutional capacities, human resources, nexus thinking, and multistakeholder/multisectoral planning—must all come together to shape and refine an effective climate governance framework.

Climate Change Impacts and Adaptation Priorities in Jordan

Before delving into the achievements and deficits of the existing climate governance framework, it is important to arrive at a clear understanding of the real and evolving climate change impacts facing Jordan. As a party to the United Nations Framework Convention on Climate Change (UNFCCC), Jordan has been issuing National Communications since 1998. These reporting frameworks take stock of a country's greenhouse gas (GHG) emissions, highlight climate change impacts and vulnerabilities, and present priority climate actions. More importantly, they are central to the transparency frameworks espoused by the UNFCCC, which signatory countries can leverage to demonstrate national progress against targets and attract further support from investments, technical assistance, and finance.

In the run-up to the 26th Conference of the Parties (COP26) in Glasgow, and following the 2020 launch of its GG-NAPs, Jordan issued updated NDCs raising its ambition of reducing GHG emissions by 31 percent by 2030, up from 14 percent. (Jordan had already achieved 12 percent by 2022.) This target is only 5 percent "unconditional" and based on national means; 26 percent is "conditional" on receiving international support. Jordan must leverage its efforts to meet this target in order to attract billions of dollars in climate finance to realize strategic projects in all sectors. Although Jordan contributes a mere 0.06 percent of global GHG emissions, such declarations represent important commitments to the global climate agenda and encourage the country to develop a pipeline of low-carbon, climate-responsive investments with development cobenefits. Jordan's engagement with these global climate policy frameworks can transform national mitigation and adaptation priorities into opportunities for bilateral cooperation, investments, grants, knowledge transfer, and technical assistance. This approach has already borne fruit, with Jordan receiving $33 million from the Green Climate Fund to promote climate-smart agriculture and improve water security in rural communities. Such successes need to be scaled and replicated in this and other sectors.

In terms of mitigation, Jordan achieved 27 percent renewables in its electricity mix by 2022, and hence it is on track to meet and likely exceed its target of 31 percent by 2030. Jordan also was among the first regional adopters of hybrid and electric vehicles, largely owing to favorable tax and customs exemptions at the onset. Such vehicles currently make up 18.5 percent of the total vehicle fleet. However, for Jordan and many other developing countries, adaptation is the priority, despite this demonstrable progress on the mitigation front.

Jordan recently issued its Fourth National Communication (4NC), the latest official document on the country's climate progress and priorities for adaptation and mitigation. It builds on the findings of the National Adaptation Plan, the Updated Climate Change Policy (2022–2050), EMV, and updated NDCs. According to the 4NC, by 2100, Jordan will have a warmer, significantly drier climate. These impacts do not bode well for existing vulnerabilities unless concerted adaptation actions are taken in the next decade. These actions have been examined in the 4NC and are discussed below, considering perspectives from vulnerable and impacted communities.

Agriculture and Food Security

Although the agriculture sector represents only about 5.6 percent of GDP (not considering backward and forward linkages across the value chain, which would raise the GDP contribution to 15–20 percent), Jordan has managed to achieve self-sufficiency in olives, vegetables, fruits, eggs, milk, and dairy. However, because of climate change, an overall 20 percent yield reduction is expected in rainfed olives, a crop of historic, cultural, and export significance for the country. More than 80,000 families work in olive cultivation, and olive growers are already experiencing significant yield reductions due to reduced and changing rainfall seasons. Fayyad Zyoud, chairman of Jordan's Olive Producers and Exporters Association, has identified delayed rainy seasons and severe frosts as the main climate culprits harming Jordan's olive industry.[16]

Similarly, climate change is expected to result in a 15 to 31 percent reduction in rangeland and feed resources, which will directly harm cattle and livestock value chains. Jordan's National Food Security Strategy, prepared by the Ministry of Agriculture, has made strengthening "climate resilience" a main objective and states that "climate change affects all the components of food security and food systems in Jordan." It identifies "small and subsistence farmers who mainly depend on rain-fed agriculture and extensive semi-intensive livestock raising" as particularly vulnerable to the effects of climate change, and it highlights Tafilah as the most food-insecure governorate. It also cites an alarming statistic: 53 percent of Jordanians, around 3.9 million people, are vulnerable to food insecurity.

Priority adaptation measures identified in the 4NC include the need to integrate climate resilience into policy and institutional reforms in the agricultural sector, enhance drought management systems, shift to water-efficient crops, improve irrigation system efficiency, and strengthen hydrological and meteorological services. The Ministry of Agriculture,

in coordination with other line ministries, will need to adopt more holistic, nexus-based planning approaches. According to farmers like Zyoud, Jordan also needs to invest in early warning weather stations with accessible communication systems, as well as capacity-building programs targeting farmers. At the same time, Zyoud calls for adoption of native species that demonstrate resilience in the face of frost, drought, and other climate impacts.[17] It is evident that strengthened planning, coordination, and governance measures are just as important as technologies and capacity-building solutions. Proactive engagement with vulnerable groups, like olive farmers, will also be needed to develop targeted adaptation interventions and public-private partnerships.

Water

Even though water scarcity is a major threat to resource security and economic development, little progress has been made to significantly alter Jordan's position as one of the most water-scarce countries globally. According to the 4NC, climate change is expected to result in an 18 percent reduction in surface runoff and a 16 percent reduction in groundwater recharge. Jordan's per capita renewable freshwater resource stands at 61 cubic meters per year (m^3/year), well below the "severe water scarcity" threshold of 500 m^3/year. The water sector is also "considered the most vulnerable sector to climate change," considering the significant risks brought about by rising temperatures, reduced rainfall, droughts, and floods. Water scarcity also means less water for rainfed and irrigated agriculture. In addition, electricity costs represent the majority of operational expenses in the water sector, which underscores the need to ensure holistic and nexus-based governance between these interlinked sectors.

Climate change resilience is clearly embedded within the latest National Water Strategy, an approach that needs to be streamlined across all sectors of the economy. In addition, synergies and trade-offs need to be addressed through a nexus-based governance approach, backed by a neutral, science-based centralized government function that can ensure longer-term overall economic benefits, rather than short-term gains for a particular sector. The EMV called for a Water-Energy-Food-Environment (WEFE) Nexus Council, but this has yet to be fully institutionalized and operationalized. However, if strategically capacitated and empowered, it could provide the type of cross-sectoral, multidisciplinary coordination needed to maximize the economic benefits of policies, regulations, strategies, projects, and financing within these sectors. This would also advance the strategic objectives of water, food, and energy security for the country.

On top of these mounting climate pressures, Jordan continues to grapple with the growing demand on its precious resources caused by the significant influx of refugees: its population has almost doubled from 6.3 million in 2008 to 11.5 million in 2023. This rapid population increase helps explain the anticipated growth in water demand and the related deficit in the water balance, estimated at a negative 835 million cubic meters by 2050. In response, Jordan launched the global Climate-Refugee Nexus Initiative at COP27 to attract global support, assistance, and finance for countries like Jordan that face the dual challenges of climate

and significant refugee populations. In the coming years, host communities will also need to prioritize efforts to tackle these risks at the top of their local and municipal development plans. This will require strengthening the decentralization agenda and empowering municipalities to develop local climate action plans, such as the Sustainable Energy and Climate Action Plans (SECAPs) developed by Irbid and Karak municipalities.

According to Rafat Naddaf, a humanitarian field expert at the Zaatari and Azraq Syrian refugee camps, "there is limited awareness of climate change impacts among refugees in the camp, and life is becoming more difficult; water supply is intermittent, and many have to walk to get their water. There is a lack of awareness on water conservation, and the camps are not prepared for heavy rains or flooding, which is becoming more of a risk. Rising temperatures in the camp are also causing more frequent power outages and impacting necessary electrification for food, medical supplies, and online learning, which is harming health and education among this vulnerable population."[18]

Similar to the agriculture sector, the first identified adaptation measure in the 4NC is better integration of climate adaptation and resilience in the policy and institutional frameworks of the water sector. Other measures have featured in countless previous strategies, including improvements in demand management and water use efficiency, as well as supply augmentation through increased contribution of nonconventional water resources and desalination.

The flagship Aqaba-Amman Water Desalination and Conveyance Project aims to supply an additional 300 million cubic meters of water across Jordan's governorates by desalinating and transporting water from the Red Sea to Amman. This project is a prime example of how Jordan can attract climate finance to a vital, multibillion-dollar project, given its target to secure at least 50 percent clean energy for the project's power needs. Nonetheless, discussions about Jordan's water security cannot be decoupled from regional geopolitics. Since "most of [Jordan's] water resources are transboundary, water should be considered a key security priority instead of merely a technical or sectoral challenge," as highlighted in a recent paper from Carnegie. As a result of the recent Israeli war in Gaza, Jordan has tabled a proposed Declaration of Intent in 2021 with the UAE and Israeli governments to assess the feasibility of a water-for-energy deal across the border—though the Palestinian side is notably absent from the deal.

Health

According to the 4NC, the Climate Change Vulnerability Assessment of the health sector revealed that "climate risks (droughts, dust and sandstorms, flooding, shift in rainy season, increasing humidity, decreasing precipitation, increasing temperature) have both direct and indirect linkages with health risks, and they impact everyone from farmers, consumers of produce, children, and vulnerable populations across the entire country at different levels." The impacts identified in the water and agriculture sectors above are also expected to interact

with potential impacts on health. Increasing temperatures translate to a rise in water-, food- and vector-borne diseases, which are expected to become more prominent in areas of water scarcity where water projects will be established, such as in the arid and semiarid eastern Badia. Similarly, water scarcity will result in reduced access to nutritious food, thereby contributing to rises in malnutrition. These impacts are amplified by direct vulnerabilities caused by increases in heat stroke and fatigue, as well as exposure to harmful solar ultraviolet radiation.

Alaa Al-Qasem, a Syrian refugee at Zaatari camp, recounted how climate change is affecting health in the camp: "When temperature rises, we feel it quickly in the caravans—mostly made of zinc boards; the walls fill like fire. As the heat and dust rises, asthma and lung diseases increase, and we are seeing more food poisoning when refrigerators stop working due to power outages."[19] Rafat Naddaf, a humanitarian field expert, also points out the health risks to diabetic patients, whose medications often require refrigeration.[20] These life-threatening risks are being amplified by climate change and require investments in the form of climate-resilient water, energy, food, and health systems. In his recent address to the United Nations General Assembly, King Abdullah II warned that "Jordan's capacity to deliver necessary services to refugees has surpassed our limits." This is among the drivers for Jordan announcing the Climate-Refugee Nexus initiative at COP27, highlighting the particular vulnerability of natural resources and national infrastructure in countries facing the dual pressures of climate change and forced migrations. The aim is to draw further attention, and more importantly, financing to impacted countries.

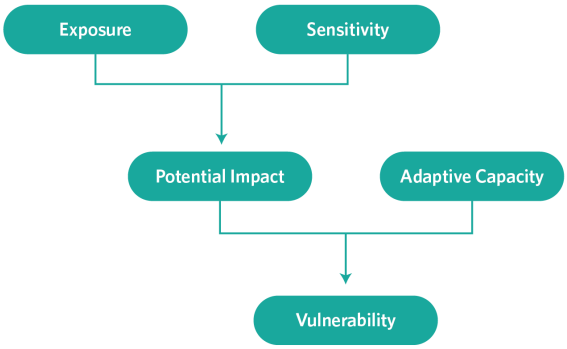
The 4NC once again calls for strengthened coordination between the water and health sectors, as well as updates to the overall strategy of the Ministry of Health to consider climate adaptation. There is also a need to strengthen national surveillance, monitoring, and early warning capacities to detect and respond to climate-induced health threats. Naturally, this endeavor requires targeted awareness, education, and capacity building with regard to the climate change impacts on health, for both the public and the medical system as a whole.

Climate and Vulnerability in Jordan

The Economic and Social Council for West Asia (ESCWA) has adopted the definition for vulnerability put forth by the Intergovernmental Panel on Climate Change (IPCC)'s Fourth Assessment Report, which breaks down the three primary components of vulnerability: exposure, sensitivity, and adaptive capacity, as shown in figure 1 below.

> "Within this context, exposure refers to the quantifiable climate change, such as in temperature and change in precipitation. Sensitivity helps to describe the natural and physical environment as well as differing population groups that are most susceptible to climate change. Coupling both exposure and sensitivity describes the potential impact. Countering potential impact is the adaptive capacity, which describes the ability to cope, mitigate and adapt to climate change. The net difference between potential impact and adaptive capacity defines vulnerability."

Figure 1. The Components of Vulnerability



The IPCC definition of vulnerable groups typically includes young children, those aged 65 or older, pregnant women, those with preexisting medical conditions, physical laborers, and those in low socioeconomic conditions. These definitions align with the approach adopted by Jordan to carry out its climate vulnerability assessments, as captured in the 4NC and summarized in the preceding section. For regional context and overall trends, the ESCWA Arab Climate Assessment Report of 2017 finds that the vulnerability in the Arab region is largely "moderate to high," with an increasing gradient from north to south. Another notable finding is that among the three components of vulnerability outlined above, "adaptive capacity" is the most likely to influence vulnerability. Calculation of adaptive capacity also includes factors related to institutional setup and governance, which means that "the ability of mankind to influence the future is stronger than that of climate change and environmental stressors." Such conclusions place a heavy burden of responsibility on policymakers and citizens, but they also offer hope that concerted efforts to strengthen a country's adaptive capacity can improve prospects for resilience and prosperity in the face of climate change. In other words, both the challenge and the solution can be addressed through political will and effective governance.

This approach can be considered in the context of socioeconomic and urban sectors, which are key sectors of vulnerability in Jordan.

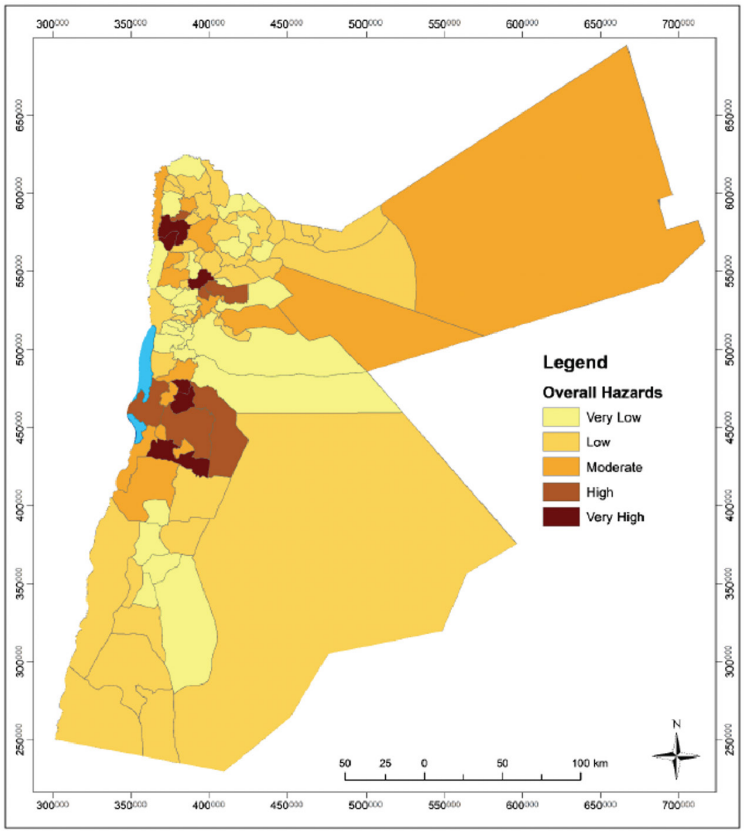
Socioeconomic and Urban Sectors

Jordan's Public Sector Modernization Roadmap identifies "evidence-based policymaking" as a key objective for an improved administrative function. This road map represents one of the three reform processes that Jordan is undertaking alongside the political and economic efforts (the latter captured through the EMV). Broadly speaking, this roadmap lays out the key reforms needed to raise the public sector's efficiency and quality from the institutional, legislative, and services standpoints. From a climate planning perspective, relevant data and analysis have been generated to inform policymaking. The 4NC overlays Jordan's

vulnerability and climate datasets, which has enabled the generation of "hazard maps" that highlight the governorates with the highest overall climate hazards: Irbid, Ajloun, Mafraq, and to a lesser extent Jerash and Karak. Furthermore, an assessment is done on how climate change can amplify underlying risks for socially vulnerable groups (defined based on income, educational attainment, gender, living standard, residency, and age) with regard to climate vulnerability factors (exposure, sensitivity, adaptive capacity, and hazards). Based on this analysis, the most impacted areas are Amman, Ajloun, and Karak. Not surprisingly, those most vulnerable are people living in poverty, older adults, and migrant communities. In terms of Jordan's proposed adaptation measures with both climate and development cobenefits, the 4NC focuses on poverty alleviation, income diversification, and improved access to basic services. Other proposed policy directions include gender mainstreaming, enhancing food security, and strengthening social safety nets. These measures would not only improve climate resilience but also address long-standing socioeconomic challenges, which policies like the EMV aim to address. There have been fragmented efforts to develop climate-responsive local action plans, such as Amman's Climate Plan and the aforementioned SECAPs for Irbid and Karak Municipalities. However, these initiatives were developed before the release of the recent vulnerability assessments and hazard mapping under the 4NC. It has yet to be seen how or if such data will inform climate-resilient policymaking in Jordan's most vulnerable cities.

Similarly, a hazard map was generated to highlight the urban areas most susceptible to droughts and floods (see figure 2). Proposed adaptation measures that align with other key policy frameworks such as the National Climate Change Adaptation Plan 2021, Jordan's National Strategy for Disaster Risk Reduction 2023–2030, and the Updated Climate Change Policy 2022–2050 include the expansion of urban green infrastructure, nature-based solutions like planting native trees, rainwater harvesting, and improved building efficiency. The impact of green spaces and community-based farming cannot be underestimated: both Al-Qasem and Naddaf highlighted the positive impacts that small-scale farming can have on refugees, including improving climatic conditions at Zaatari camp, increased food security, and possibilities for revenue generation.[21] Unfortunately, such activities face regulatory hurdles that often disincentivize farming within the camps, alongside climate pressures. "Many women earn their income from working in nearby farms; some have lost these limited incomes due to climate-induced deterioration of farmlands," Al-Qasem said. Nonetheless, observers have recognized the need to enhance the governance approach through improved community engagement in local climate action. This would require national and local public sector efforts to proactively involve citizens and neighborhood networks in a participatory approach to advance needed climate solutions in the urban context. Such an approach, particularly in planning and designing local climate adaptation plans, is highlighted in Jordan's National Adaptation Plan and the National Climate Change Policy of 2022–2050.

Figure 2. Drought and Flood Hazard Map for Jordan

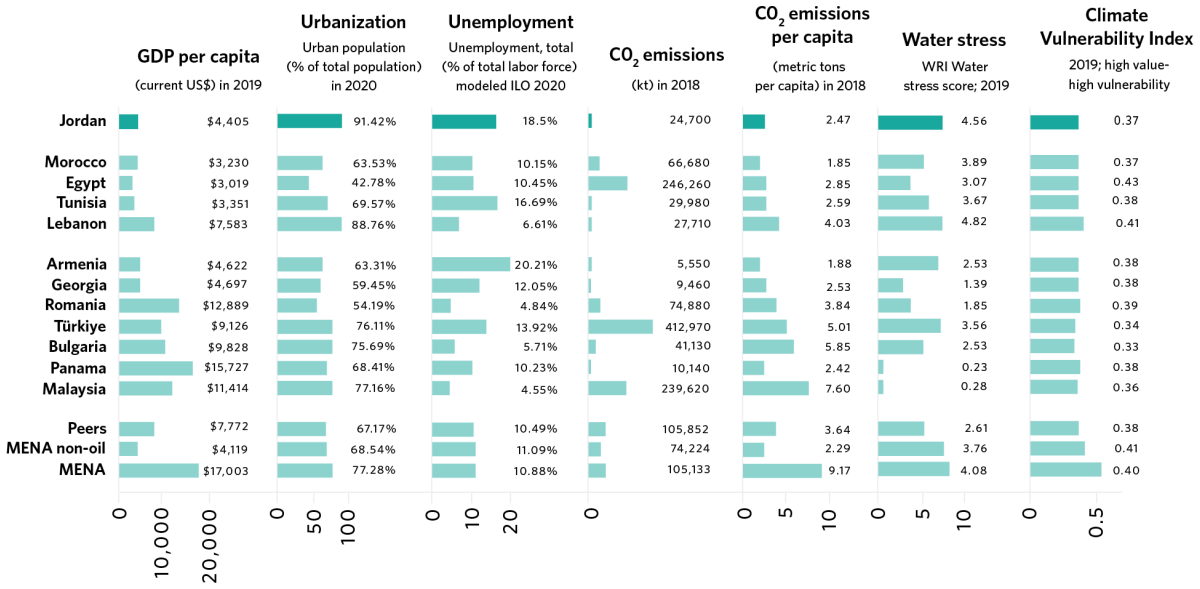


Source: "Jordan's Fourth National Communication on Climate Change," Hashemite Kingdom of Jordan, submitted to the United Nations Framework Convention on Climate Change, 2022, https://unfccc.int/sites/default/files/resource/Hashemite%20Kingdom%20of%20Jordan%204th%20National%20Communication.pdf.

Climate Vulnerability and Economic Development

To build a broader understanding of the vulnerability Jordan's economy faces in the context of climate change, the World Bank's recent Country Climate and Development Report (CCDR) highlights that Jordan ranked 75 out of 182 countries in the Notre Dame Global Adaptation Index (ND-GAIN) for climate vulnerability in 2019, down from 63 in 2015. The ND-GAIN Index ranks countries using a score that calculates their vulnerability to climate change, other global challenges, and their readiness to improve resilience. Jordan received a vulnerability score of 0.375, on par with peer countries (as seen in figure 3), driven by high subscores on freshwater withdrawal, urban concentration, and energy import dependency. This comparative analysis underscores how water, urban, and energy sector policies can directly impact Jordan's relative regional vulnerability to climate change.

Figure 3. Key Economic and Climate Indicators for Jordan Compared with Selected Peer Countries



Source: "Jordan: Country Climate and Development Report," World Bank Group, November 2022, accessible at https://openknowledge.worldbank.org/entities/publication/662a4ef2-a49b-5119-8f32-9778a95794d5.

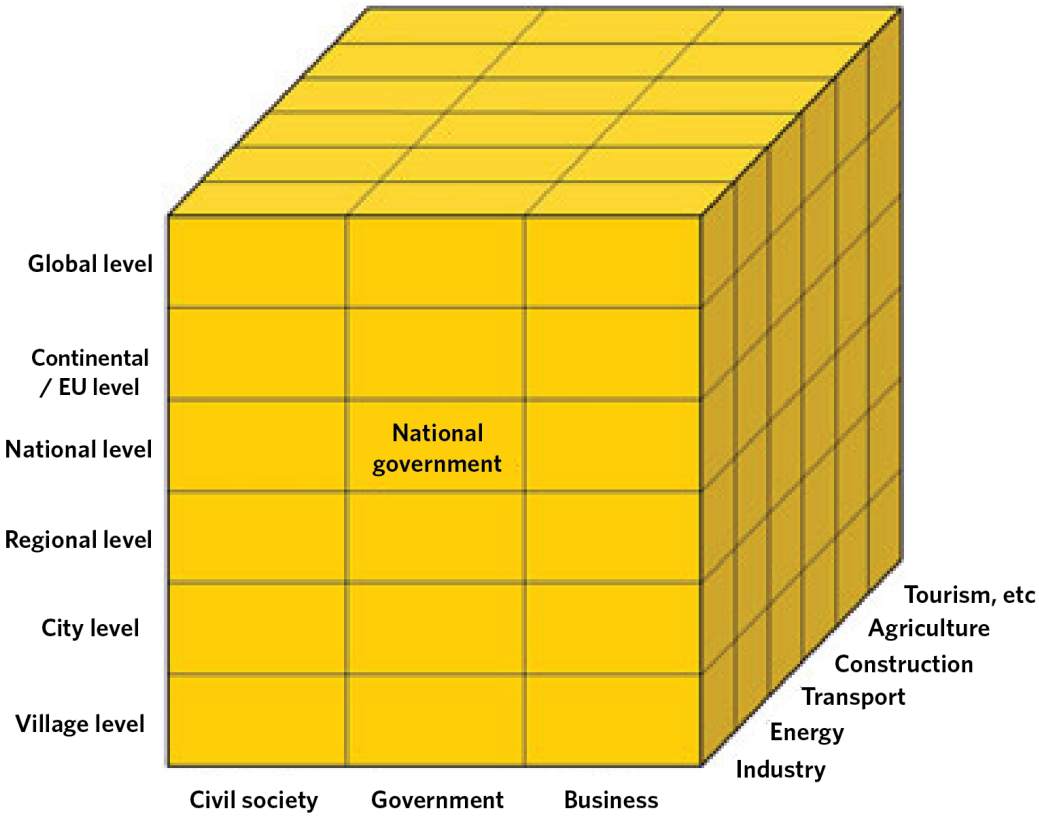
The CCDR warns that "climate change will exacerbate Jordan's development challenges by impacting people, natural resources and the economy, creating pressing adaptation needs across sectors." It cites examples such as reduced productivity in labor-intensive sectors like agriculture and construction owing to prolonged heat waves and reduced water availability. These sectors are key employers of vulnerable groups such as women and refugees and hence renders them particularly sensitive to such extreme weather events. Another finding is that climate change is expected to affect "Jordan's competitiveness, generating new risks and opportunities for the private sector." The report further describes the "serious threat" climate change represents to the tourism industry, often described as "Jordan's oil" (drawing a parallel to the economic prosperity of the fuel-based economies of the Gulf). It explains how climate change can impact tourism seasonality, locations, landscape aesthetics, and operating costs. The country's trade structure is also described as "highly vulnerable" to climate change, as its five largest export sectors—textiles, chemicals, fertilizers, pharmaceuticals, and rare minerals—are either highly water- and energy-intensive or sensitive to water and energy tariffs. In addition, climate change could have effects on the real economy because of the large size of Jordan's financial sector (181 percent of GDP) and the fact that construction, real estate, trade, and industry constitute a majority of its banks' loan portfolio. All of these sectors are highly exposed to the transition and physical risks of climate change.

Reflecting on the above, it is clear that planning within "traditional" economic areas for Jordan like tourism, unemployment, trade, finance, energy, or the real economy can no longer be decoupled from climate change considerations. A holistic governance approach that tackles climate concurrently across all sectors is clearly needed. This requires concerted coordination among all ministries and the ability to apply a climate lens to development planning and implementation. The EMV is an important enabler for improved government coordination, particularly with a delivery function set up at the prime ministerial level to advance implementation. However, this function should not be limited to oversight and monitoring but must be complemented by proactive problem-solving and advancement of strategic projects that can have a significant impact on people and the economy. Such a strategic coordination function should also leverage and coordinate closely with the WEFE Nexus governance function, whose mandate and importance are highlighted above. This approach would enable policymakers to prioritize measures that can maximize climate and development cobenefits and minimize the projected risks, over the short, medium, and long term.

Climate Change Governance: Status and Aspirations

During the historic 1992 United Nations summit in Rio de Janeiro (known as the first Earth Summit), a multilevel global governance framework was introduced to start mobilizing actors toward sustainable development. Building on this concept, a multilevel climate governance has emerged as a system that "creates opportunities for action and interaction" among all stakeholders and at all levels of governance around climate action. It is meant to be regarded as an "opportunity structure," rather than a "problem-oriented formulation," as global climate policy is commonly perceived. Its key characteristic is that it is not restricted to governments but also includes diverse actors across all levels and sectors (as shown in figure 4).

Figure 4. The Rio Model of Multilevel and Multistakeholder Governance



Source: In Martin Janicke, "The Multi-level System of Global Climate Governance: The Model and Its Current State," Environmental Policy and Governance 27, no. 2 (March–April 2017): 108–121, https://onlinelibrary.wiley.com/doi/10.1002/eet.1747.

Vertical interactions offer the opportunity for upscaling best practices and maximizing cobenefits. The multilevel climate governance framework also depends on multisectoral and multistakeholder involvement. Each layer or level has its specific role to play and results in horizontal, peer-to-peer dynamics for learning, competition, and cooperation. However, according to the model's author, "national governments, acting within networks, remain the key players in the [multilevel global] system." Governments therefore have a distinct role in leading "ambitious climate policies," supporting other layers of government (such as the regional, city, or village level), engaging globally, and articulating economic cobenefits through a multisectoral approach.

Considering this aspirational view of climate governance at the national level, it is important to acknowledge the considerable strides Jordan has taken in advancing its climate policies, regulations, and institutions. It was among the first countries in the region to issue a Climate Change Bylaw (Regulation No. 79/2019), which outlines the role of the MoEnv in serving as the national focal point to the UNFCCC; chairing the National Climate Change Committee; preparing climate policy and project proposals; and coordinating with key stakeholders on climate finance, priority projects, and market mechanisms. The bylaw is intended to enable the engagement of a broad segment of stakeholders, including sixteen public sector representatives (on the national committee) and almost thirty other entities through different groups and mechanisms (representing, for example, chambers of industry and commerce, universities, civil society, and the private sector). Other relevant climate documents issued by MoEnv include the National Adaptation Plan (2021), updated NDCs (2021), 4NC (2023), and the National Climate Change Policy of 2022–2050.

Jordan also boasts a number of other firsts at the policy level, having launched the first climate change policy in the region, for the period 2013–2020, and the first National Green Growth Plan in 2017 (followed by six sectoral GG-NAPs, as noted above). Jordan was also recognized by the World Economic Forum as a "climate action pioneer" due its issuance of a first-of-a-kind monitoring, reporting, and verification program to track GHG emissions in key sectors (starting with energy). However, the focus now needs to shift from generating additional policies and strategies to streamlining, consolidating, and ensuring coherence across the climate policy landscape in the country. This must be accompanied by an examination of existing laws, policies, strategies, and national committees. A clear regulatory framework will always be the backbone to an institutional, sustainable, and systematic governance model.

Despite this progress at the regulatory, policy, and project levels, the climate change governance framework in Jordan has not yet delivered the type of transformative impact the country needs. Ruba Ajjour, manager of the Climate Change Studies Division at the Royal Scientific Society, notes:

> "We are missing readiness at a higher level. The bylaw is important, but it needs to be better operationalized. The Ministry of Environment does so much, but [it] need[s] additional capacities, specialized in the different areas of climate change, to be able to engage key stakeholders and advance multiple national projects. Jordan, as well as other Arab countries, need to strengthen their negotiation capacities at COPs and better coordinate their regional positions."[22]

There is a need to recognize and enable the MoEnv as one of Jordan's sovereign ministries, alongside those typically in this category such as defense, finance, interior, and foreign affairs. This status would enable it to lead on applying a green lens to all development frameworks in the country, thereby safeguarding the quantity and quality of precious natural resources and attracting billions in green finance and investments to the country.

The UAE—the host of last year's COP28—has a dedicated Ministry of Climate Change and Environment, with a stated mandate to "integrate environmental protection in socio-economic development plans and promote sustainable use of vital resources." Jordan's GG-NAPs outline a similar desired impact of "sustainable economic growth, social development and poverty reduction, climate change adaptation and mitigation, resource efficiency, and enhanced natural capital"—all of which cannot be realized without sufficient cross-sectoral awareness and an empowered ministry to lead not only on conceptualization but also on coordination of implementation.

But even within the executive branch, MoEnv cannot realize the national climate change agenda on its own. Other stakeholders have an important role to play in their respective jurisdictions, including the Aqaba Special Economic Zone Authority, the Greater Amman Municipality (GAM), and municipalities vying for stronger decentralization. Fortunately, each of those also boasts its relevant strategies and projects, which now need to be scaled up and leveraged for partnerships with the private sector. This includes GAM's Green City Action Plan (including thirty-seven actions with a $300 million price tag), an updated land use master plan for Aqaba in line with a green, smart cities approach (under development in line with the EMV Executive Program), and a number of SECAPs developed for municipalities like Karak and Irbid.

Elham Alabbadi, a farmer and local activist in Balqa governorate, stated,

> "Despite the many plans and strategies, little direct benefit can be felt by farming families. There is a need for governments and municipalities to move away from centralized thinking and really work with cooperatives, the private sector, and proactive individuals to implement useful projects on the ground. Access to grant financing and subsidies is important, as farmers are being burdened and forced to leave their lands."[23]

Such testimonies should be a wake-up call for the existing governance and institutional structures to engage more effectively with local communities, civil society, the private sector, and community leaders across the country. Particular attention should be paid to engaging women, youth, the elderly, and people with disabilities.

The legislative branch is also beginning to integrate climate change into its agenda. Member of Parliament Zaid Otoom has called for the establishment of a new Environment and Climate Change parliamentary committee, which has been launched in the most recent session of Parliament. He believes

> "such a committee is needed to enable parliament to fulfill its oversight role over the government's progress on the climate change file. Many areas are already experiencing the dire impacts of climate change, with water scarcity impacting farming communities and accelerating rural-to-urban migration.

> At the same time, Jordan with its abundant solar and wind resources is well-positioned to become a hub for clean energy. But the government must focus on ensuring a 'just transition,' creating jobs and opportunities for all."[24]

The EMV aims to create a million jobs and attract billions in investment opportunities with "green growth" as a key economic driver, yet it incorporates energy sector initiatives that continue to align with more conventional energy technologies such as oil, gas, and shale. Because the vision's executive programs are revisited regularly, Jordan will need to keep these "just transition" considerations in mind and recognize the accelerated global efforts toward decarbonization as promoted at COP28. (Even though the UAE Consensus did stop short of calling for the global phaseout of fossil fuels advocated by climate activists and vulnerable nations, a "just transition" was still a key outcome.)

Similarly, a Senate committee headed by Mustafa Hamarneh has issued a position paper on "opportunities for economic growth and job creation through climate-responsive measures across sectors" and convened discussions with government bodies to assess progress. This growing alignment between the executive and legislative branches bodes well for Jordan's climate change governance and its effectiveness in delivering economic benefit to all Jordanians.

The National Agricultural Research Center is one of the first national institutions to issue an internal circular on adopting a WEFE nexus lens in all plans and projects. A major challenge highlighted by Nizar Haddad, director general of the National Agricultural Research Center, is that

> "any climate issue has to be considered from a nexus approach, rather than single sector planning we often see. We also need to consider the lifecycle ecological footprint of any technology, including extraction, manufacturing, transportation, and disposal. A holistic approach is needed; even when considering the 'circular economy,' the focus should not only be on the material and monetary aspects but the socioeconomic dimensions as well. Jordan can also do better in attracting climate finance for strategic projects in all sectors."[25]

The above dimensions—vision, regulations, policies, institutional capacities, human resources, nexus thinking, and multistakeholder/multisectoral planning—must come together to hone an effective climate governance framework. This framework, in turn, can then unlock climate finance and investments, thereby creating new jobs and revenue-generation opportunities. This would contribute to the delivery of the EMV's ambitious targets. It will require a robust public financial management system, with capabilities for "climate budget tagging." This can then be reflected in the project pipeline of the public investment management and public-private partnership framework, enabling Jordan to track how it is allocating its own resources to climate actions to meet its NDC target of 5 percent unconditional GHG reduction by 2030. This is where monitoring, reporting, and verification comes in, as a pioneering tool that enables Jordan to transparently track its

national contributions to climate action and engage international investors and financiers in bridging gaps to achieving the 26 percent conditional GHG reduction target. Such a framework also lends itself to other green finance and investment opportunities, including green bonds, green public procurement, carbon markets, and climate-debt swaps. Jordan's private sector, with an International Finance Corporation contribution, has already capitalized on relevant developments and issued the country's first green bond in 2023.

Conclusion

Despite the existential threats posed by climate change, multiplied for a refugee-hosting country like Jordan, it is not too late to take serious and concerted efforts to apply a climate lens to all layers and sectors of governance. Jordan is capable of unlocking significant economic benefits that align with the ambitious EMV targets of 41 billion Jordanian dinars (around $57 billion) in investment and 1 million jobs by 2033. Mega green investments—like Jordan's memorandums of understanding for the manufacture and export of green hydrogen/ammonia (as per the EMV) and the almost $8 billion pipeline of climate-resilient and low-carbon development projects highlighted in the Climate Investment Mobilization Plan—clearly demonstrate how green, climate-responsive investments can meet a significant portion of the country's overall investment target. Jordan has demonstrated the possibility to attract climate finance for the Aqaba-Amman Water Desalination and Conveyance Project, which can only succeed if financial closure is achieved in a way that can result in a feasible public-private partnership. Similarly, GIZ (the main German development agency) recently conducted a Green Jobs Assessment in six sectors of Jordan's economy, where it was demonstrated that approximately 113,000 jobs could be generated if certain what-if scenarios and green investments are implemented.

Recent analysis on Jordan's growing climate vulnerability in light of drier, hotter, and more extreme weather projections, overlayed against data on existing socioeconomic challenges (including poverty and unemployment), has generated climate hazard maps that need to inform priority adaptation interventions where they are needed the most across the country. Particularly vulnerable refugee and farmer populations can benefit from improved early-warning systems and investments in climate-smart, data-enabled, and resilient infrastructure. Climate change also impacts key economic considerations related to trade, water and energy tariffs, unemployment, the real economy, and the financial services sector. Addressing all of these concerns will require improved cross-sectoral, nexus-based coordination, planning, and delivery approaches by all ministries.

Endowed with a favorable regulatory and policy framework, and actual "green" success stories in every sector, Jordan will need to invest in strengthening the climate governance framework from a multilayer governance approach. Most importantly, it is imperative that Jordan focuses on enhancing national capabilities to attract and mobilize climate finance (nationally and internationally), leveraging the existing pipeline of climate-responsive projects and investments.

CHAPTER 5

Assessing Climate Vulnerabilities in Amman City

Reem Halaseh

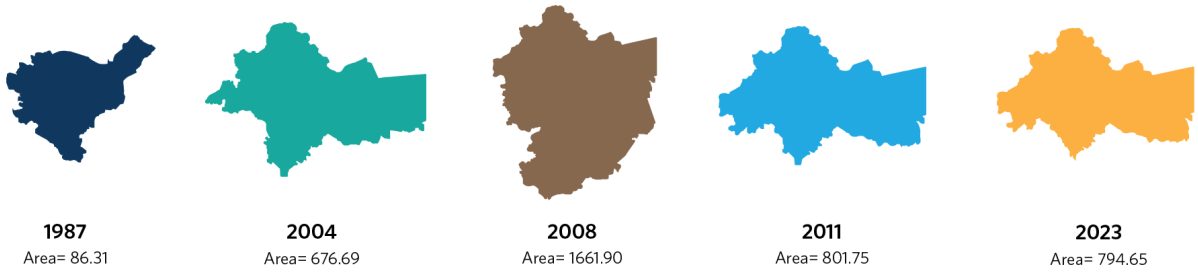
Climate change impacts are felt worldwide, manifesting in diverse ways across different regions. Jordan, too, has experienced intensified and more frequent heatwaves, flash floods, droughts, and associated health issues due to climate change. This article aims to unveil evidence-based vulnerabilities and risks to climate change in urban areas within Jordan, focusing on its capital, Amman.

Jordan has joined 195 countries in adopting the Paris Agreement's goal to hold "the increase in the global average temperature to well below 2 degrees Celsius above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1.5 degrees Celsius above pre-industrial levels." Recently, it has been agreed that the threshold of 1.5 degrees Celsius (°C) should be targeted until 2100.

Cities and local governments are at the front line of tackling climate change and achieving progress toward keeping the global temperature below 1.5°C. Their efforts have evolved around mitigation and adaptation measures. Amman, a highly urbanized capital, faces environmental challenges and climate vulnerabilities. This piece highlights Amman's issues and explores how this middle-income city in the Middle East and North Africa (MENA) region articulates its policies in responding and adapting to the climate crisis.

To do so, it utilizes vulnerability mapping to assess the projected vulnerability and impact of climate hazards—such as heatwaves, flash floods, droughts, and diseases—across Amman's twenty-two districts. It focuses on the adaptation measures the city needs. This approach helps the Greater Amman Municipality (GAM) prioritize adaptation projects and allocate budgets for localized climate change interventions. Enhancing the city's climate resilience stands as a crucial response to the climate change crisis, enabling more effective policies, action plans, and engagement with vulnerable groups while safeguarding natural resources and bolstering urban resilience against climate impacts.

Figure 1. Changes in the Boundary of the Greater Amman Municipality



Source: Data from the Greater Amman Municipality, 2023

The Socioeconomic and Environmental Context of Amman City

The capital city of Jordan, Amman, has witnessed exponential change in its demographic, social, and economic context. Since the GAM was founded in 1987, the city has expanded nine times from 86.31 square kilometers (km^2), to reach 794.65 km^2 in 2023, as illustrated in figure 1.

The population of Amman has grown rapidly, reaching 4,642,000 in 2021, stemming from natural population growth, an exodus from rural areas, and a high influx of refugees and migrants seeking jobs. Women make up 46.3 percent of Amman's population. People with disabilities account for 10 percent of Amman's population. The average household size in Amman is 4.6 persons. The Jordanian community is known to be youthful, where 40.81 percent of the population are younger than nineteen years old and only 4.2 percent are above sixty-five years old.

Amman has witnessed multiple trends that exacerbate the city's systems and citizens' vulnerability to climate challenges. Urbanization is among the most pressing challenges correlated to the climate crisis. It has put significant and unprecedented pressure on the city's aging infrastructure; widened the institutional, resources, and preparedness gaps; and decreased citizens' institutional trust. Amman's political and economic status drives internal migration from other Jordanian cities, specifically rural areas where people are in search of better services and livelihood opportunities. Consequently, about 40 percent of Jordan's population resides in the capital city. It is the country's most urbanized city, with an urbanization rate of 97.2 percent and a population density of 612.5 persons/km^2. The protracted crisis in the region and the consequent high influx of refugees has played a central role in the unforeseen population growth of Amman. The number of refugees hit 193,781 in 2020. At the same time, a 24 percent unemployment rate in the city contributes to rising vulnerabilities to the climate crisis.

Urban sprawl, inefficient urban planning, and poor land use management have significantly exacerbated climate challenges. It is worth noting that both the first growth plan developed in 1987 and the 2008 Amman growth plan called for protecting agricultural areas from urban encroachment. The GAM developed the first comprehensive plan for Amman City in 1987, unveiling the city's growth plan until 2005. However, the city boundary was 86.31 km^2 in 1988; currently, it covers 794.65 km^2.[26] The city government's massive investment in developing road infrastructure for the past three decades, focusing on vehicle needs more than people-centric planning, has turned Amman into a car-dependent city, with rising levels of air pollution and a deteriorated public transport system.

The availability of green spaces in Amman is a protracted challenge. Urban encroachment on agricultural lands in Amman has affected the quantity and quality of green elements in the city. Despite the city's efforts to increase the green infrastructure in Amman, until 2022, it accounts for only 1.768 percent of the city's area, whereas 3.18 square meters (m^2) is the per capita share. The city aims at increasing the per capita share by the end of 2026 to reach 4.3 m^2.

Amman has a semiarid climate, situated within the northern central highlands of Jordan, which received 197.3 cubic millimeters precipitation in 2016–2017. A total of 42 percent of Amman is built, while 30 percent is bare soil, and 13 and 11 percent accommodate fertilized agricultural lands—rainfed crops and orchards—and grasslands, respectively. The city has complex topography that spans from 82 meters to 1,108 meters above sea level. This variation in the terrain gives a unique climate characteristic to each district, where high districts perceive high precipitation, have cooler weather in summer, and have better vegetation coverage. According to Jordanian standards, Amman has good ambient air quality. However, the human footprint, such as industrial activities, transport, and the irresponsible consumption of fossil fuel, concentrate the fine particles of PM2.5 in the air that has had a deteriorating effect on the environment.

Despite Jordan's high-water stress, 99 percent of the drinking water quality in Amman meets the national standards. Up through 2020, the number of water-related illnesses significantly declined, according to the Ministry of Health Statistical Report 2022. All citizens have access to safe sewage disposal systems: 76 percent of the city is covered with a sewage network, while the rest connect to local septic tanks.[27] Amman has three wastewater treatment plants, from which the treated water is used not for drinking but for irrigation and industrial activities. However, water accessibility will be threatened by not only overexploitation but also climate change.

Historical Impact of Climate Extremes

Climate hazards have serious environmental, economic, health, and social consequences. They can exacerbate the vulnerability of people, city systems, and assets. The most prominent climate hazards that Amman experiences are heatwaves, drought events, flash floods, and air- and vector-borne diseases. To better understand the implication of each

hazard, it is worth reflecting the definition of these hazards in the Jordanian context. The World Meteorological Organization and the World Health Organization define heatwaves as "periods of unusually hot and dry or hot and humid weather that have a subtle onset and cessation, a duration of at least two to three days and a discernible impact on human activities." In the past two decades, Amman witnessed three heat waves: in 2000 and 2010 exceeding a threshold of 40°C, with the highest reaching 43.5°C, over eight continuous days. The most recent heatwave, which hit the city in 2020 and persisted for eleven consecutive days, recorded a high of 43°C.

The Intergovernmental Panel on Climate Change (IPCC) defines drought as "a period of abnormally dry weather long enough to cause a serious hydrological imbalance." As per Jordan's Fourth National Communication Report (4NC), Jordan has experienced periodic drought events throughout its history, which, coupled with increased demands from population and economic growth, have exacerbated its water-stress level, reaching 104.31 percent in 2020. Drought events in Jordan are characterized by below-average precipitation and declining water levels in surface and groundwater resources.

These events have profound implications on the rapidly growing, densely populated city. Water shortages detected through intermittent water supply, and increased water prices, have affected socioeconomic vulnerabilities and the well-being of residents. Leakages and defective metering systems in Amman's aging water infrastructure have created nonrevenue water, further contributing to water challenges.

During the past decade, Amman had witnessed intense rainfall events that have caused flash floods, especially in lower-lying areas of the city such as Al Madinah District. Factors contributing to these flash flood incidents include urban sprawl over natural water streams, population growth putting pressure on the poorly maintained stormwater infrastructure, insufficient green areas, and wide areas of impermeable asphalted surfaces hindering the infiltration of rainfall into the groundwater. For three consecutive years, starting in 2013, Amman experienced severe flash floods that caused deaths and damaged infrastructure and assets. Earlier, a destructive flood hit the city in 2019, not only affecting people and properties and increasing the financial burden on the greater municipality but also harming the city's heritage—the flooding sank the archaeological site of a Roman theatre in downtown Amman.

Over the past five years, citizens have detected extraordinary spread of insects and related diseases. Leishmaniasis, a vector-borne disease transmitted through sand fly bite, is highly connected to climate extremes, especially rising temperatures and heat waves. German and American cockroach spread, which is interconnected with rising temperatures, can transmit foodborne diseases. Insect outbreaks, such as ground and bark beetles and termites, also have been observed.

The exponential deterioration of air quality in Amman has contributed to rising cases of airborne and respiratory diseases as the concentration of PM2.5 rises and the city has limited greenery to purify the environment. Asthma and respiratory system allergies are among the

most highly observed cases, especially in toddlers and adolescents. As per the World Health Organization, in 2019, the spread of ischemic heart disease; trachea, bronchus, and lung cancers; lower respiratory infections; stroke; and chronic obstructive pulmonary disease are attributable deaths of ambient air pollution.

Local Climate Governance: Amman Roadmap for Climate Action

Jordan endeavors to be a "resilient low-carbon nation" by 2050. Aligning with its Economic Modernization Vision and the United Nations Framework Convention on Climate Change objectives, the kingdom has recently developed the National Adaptation Plan (2021) and Climate Investment Mobilization Plan, in addition to updating three national climate policies: the National Climate Change policy (2022–2050), Nationally Determined Contributions (NDCs) (2021), and the 4NC. The updated NDCs show the country's new target in raising its macroeconomic greenhouse gas (GHG) emission reduction target from 14 percent in the first NDC to 31 percent, focusing on five sectors—energy, transportation, industrial processes and product use, waste, and agriculture—with an estimated cost of $7.54 billion. The NDC on adaptation addresses measures on water resource management, agriculture and food security, biodiversity and ecosystems, health, urban resilience and disaster risk reduction, coastal zone management, and cultural heritage and tourism.

Since 2017, the city has developed strategies and action plans responding to climate change, marking a paradigm shift in the GAM's commitment to the issues. It has aligned its efforts with Jordan's commitment to Paris Agreement, limiting the average global temperatures to well below 2°C, in addition to achieving progress toward the 2030 Agenda and its Sustainable Development Goals (SDGs). Some of these plans are given below.

- The Amman Resilience Strategy has paved the way for Amman's progress toward a multisectoral, systematic, and actionable strategy that will build a city more resilient to multiple shocks, including climate-related ones. Comprising five pillars, the strategy aligns five goals under "an environmentally proactive city" pillar, addressing Amman's climate change commitments endorsed during COP21 and C40 Cities actions, energy resources diversification, green buildings, water resources management, and municipal solid waste management. It encompasses 16 goals and 54 actions. Building on this strategy, Amman adopted its first Climate Action Plan (CAP) in 2019, envisioning ambitious targets until 2050 for reducing GHG emissions and building climate resilience through six sectoral pillars: renewable energy, water and wastewater, transport, buildings, solid waste management, and urban planning. The action plan has 21 goals and 51 actions.

- The Amman Green City Action Plan is an updated evidence-based roadmap, based on the city's environmental challenges and priority sectors, to guide the city's transition toward a more sustainable future. It outlines a comprehensive range of 64 short- and long-term actions and initiatives under 19 goals, responding to key sectors:

energy systems and buildings, urban mobility (including pedestrian network and public transportation), solid waste management, water resource management, land use planning, and climate adaptation policies.

- The Amman Smart City Roadmap has five pillars: smart environment, smart public, health, smart public safety, smart energy, and smart mobility. It intends to achieve 11 smart projects.

- Amman's Voluntary Local Review (2022) has also measured and reported the city's progress on SDG 13 of Climate Act, calling for "urgent action to combat climate change and its impacts." It supports the city's GHG emissions reduction and builds its resilience to climate shocks and adaption of infrastructure as renewable energy, water and wastewater management, and green buildings.

- The new GAM Strategic Plan (2022–2026) has built a five-year strategy while addressing climate change as a priority for the city. Climate action is embedded within GAM units and departments. It shows the multilevel climate act through 212 projects around 30 goals.

- The city is at the final stages of releasing the updated Amman Climate Action Plan. By applying the C40 CAP Framework, the GAM aims at expanding climate change adaptation and disaster risk management and mainstreaming climate change mitigation and adaptation across all GAM's operations. The 2023 plan reflects the evolving contexts of urbanization, high population, and development projects. It addresses the gap in achieving targets of 32.4 percent of GHG emissions reduction through ongoing and proposed actions by 2030. It aligns with national and local strategies such as the National Climate Change Policy (2022–2050), the Long-term Low-carbon and Climate Resilient Strategy for Jordan, and Jordan's Economic Modernization Vision, as well as the GAM Strategy (2022–2026).[28]

- In parallel with the new Amman Climate Action Plan, the GAM has conducted a Climate Change Risk Assessment for Amman City, a spatial district-level assessment that gives the city a comprehensive overview on the likelihood and magnitude of climate hazards on the city's districts. It positions Amman's action plan at the core of climate adaptation.

Projected District-Level Vulnerabilities to Climate Hazards

How vulnerable is Amman City to climate hazards? What is Amman's districts' vulnerability to heat waves, flash floods, and airborne and vector-borne diseases?

Amman City has considered climate-related challenges through the Amman Metropolitan Growth Plan by developing a comprehensive master plan that rethinks urban planning and built environment challenges. It plays a pivotal role in responding to urban sprawl and

population growth in the city sustainably and resiliently. The plan encompasses multiple approaches to tackle the impact of urbanization and accompanied environmental challenges such as the urban heat island effect, natural resources depletion, air pollution, floods, and water scarcity. The municipality has identified energy, municipal solid waste, water and wastewater, transport, and urban planning as sectors prominently contributing to climate change risk in the city.

The GAM conducted evidence- and scientific-based climate change vulnerability and risk assessment for Amman City, as per the C40 CITIES Climate Leadership Group requirement, following the Climate Change Risk Assessment Guidance. It aims to understand better and align its policies, strategy, and climate action plans and devote resources to confront climate change impacts at the district level. The evidence-based assessment paves the way for Amman City to localize district-level climate action. It assists the city in mobilizing resources to a specific, accurate, and targeted action plan. The GAM aims to align its policies, strategy, and climate action plans and to devote resources to confront climate change impact at the district level.

Although heatwaves, droughts, and flash floods have been widely observed and studied in the city, air- and vector-borne diseases are less studied, though they are highly correlated to climate change and the emergence of public health concerns in Amman.

Amman's District-Level Vulnerability to Heatwaves

Heatwaves have emerged prominently as a significant hazard in Amman over the past decade. The city grapples with a pronounced heat island effect, amplified by high urbanization rates, limited green spaces, and escalating human activities like transportation and construction. Assessing the vulnerability of Amman's districts to heatwaves involves analyzing exposure levels of people and assets, identifying sensitivity among specific groups and urban systems, and evaluating the adaptive capacity of these systems and sectors.

Factors such as population, population density, refugee populations, and household numbers serve as crucial benchmarks for gauging district exposure to heatwaves. Although all citizens face exposure, the focus of assessment remains on particularly vulnerable groups that are highly susceptible to heat-related stress and health issues—namely, women, people with disabilities, refugees, youth, older people, and city workers. Districts hosting refugee camps also demonstrate sensitivity to such extreme events because of the poor living conditions for refugees such as overcrowding, less economic opportunities, and health issues.

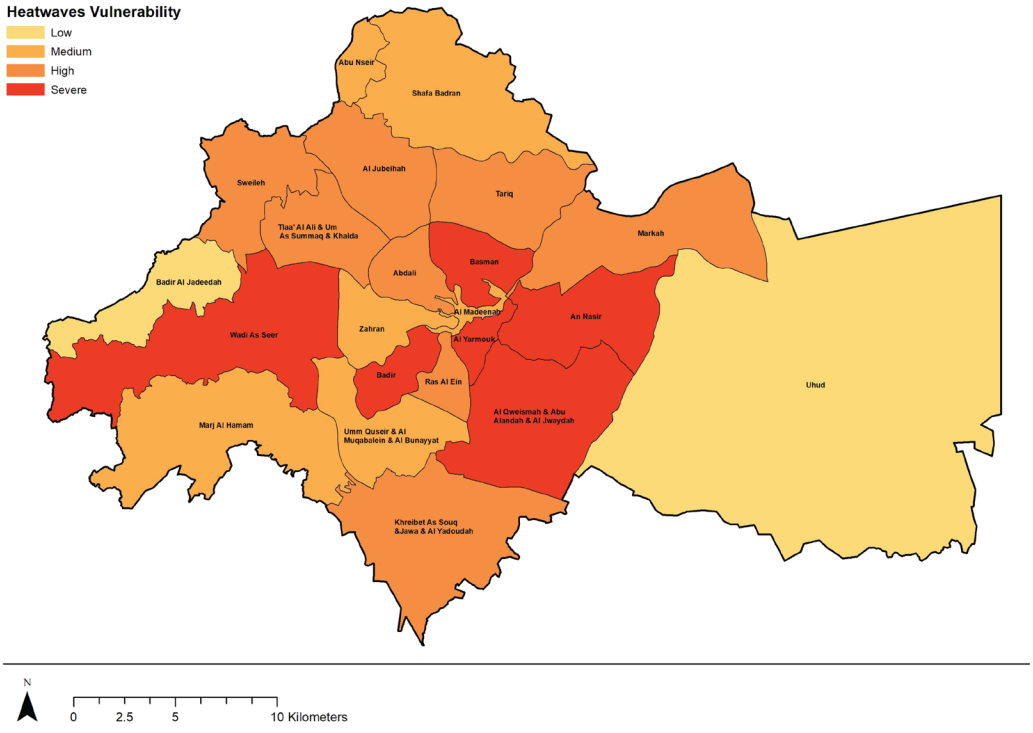
Heatwaves strain water and electricity consumption, leading to potential shortages or blackouts; exacerbating water stress; and impacting the availability of resources for people, animals, and vegetation. Districts with impaired water networks are notably sensitive to consequences arising from heatwaves. Rising temperatures can also affect vehicle efficiency and lead to malfunctions, particularly in built-up areas that significantly contribute to the heat island effect. These malfunctions render these districts even more sensitive to heatwaves.

Moreover, heatwaves intensify drought conditions, impacting undeveloped green areas and causing soil erosion. Assessing district vulnerability to heatwaves also encompasses evaluating public health aspects. Elevated temperatures correlate with increased insect reproduction, prompting the municipality's digitized complaint system on insect and rodent control to shed light on spatial distribution and identify problem areas affecting public health.

Conversely, evaluating the vulnerability of city systems and services across multiple sectors involves considering the availability and coverage of green infrastructure, the adoption of renewable energy like solar systems, GAM emergency units' readiness for emergency response to heatwaves, and the healthcare sector's responsiveness. This evaluation includes the distribution of healthcare centers across districts and the number of citizens covered by health insurance, both public and private.

The vulnerability map in Figure 2 highlights central districts like Basman, Al Yarmouk, An Nasir, Badir, Al Qweismah, Abu Alanda, Al Jwaydah, and the western district of Wadi As Seer as severely vulnerable to heatwaves. In contrast, peripherally located districts like Uhud, with minimal population and fewer built-up areas, and Badir Al Jadeedeh, known for its conserved natural forests and planned green residential zones, exhibit comparatively lower vulnerability.

Figure 2. District Vulnerability to Heatwaves



Source: Greater Amman Municipality (GAM), "Climate Change Risk Assessment for Amman City," 2024 (submitted for publication), used with permission from GAM and the UN Development Programme.

Amman's District-Level Vulnerability to Drought

The impact of drought on water security in Amman is undisputable. The vulnerability assessment focuses on understanding each district's exposure, sensitivity, and level of adaptation to drought. Factors such as population distribution, refugee density, and household numbers indicate the district's exposure. Residential and commercial areas exhibit the highest sensitivity to water scarcity; industries and heritage sites also face considerable exposure. Public green spaces and trees are at risk owing to limited water availability and decreased precipitation. Moreover, the soil quality in undeveloped areas deteriorates with recurrent drought events.

Although the entire population is sensitive to drought, certain groups—women, people with disabilities, youth, older people, and city workers—are particularly vulnerable. During drought events, public water subscribers, especially in residential buildings, endure more frequent water supply restrictions, particularly in hot summers, escalating water consumption demands. Additionally, damaged water networks impede efforts to address nonrevenue water issues, exacerbating the situation.

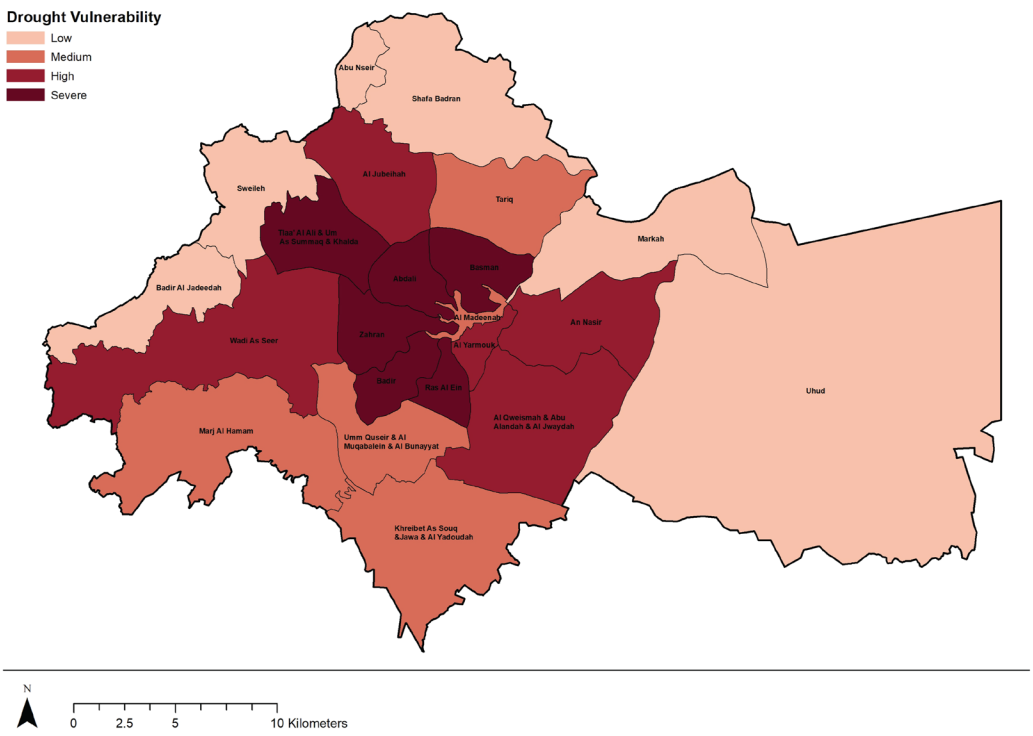
The GAM has been actively implementing projects to manage water resources and bolster resilience against water scarcity exacerbated by urbanization. These initiatives encompass promoting water harvesting, investing in green infrastructure, and enhancing wastewater treatment technologies. The city has constructed underground water-harvesting tanks and wells for irrigation purposes.

Efforts by Miyahuna, the water company in Amman, include technical maintenance of pumping stations and public/private water and wastewater networks, fostering efficiency, water harvesting through reservoirs, and public awareness campaigns. Analyzing Amman's systems, including the GAM, Miyahuna, and the Ministry of Health, aids in assessing the city's coping capacities. Increased green space coverage and available vacant lands reduce the impact of drought by facilitating water infiltration during rainy seasons and replenishing groundwater wells in Amman. Furthermore, the availability and capacity of main water reservoirs, irrigation water storage, and livestock facilities play crucial roles.

Water scarcity has health implications for all citizens, especially vulnerable groups. The distribution of healthcare centers across the city and ensuring citizens are registered for health insurance contribute significantly to citizens' adaptation to drought.

As seen in Figure 3, central districts like Basman, Abdali, Badir, Zahran, Ras Al Ein, Tlaa' Al Ali, Um As Summaq, and Khalda are highly vulnerable to drought. Conversely, northern and western districts with abundant green spaces—such as Abu Nseir, Shafa Badran, Sweileh, and Badir Al Jadeedeh—are seen as less susceptible. Areas like Markah, which has groundwater wells, and Uhud, which has a lower population density, exhibit lower vulnerability to drought.

Figure 3. District Vulnerability to Drought



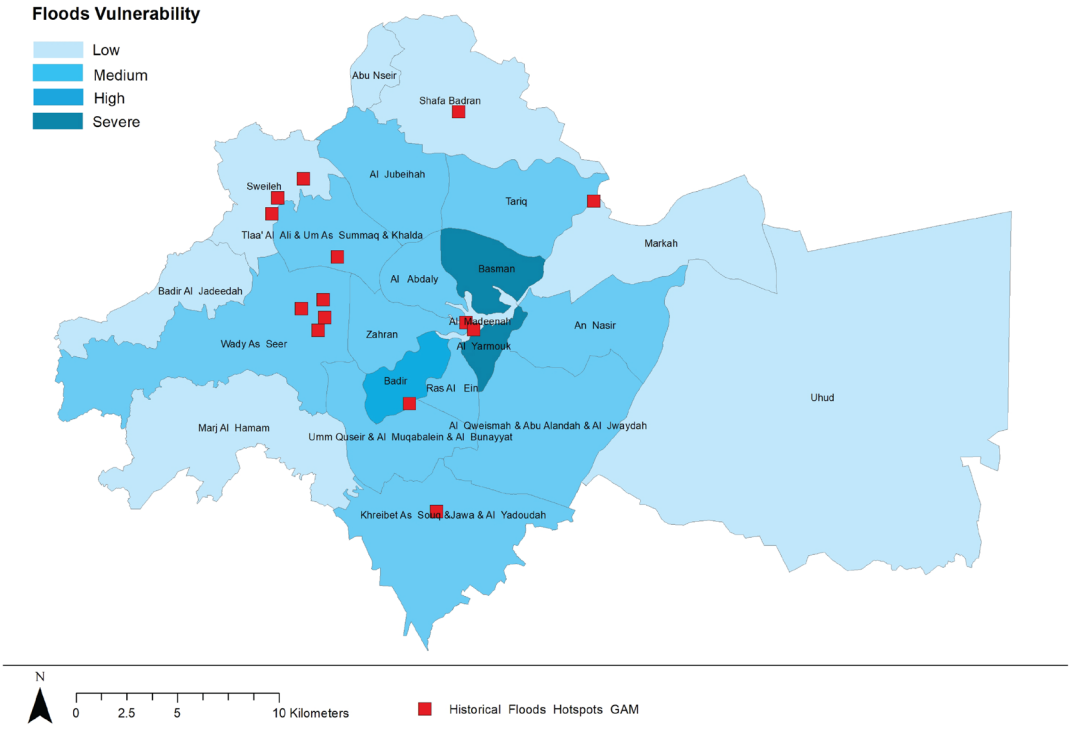
Source: Greater Amman Municipality (GAM), "Climate Change Risk Assessment for Amman City," 2024 (submitted for publication), used with permission from GAM and the UN Development Programme.

Amman's District-Level Vulnerability to Flash Floods

In recent times, Amman has faced increased flash flood occurrences. Initially, these issues were limited to lower-lying districts such as Al Madinah. However, this phenomenon has expanded to multiple districts, including Badir, Sweileh, Wady As Seer, Tlaa' Al Ali, Um As Summaq, Khalda, Tariq, Shafa Badran, Khreibet As Souq, Jawa, and Al Yadoudah. In addition to topographical, hydrological, and land use characteristics of Amman's districts, populated areas, including underprivileged refugee spaces, face greater exposure to flash floods. The presence of residential spaces, commercial hubs, and schools amplifies district vulnerability. Furthermore, heritage sites are highly susceptible to flood risks, especially in Al Madinah district.

Specific demographics—such as women, people with disabilities, youth, older people, and city workers—emerge as particularly sensitive populations during these events. Factors like concentrated refugee camps, tunnel infrastructure, and impermeable surfaces like asphalt contribute significantly to heightened vulnerability to flash floods. Conversely, green spaces and vacant lands are pivotal in augmenting districts' adaptation capabilities.

Figure 4. District Vulnerability to Flash Floods



Source: Greater Amman Municipality (GAM), "Climate Change Risk Assessment for Amman City," 2024 (submitted for publication), used with permission from GAM and the UN Development Programme.

Strategies such as stormwater drainage networks and using box culverts in tunnels have notably mitigated the impact of flash floods. The GAM has implemented emergency plans through its civil defense and emergency centers, effectively responding to these events, especially during the rainy seasons. The healthcare system's availability and coverage through insurance play crucial roles in adapting to and managing the aftermath of floods.

Assessments reveal Basman and Al Yarmouk as severely vulnerable to floods (see figure 4). Marj Al Hamam, Al Madeenah, Abu Nseir, Shafa Badran, Sweileh, Badir Al Jadeedeh, Markah, and Uhud are least impacted by flash floods.

Amman's District-Level Vulnerability to Vector-borne Diseases

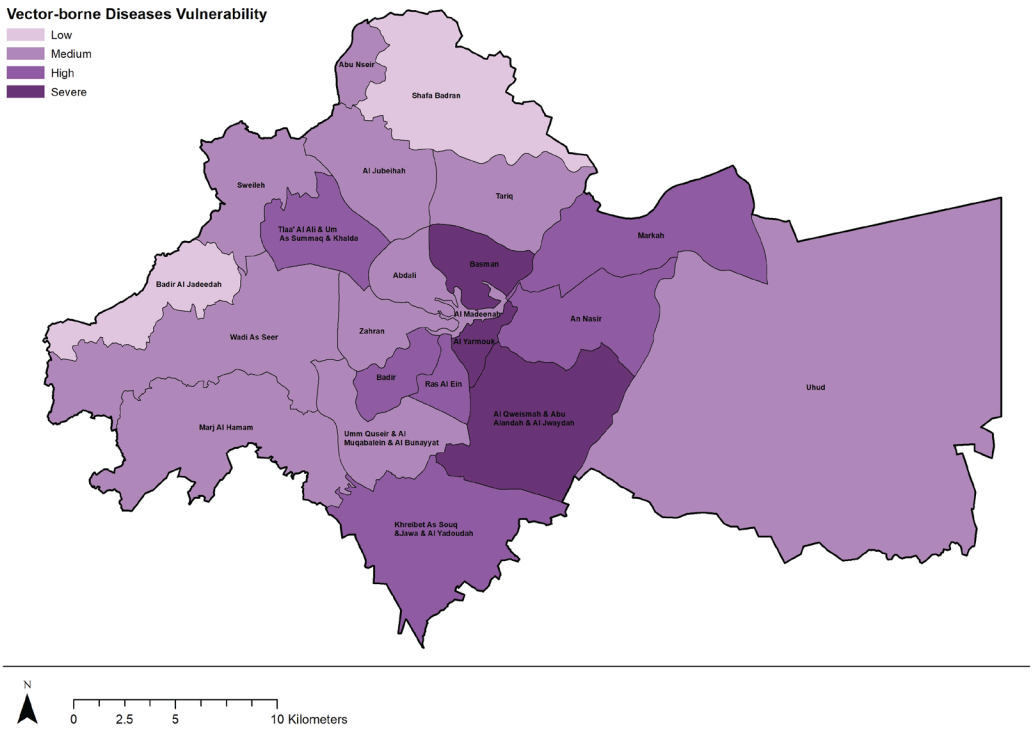
Factors like high population density, refugee settlements with poor hygiene conditions, and various types of households contribute significantly to the spread of vector-borne diseases in urban areas. Residential, commercial, and industrial zones face heightened exposure. Owing to their vulnerable populations, services, and infrastructure, specific districts exhibit varying

degrees of susceptibility to these diseases. Issues like damaged water systems, high waste generation, and prevailing public health concerns like insect infestation, rodent presence, and localized health risks compound the sensitivity of these areas to vector-borne illnesses.

Certain groups within the city, such as women, people with disabilities, youth, older people, and city workers, are sensitive to these diseases. Although the city has a robust pest control system, ensuring overall healthiness, the extent of sewage network coverage and the number of subscribers directly impact public health and disease prevalence. Public green spaces play a crucial role in moderating temperatures within districts, curbing the rampant proliferation of disease-carrying insects. Efficient and regular collection and safe disposal of municipal solid waste play a vital role in controlling the spread of these diseases. Additionally, well-situated health facilities and comprehensive health insurance coverage enhance the city's adaptation to combat these health risks.

As a result of these factors, specific districts like Basman, Al Yarmouk, Al Qweismah, Abu Alanda, and Al Jwaydah are identified as highly vulnerable to vector-borne diseases (see figure 5). Conversely, areas like Shafa Badran and Badir Al Jadeedeh exhibit excellent adaptive capacities and are less vulnerable.

Figure 5. District Vulnerability to Vector-Borne Diseases



Source: Greater Amman Municipality (GAM), "Climate Change Risk Assessment for Amman City," 2024 (submitted for publication), used with permission from GAM and the UN Development Programme.

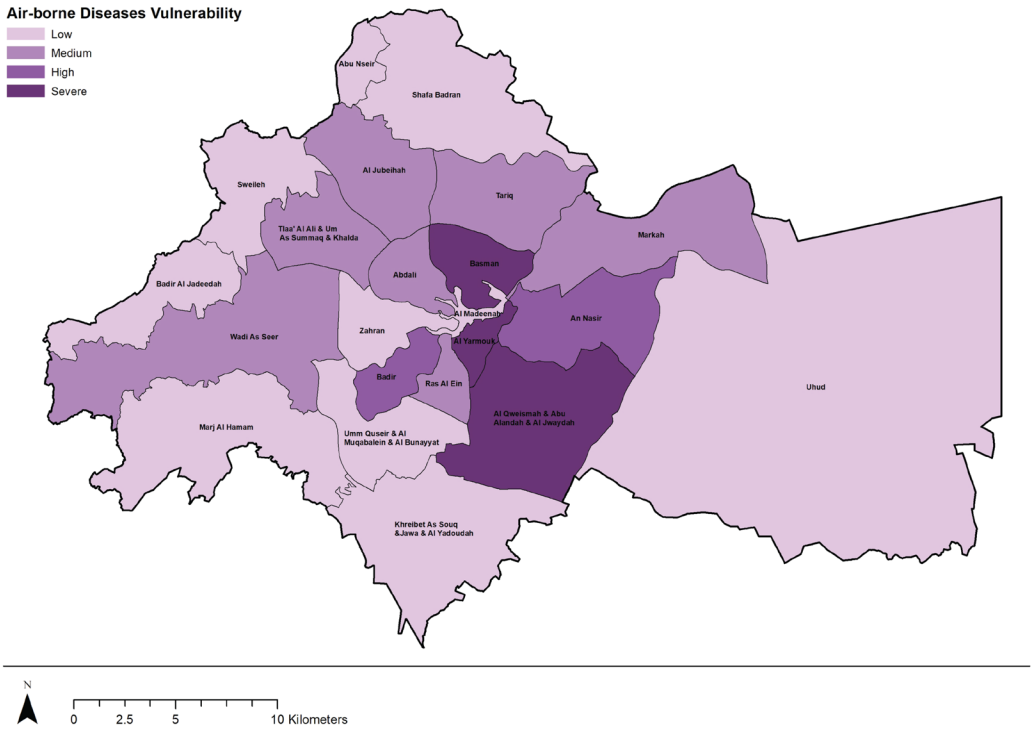
Amman's District-Level Vulnerability to Airborne Diseases

Air pollution and climate change are extremely interconnected. The evolving concentration of fine particles, especially PM2.5—particulate matter with diameters that are less than or equal to 2.5 micrometers in size—causes air pollution, contributes to emergence of allergies and respiratory diseases, and aggravates the impact of noncommunicable diseases. In 2019, 3,074 people died in Jordan from causes attributable to fine particle pollution.

Figure 6 presents the airborne diseases vulnerability assessment in Amman City. It looks at the exposure of the general population and refugees, the density of the population, and the number of families in each district. In terms of human activities, districts with more residential, commercial, and industrial areas are highly expected to be exposed to airborne pathogens. People with disabilities, youth, older people, and city workers are more likely to be vulnerable to such diseases. Refugee camps with poor living conditions, such as overcrowding and inadequate ventilation, also make their residents vulnerable to such diseases.

Factors affecting the jurisdiction of Amman's districts' adaptation to airborne diseases are the green coverage represented by public green areas, electricity generation using renewable resources, and households using solar systems for water heating. All of these elements help

Figure 6. District Vulnerability to Airborne Diseases



Source: Greater Amman Municipality (GAM), "Climate Change Risk Assessment for Amman City," 2024 (submitted for publication), used with permission from GAM and the UN Development Programme.

reduce air pollution. Moreover, healthcare system availability and accessibility are both crucial in helping residents adapt to respiratory and air quality–affected diseases.

The Amman vulnerability map below shows that Basman, Al Yarmouk, Al Qweismah, Abu Alanda, and Al Jwaydah, followed by Badir and An Nasir, are most acutely vulnerable and highly impacted by airborne and respiratory diseases (see figure 6).

Climate Projections: Districts at Risk

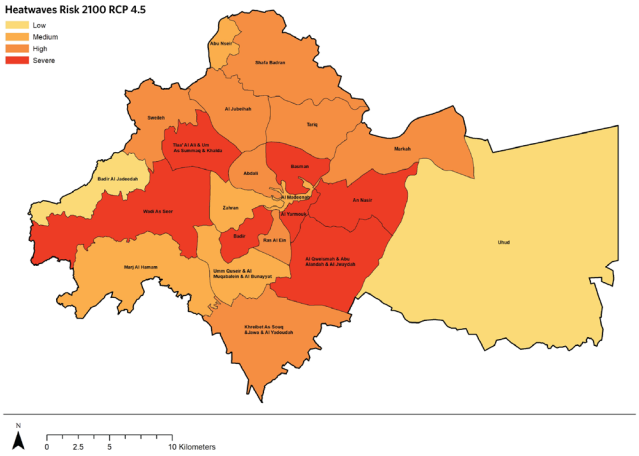
The IPCC defines risk as "The potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems. In the context of climate change, risks can arise from potential impacts of climate change as well as human responses to climate change. Relevant adverse consequences include those on lives, livelihoods, health and well-being, economic, social and cultural assets and investments, infrastructure, services (including ecosystem services), ecosystems and species."

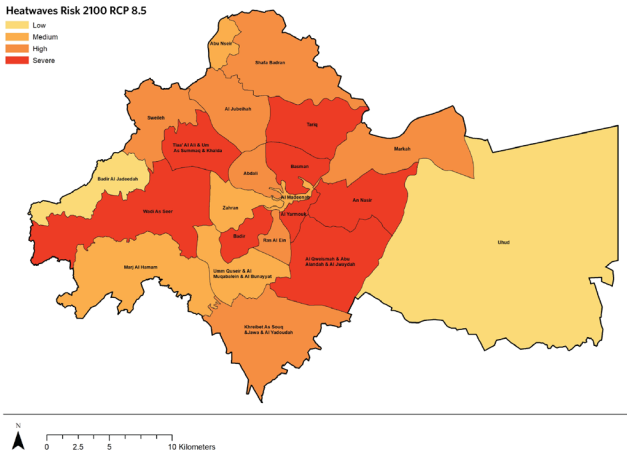
By the end of the century, Jordan is projected to experience a warmer, drier, slightly humid climate. Rising air minimum and maximum temperatures for two GHG emissions pathways (Representative Concentration Pathways, or RCPs), RCPs 4.5 and 8.5, are most likely to increase by 1.2°C and 2.7°C, respectively, due to RCPs 4.5 and 8.5, respectively. As per the 4NC report, there is no evidence of future heavy rain days (more than 20 millimeters), yet projections show decreasing likelihood of intense precipitation, particularly under RCP 8.5 compared to RCP 4.5. However, the severity varies by location, leaning toward increased intensity by the middle of the twenty-first century and decreasing toward the century's end. Further, the report reveals the future trend of drought with an increase in drought events, scale, and duration, with anomalies in severity across the country. Heatwaves are forecasted to happen more frequently and intense in magnitude and intervals of time.

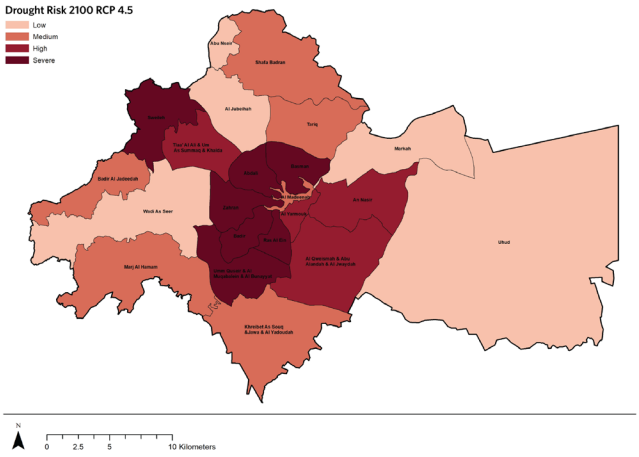
The risk assessment considers the interplay between future climatic hazards and the vulnerability specific to each hazard. This assessment extends until 2100, utilizing scientific data from the 4NC report and focusing on two representative concentration pathways: RCP4.5 and RCP8.5.

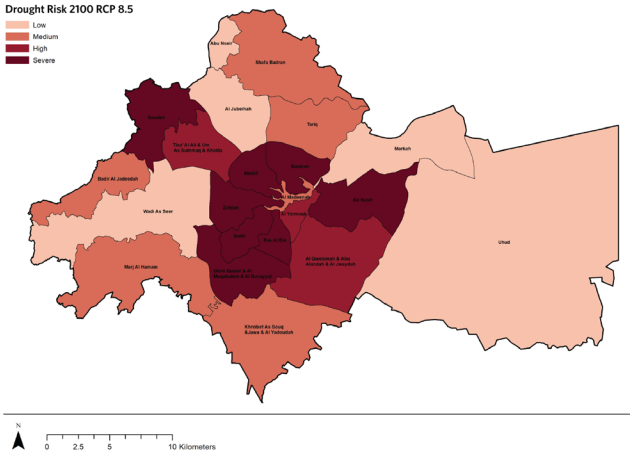
By 2100, heatwave risks in Amman are expected to be notably high in Basman, Badir, Al Yarmouk, An Nasir, Al Qweismah, Abu Alanda, and Al Jwaydah for both RCP scenarios. Drought will significantly affect Abdali, Badir, Basman, Zahran, Ras Al Ein, Sweileh, Um Quseir, Al Muqabalein, and Al Bunayyat under RCP4.5 and RCP8.5. Regarding flash floods, discrepancies are observed between RCP4.5 and RCP8.5. Districts such as Tlaa' Al Ali, Um As Summaq, Khalda, Basman, Al Yarmouk, Badir, Al Qweismah, Abu Alanda, and Al Jwaydah face elevated risk of flooding. In contrast, under RCP8.5, the most pronounced impacts are expected in Basman, Badir, Al Yarmouk, Um Quseir, Al Muqabalein, Al Bunayyat, Al Qweismah, Abu Alanda, and Al Jwaydah. Basman and Al Yarmouk are particularly susceptible to vector- and airborne diseases, while Badir, Al Qweismah, Abu Alanda, and Al Jwaydah also face risks related to airborne illnesses.

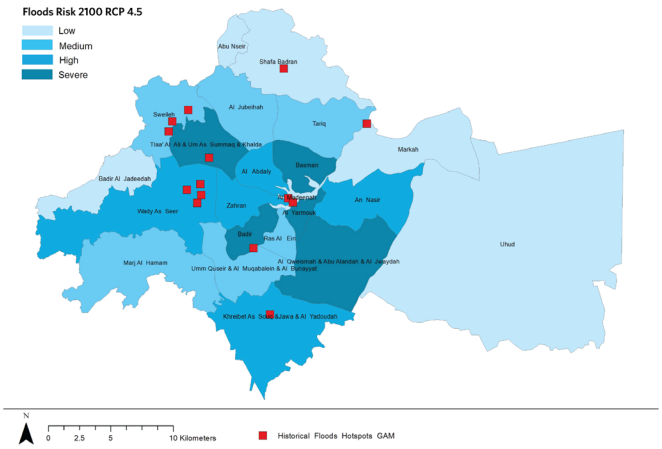
Figure 7. Risk Maps

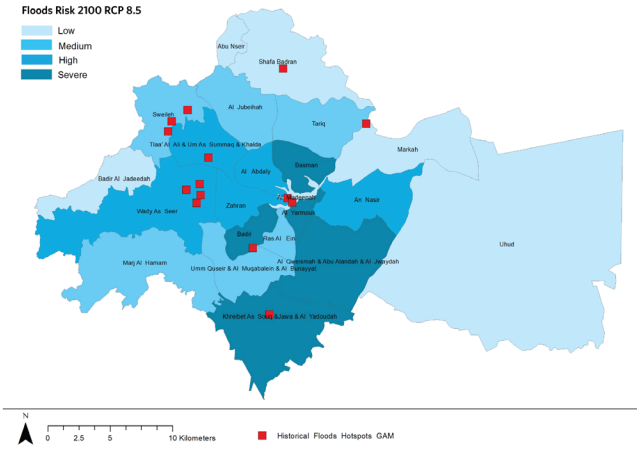


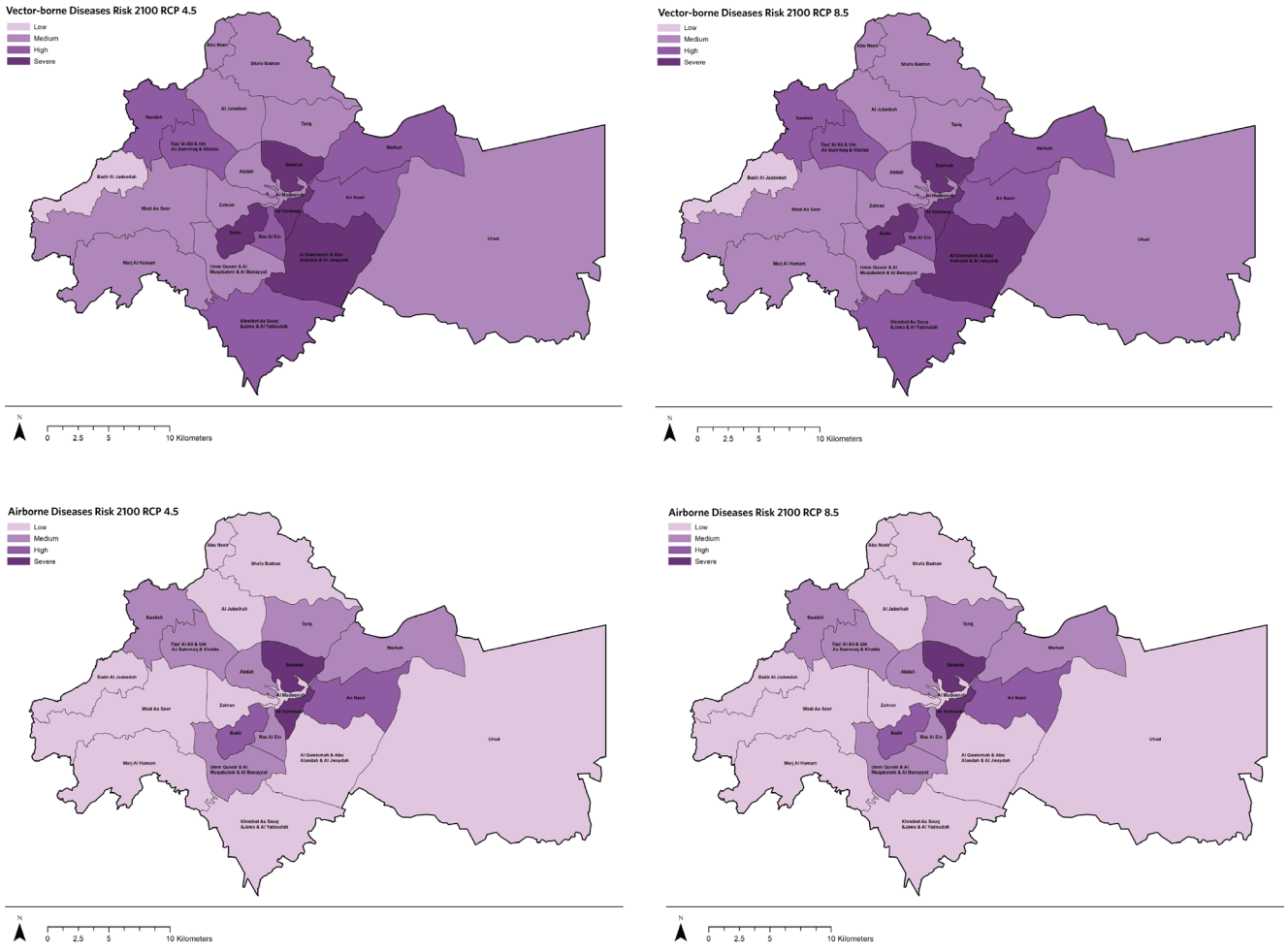












Source: Greater Amman Municipality (GAM), "Climate Change Risk Assessment for Amman City," 2024 (submitted for publication), used with permission from GAM and the UN Development Programme.

Conclusion

The city of Amman stands out as a pioneer in climate governance within the region, with ambitious climate action plans and strategies. Despite these strides, the journey of adapting to and addressing forthcoming climate risks, as well as curbing their impact, remains arduous. The city is lagging in the determined reduction of carbon dioxide emissions stated in its first Amman Action Plan, as the IPCC underscores the uncertainties surrounding climate actions, and cautions against potential risks arising from implementation, policy effectiveness, technological advancements, and system transitions.

For Amman, prioritizing climate resilience is imperative. It will be crucial for the city to align its adaptation plan with the national strategy. Embracing social infrastructure, nature-based solutions, and upgrades to critical physical infrastructure can bolster the city's capacity to withstand climate-related hazards. The prolonged challenge of urbanization, inefficient land use and zoning planning, and the looming threat of exacerbated inequalities caused by uneven distribution of natural resources underscores the need for a paradigm shift in city development through integrated urban planning, ensuring a resilient, green, just, and inclusive city.

The cornerstone of effective mitigation and adaptation lies in disaggregated climate data. Amman's Urban Observatory must devise inclusive, evidence-based environmental indicators aligned with climate plans and SDGs, all of which can emphasize district-level socioeconomic and health data for inclusivity and reduced inequalities among vulnerable groups. Coordinated efforts across multiple levels and stakeholders are essential. Consequently, it is vital for the city to establish an Early Warning System aligned with the national early warning system and develop local disaster risk reduction strategies.

Disaggregated climate data make up the cornerstone of effective and efficient mitigation and adaptation to climate resilience. Amman's Urban Observatory must develop inclusive environmental and climate-hazard indicators. Indicators must be measurable, scientific, evidence-based, and up to date to be monitored in the short, medium, and long terms. Moreover, disaggregating socioeconomic and health data at the district level ensures inclusivity and reduces inequalities, creating an approach that better serves vulnerable groups exposed to multilateral climate crises. Finally, multilevel and multistakeholder coordination on data is a must.

As in many cities, financial resources are at the top of challenges. Amman requires innovative and sustainable climate action financing mechanisms and partnerships through public-private partnerships to implement the necessary projects. Local and national government efforts, citizen awareness, and behaviors encouraging more responsive consumption of resources will all be necessary for effective climate action in Amman.

This article is based on the findings and analysis from the Climate Change Risk Assessment for Amman City. That assessment was sponsored by the United Nations Development Programme (UNDP), the United Nations Human Settlements Programme (UN-Habitat), and the United Nations Environment Programme (UNEP) and produced for the Greater Amman Municipality. The author of this article was the lead expert on the assessment. The views expressed in this publication are those of the author and do not represent those of the UNDP, UN-Habitat, UNEP, or Greater Amman Municipality. While every effort has been made to ensure the accuracy and reliability of the data and analysis provided in this article, readers are advised to exercise discretion and consult additional sources for specific inquiries or decisions. The author and contributors disclaim any liability for errors, omissions, or interpretations arising from the use of this article.

CHAPTER 6

Just Energy Transitions? Lessons From Oman and Morocco

Manal Shehabi

For Arab countries, the combination of oil price volatility and the accelerating global energy transitions to mitigate climate change poses both an existential threat and an economic and environmental opportunity. Those states not only are hydrocarbon-dependent but also face severe climate vulnerabilities. Many have adopted domestic energy transition plans, but as an economic, not an environmental, response, specifically to generate the new export revenue that will be needed to maintain the political equilibrium and the role of the state and to fund socioeconomic development. Across the region, economic development and energy transition plans generally deprioritize the environment, albeit to varying degrees, potentially exacerbating climate-related vulnerability. As such, it is imperative to make energy transitions climate-resilient and ensure they benefit, not harm, the environment. According to the International Energy Agency, there are three major goals for a climate-resilient energy transition strategy (a mitigation strategy at heart) in the Middle East and North Africa (MENA) region: clean energy, energy security, and climate change adaptation. In addition, a climate-resilient energy transition strategy must include three additional goals critical for economic and environmental sustainability in the MENA and Arab states, namely energy affordability; existing natural resources protection, particularly for water and land; and quality of life and health equity. To ensure socioeconomic development and political stability, the transition must be a just transition, one that is fair, equitable, and able to minimize negative and maximize positive impacts on communities and the environment. This requirement presents the question: To what extent can energy transition pathways be climate-resilient to generate a just transition with environmental benefits in Arab states?

Using illustrations from Oman and Morocco, this piece argues that economically motivated energy transitions should incorporate climate resilience and environmental targets. Nevertheless, significant challenges persist to that end. Failure to address these challenges will hinder just energy transitions and climate resilience and reduce the ability of Arab states, especially wealthier hydrocarbon exporters with higher emissions and net-zero pledges, to achieve both emissions and equitable economic targets.

Global energy transitions away from hydrocarbons have accelerated since the Paris Agreement. In the 2020–2023 period, investments in clean energy globally surged by 40 percent. The acceleration is urgent and driven largely by national commitments to reduce greenhouse gas (GHG) emissions and, therefore, limit global warming to no more than 1.5 degrees Celsius (°C) above preindustrial levels—a threshold that the world is expected to breach by 2027. The UAE Consensus adopted by the 28th Conference of the Parties (COP28) in December 2023 called on the parties to achieve the 1.5°C target through various measures, including "transitioning away from fossil fuels" (articulating fossil fuels for the first time in the twenty-eight years of COP meetings), tripling renewables, and doubling energy efficiency globally by 2030. The reduction of global fossil fuel production and consumption necessary to achieve that target will continue to directly affect Arab countries.

Specifically, the global energy transition threatens the economic sustainability of Arab states, although to varying degrees, forcing changes in their economic and energy structures. The ensuing existential threats are most evident for the economies of hydrocarbon-dependent welfare states of the Gulf Cooperation Council (GCC): Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE). For decades, these economies have been overly dependent on hydrocarbon exports as the primary contributor to their governments' revenue. In 2021 alone, hydrocarbon exports amounted to well over half of government revenue: 60 percent in Saudi Arabia, 63 percent in Bahrain, 74 percent in Oman, and between 80 and 84 percent in the UAE, Qatar, and Kuwait. Hydrocarbons remain the primary energy sources and economic drivers in these countries despite their ambitious strategies to diversify away from hydrocarbons, as articulated in grandiose economic development plans known as *Visions* (to be realized by 2030–2040). Episodes of oil price collapse, especially that of mid-2014, coupled with declines in oil exports have exposed the depth of economic challenges of hydrocarbon reliance. These price fluctuations forced unprecedented, politically contentious energy subsidy reforms, such as Oman's energy price reform in 2015 and subsequent phaseouts of water and electricity subsidies. They also exposed the difficulties of implementing urgent economic reforms and diversifications.

Although less-evident, other states liable to be substantially impacted by energy transitions are hydrocarbon net-importing Arab states—most notably Egypt, Jordan, Morocco, and Tunisia. Those states are reliant on energy and energy-intensive imports and suffer significant inflationary waves (including for imported food) and industrial challenges following hydrocarbon price hikes. Crucially, their economies also depend on foreign remittances from labor working primarily in GCC states, constituting substantial shares of gross domestic product (GDP)—28 percent in Lebanon, 10 percent in Jordan, 9 percent in Morocco, and 6 percent in Egypt. Economic downturns in GCC states reduce remittances and, therefore, GDP, in those economies. Against this background, domestic energy transitions offer immense direct economic opportunities with equally immense environmental implications.

Oman and Morocco stand on opposite sides of hydrocarbon exportation, but they share important commonalities that call for closer comparison. Both depend on natural resources—including hydrocarbons and land—for economic sustainability, and their energy transition projects leverage their respective natural resources. They have comparable levels of

GDP, total emissions, energy transition targets, and constrained fiscal spaces. Notwithstanding differences across Arab states, Oman faces challenges common to Arab hydrocarbon exporters, and Morocco to importers. As such, this comparative assessment offers insights applicable to just energy transitions and sustainability in Arab states.

Environmental Vulnerabilities and Opportunities of Energy Transitions

The MENA region enjoys tremendous opportunities for energy transitions. It boasts some of the world's best solar and wind energy potential, and therefore some of the lowest prices, along with established trade relations and a strategic location near centers of demand in Europe and Asia. Combined with hydrocarbon resources, those advantages offer GCC economies potential new export revenue from renewables and clean hydrogen to partially replace expected losses in hydrocarbon export revenue and increase diversification. Clean (low carbon) hydrogen is an especially attractive opportunity. As an excellent energy carrier and storage medium, hydrogen can contribute to decarbonization of fertilizers, petrochemicals, power, transport, and hard-to-abate sectors (those that are difficult to electrify, such as steel and cement). Its share in total energy demand is projected to range from 12 percent to 22 percent by 2050. Because GCC states produce large quantities of "dirty" hydrogen (derived from hydrocarbons), they are also well positioned to be leaders in blue hydrogen, which is conventional hydrogen but with lower emissions using carbon capture technology. GCC states also have a potential comparative advantage in green hydrogen, which is produced using renewable energy to separate hydrogen from oxygen molecules in water without direct carbon emissions (excluding emissions along the supply chain), often using electrolysis. North Africa shares a similar potential comparative advantage in green hydrogen.

To realize these opportunities, numerous Arab states have adopted local energy transition projects and plans. GCC states have announced net-zero emissions targets, of which energy transitions form a part: in 2021, the UAE pledged to reach net zero by 2050, and Saudi Arabia and Bahrain pledged the same goal by 2060. In 2022, Oman pledged to reach net-zero targets by 2050 and Kuwait by 2060. GCC states also announced ambitious renewable energy targets (ranging from 15 percent in Kuwait to 50 percent in Saudi Arabia by 2030 and in the UAE by 2050), and clean hydrogen and decarbonized hydrocarbons and industries through the use of carbon capture and storage/carbon capture, utilization, and storage (CCS/CCUS) technologies. Nature-based solutions feature strongly, especially in the Saudi Green Initiative and the UAE's coastal ecosystems. Importantly, hydrocarbons remain an important part of these countries' energy transition pathways, but in the form of lower emissions hydrocarbons using technology and carbon storage that leverage the region's geological advantages. But those energy transitions also have an economic motive: domestic-targeted projects, such as renewables, have been delayed, while export-targeted projects, such as green hydrogen, have been accelerated.

For hydrocarbon-importing Arab states, energy security and fiscal balance improvements initially drove expansions in renewable energy. But similar opportunities for new export revenue have driven additional targets for renewable power and plans for green hydrogen. Ambitious

renewable energy penetration targets range from 30 percent by 2030 in Tunisia to 52 percent by 2050 in Morocco. Despite their relatively limited fiscal resources, these states lead GCC states in renewable energy.

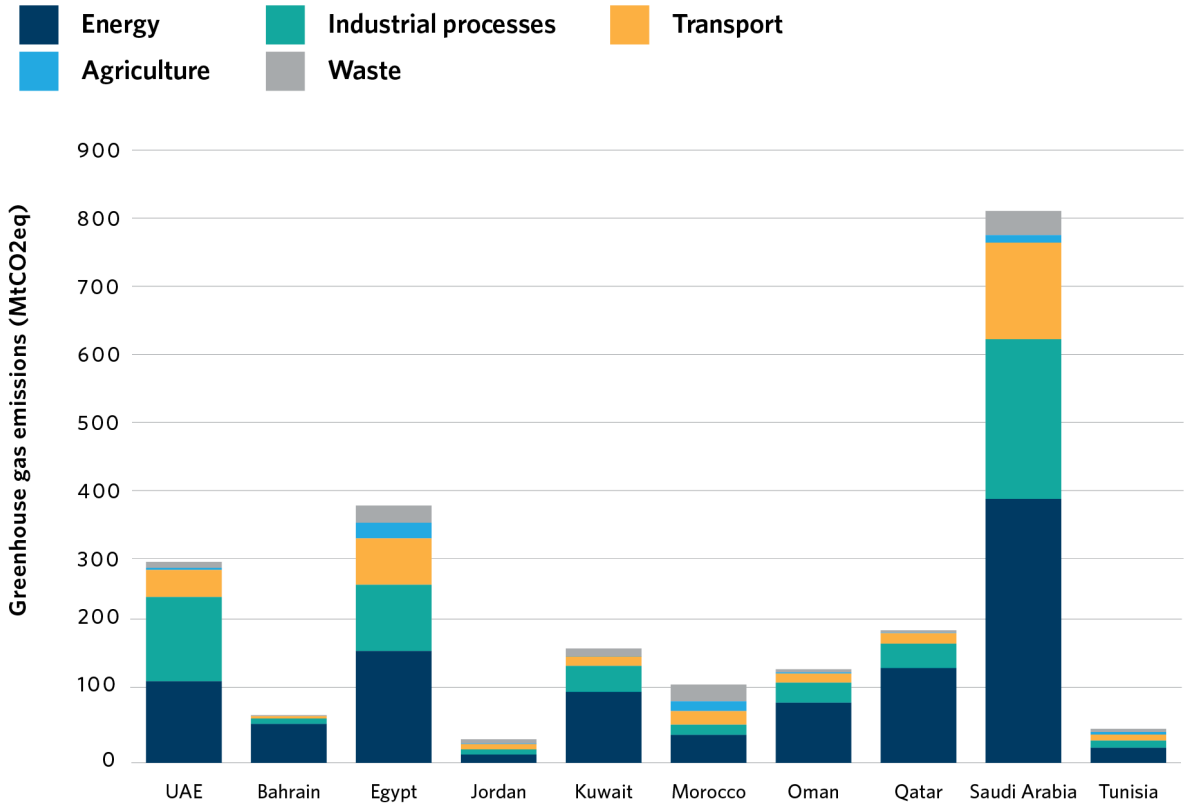
The environmental opportunities of energy transition pathways are equally important for the region's livelihood and stability. Arab states are environmentally threatened, and impacts of climate change further exacerbate regional conflict and social upheavals. According to a Stockholm International Water Institute and UNICEF report, in 2018 fourteen of the seventeen most water-stressed countries globally are in the MENA region. The top six among them—Kuwait, Libya, Qatar, Saudi Arabia, the UAE, and Yemen—are all Arab states. In the case of Oman, it has a critical water stress level and ranks fifteenth-most-water-stressed globally, compared with Morocco's medium level and a water stress global rank of thirty-five. Volatile precipitation patterns have exacerbated water scarcity and caused various extreme natural disasters, including droughts in Morocco in 2022, Oman's Category 3 Tropical Cyclone Mekunu in 2018, and intense floods in 2022 in Oman and the Gulf region.

Local water demand has exceeded natural replenishment in many areas. Groundwater remains the primary source for agricultural industry and for farms and inland towns, yet it is being depleted at a rate of 1.34 million cubic kilometers per year (km3/yr). Morocco's water demand in 2020 reached 16.2 billion cubic meters (m3), for drinking and water-intensive agriculture. Recent droughts along with increased water usage are depleting the country's 29 billion m3 of renewable water resources at increasing rates, with an overuse of water and overexploitation of some aquifers. Reservoir storage capacity loses about 75 million m^3 per year because of Moroccan dam silting. Currently, 86 percent of Oman's water is desalinated (the second-highest rate in the GCC, after the UAE). Desalinated seawater met 3 percent of Morocco's water needs, but a higher share is expected with desalination responses to drying reservoirs and droughts.

Emissions reduction to limit rises in temperatures is another opportunity. The MENA region is warming at nearly twice the global average, which is partially attributable to increases in total and per capita emissions.

As seen in figure 1, countries' emissions profiles mirror their economic structure. Relative to others in the region, Oman and Morocco have medium-level emissions: Oman produces 137.2 million metric tons of carbon dioxide equivalent ($MtCO_2eq$) and Morocco produces 114.8 $MtCO_2eq$. Yet their production sources have two key differences. First, the energy sector (including electricity) is responsible for around one-third of emissions in Oman, compared with around one-third in Morocco. Industrial processes contribute 22 percent of emissions in Oman, compared with 13 percent in Morocco. In the case of Oman, petrochemicals account for the difference. Second, Morocco's agricultural and its related waste sector drive 13 percent and 21 percent of emissions, respectively, compared with negligible contributions (1 percent and 3 percent) in Oman. Emissions from the remaining sectors are more comparable, though Morocco's transport sector produced 17 percent of emissions, compared to 10 percent in Oman.

Figure 1. Greenhouse Gas Emissions in GCC and Select MENA Hydrocarbon Importers by Sector (2022)



Source: Author's analysis and compilation based on data from Emissions Database for Global Atmospheric Research (EDGAR) v8.0 (2023), https://edgar.jrc.ec.europa.eu/dataset_ghg80.

Although country-specific data are scarce, studies suggest that the MENA region is expected to experience the third-highest GDP losses (6 percent) only from climate-related physical risks, after South and Central Asia and sub-Saharan Africa. Domestic energy transitions will be an important part of reducing local emissions and their ensuing environmental challenges.

Energy Transition Pathways in Oman and Morocco

Energy transitions are an urgent economic priority for Oman and Morocco, but their pathways to these transitions diverge, reflecting differences in their natural wealth and dependence on hydrocarbons. As seen in table 1, their GDP, total energy consumption, and total emissions are fairly comparable. Yet Morocco's population is more than 8 times greater than Oman's, so the latter's per capita GDP, emissions, and energy consumption levels are seven to nine times higher. Both have significant water stresses, but Oman is the more severely stressed of the two.

Table 1. Key Economic, Energy, and Emissions Indicators, Oman and Morocco

Indicator	Oman	Morocco
GDP (2022)	$114.7 billion	$130.9 billion
GDP per capita (2022)	$25,057	$3,442
Population (2022)	4.58 million	37.46 million
Total energy consumption (2021)	1.31 quadrillion Btu	0.95 quadrillion Btu
Total energy consumption global rank	52	61
Energy consumption per capita (2021)	288.78 million Btu	25.58 million Btu
Energy consumption per capita global rank	11	123
Energy consumption per GDP (at purchasing power parities)	8.14 thousand Btu per U.S. dollar	3.13 thousand Btu per U.S. dollar
Energy consumption per GDP global rank	13	104
Total emissions (2022)	137.2 MtCO2eq	114.8 MtCO2eq
Emissions per capita (2022)	29.99 tCO2eq per capita	3.06 tCO2eq per capita
Annual renewable fresh water (2020)	1 billion m^3	29 billion m^3
Renewable energy share of electricity (2021)	0.4%	34%
Installed electrolyser capacity targets for green hydrogen projects	25 GW by 2050	3-5 GW by 2030; 31–53 GW by 2050
Renewable hydrogen production targets	1 million tonnes per year by 2030; Up to 3.75 million tonnes by 2040; Up to 8.5 million tonnes by 2050	9 million tonnes per year by 2050
Levelized costs of producing renewable energy	Varies, as low as $0.035–$0.07 /kWh	Varies, as low as $0.038/kWh
Classification of water stress level	Critical	Medium
Available annual freshwater resources (2020)	1 billion m^3	29 billion m^3
Renewable internal freshwater resources per capita (2020)	308 m^3	790 m^3

Source: Cited in the text, including World Bank Data Bank, https://data.worldbank.org; U.S. Energy Information Administration (EIA) country profiles for Morocco and Oman; Krumpelmann (2023); Lee (2021); Ahshan, Onen, and Al-Badi (2021); Daoudi, Mou, and Naceur (2022); and International Energy Agency.

Note: British thermal units (Btu); gigawatt (GW); kilowatt hour (kWh); metric tons of carbon dioxide equivalent (MtCO2eq); cubic meters (m^3); tons of carbon dioxide equivalent CO2 (tCO2eq).

Oman

Oman has relied heavily on hydrocarbons since commercial production started in 1967. The fourth-largest hydrocarbon producer in the GCC, in 2021 Oman produced 1.05 million barrels (mb) per day, with 971 mb of oil and 43.6 billion cubic meters (bcm) of natural gas. In the same year, crude oil, gas, and refined petroleum exports contributed 74 percent of government revenue and 54 percent of total export revenue, and industry contributed 30 percent of GDP. The manufacturing sectors contribute 10 percent of GDP but a substantial 34 percent of exports—making Omani exports among the most diversified in the GCC—and promise future exports in decarbonized industries.

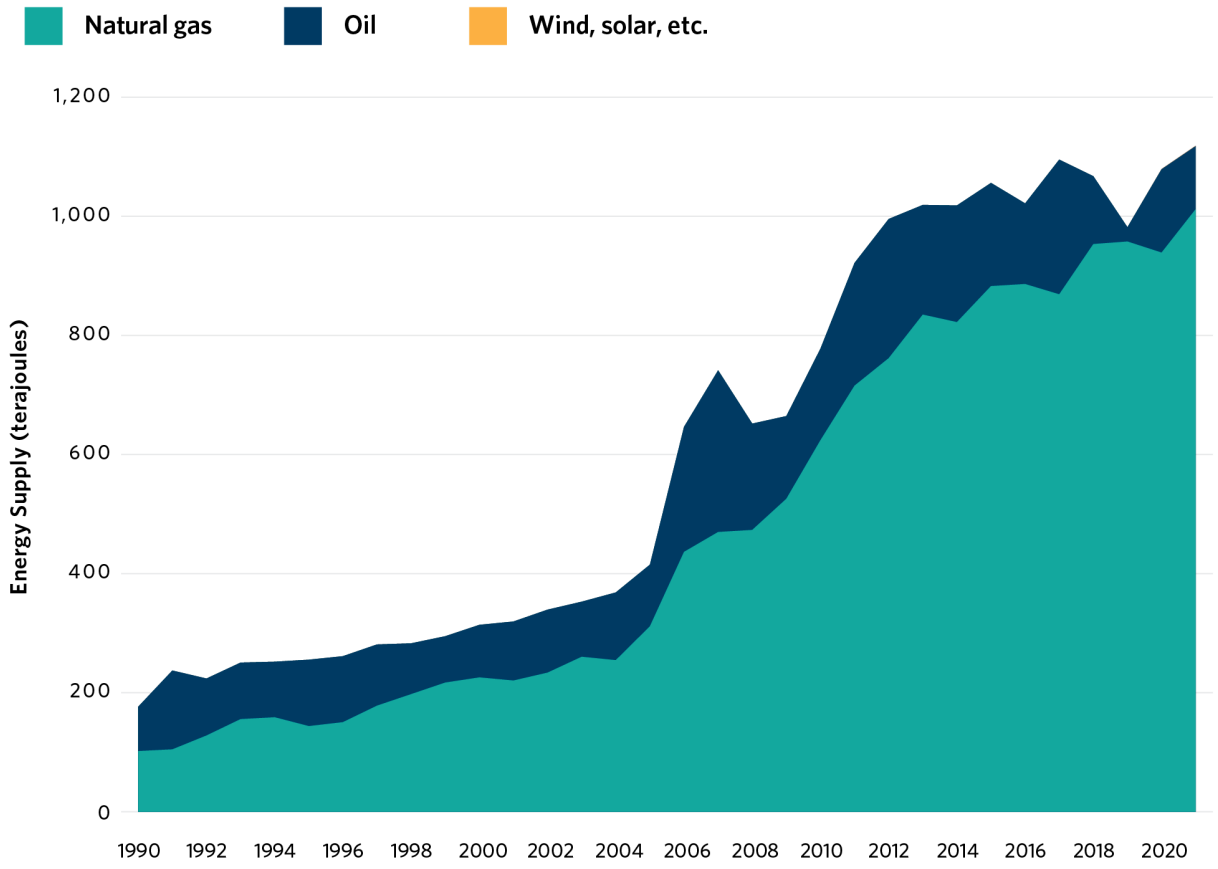
Owing to its high dependence on hydrocarbons, Oman has grappled with substantial fiscal pressures, with rising domestic expenditures (especially following the coronavirus pandemic) along with diminishing hydrocarbon export revenues. Temporary surges in oil prices in 2022 triggered by Russia's invasion of Ukraine improved its fiscal position, yet diversifying government revenue sources remains an imperative. For example, the government's Social Protection Law paves the way to universal social protection to mitigate the impacts of future oil export revenue declines, but implementing this law requires fiscal sustainability. Finally, wildlife, ecotourism, and rich natural attractions have been drivers of in-country and international tourism, contributing 3 percent of GDP in 2022 (according to official data from the Statistical Yearbook). To diversify its economy, Oman aims to increase this share of GDP to 10 percent by 2040 and attract 11.7 million tourists.

Energy transitions are also an opportunity to diversify the energy mix and release additional hydrocarbons for exports. In 2021, oil and natural gas constituted respectively 9.4 percent and 90.5 percent of the total supply, with only a negligible share from renewables (0.4 percent, or 938 terajoules (TJ)). Since 2008, Oman has been importing relatively small amounts of natural gas, which in 2022 reached 2,076 million standard cubic meters (see figure 2).

Energy transitions are thus pathways for economic diversification. Oman's Vision 2040 (adopted in 2020) charts the path toward a low-carbon economy. Oman's National Strategy for an Orderly Transition to Net Zero details the economic aims of the transition: reduced energy system costs; an additional 50 percent of GDP (two-thirds from green hydrogen and one-third from green power capacity); an improved fiscal balance; employment generation and higher social impacts; and security in energy supply through self-sufficiency in power, hydrogen, and hydrocarbons. This plan is intended to reduce the share of hydrocarbons in GDP and increase export diversification. Measures to achieve these aims include increasing shares of renewable energy in power generation: 10 percent by 2025, 20 percent by 2027, and 35–39 percent by 2040, as well as 63 percent efficiency at gas-fired plants by 2027.

Green hydrogen is the other major pathway, especially as Oman is less endowed in hydrocarbons relative to other GCC states. Options for blue hydrogen are limited, but Oman's significant renewable solar and wind energy resources present ample opportunities for green hydrogen. The government adopted the green hydrogen strategy in 2020, then

Figure 2. Total Energy Supply Mix in Oman



Source: Author using data from the International Energy Agency Key Energy Statistics (2021), https://www.iea.org/countries/Oman.

in 2022 it established an independent entity—Hydrogen Oman (HYDROM), owned by Energy Development Oman and regulated by the Ministry of Energy and Minerals—to lead and manage it. Production targets are ambitious: at least 1 million metric tons (mt)/year by 2030, at least 3.25 million mt/year by 2040, up to 8.5 million mt/year by 2050—a target that exceeds Europe's total hydrogen demand of 8.2 million mt in 2022. In 2020 and 2021, Oman's oil company OQ signed concessions and joint venture, creating the Hyport Duqm Project in the Special Economic Zone at Duqm. The planned green hydrogen and ammonia plants in this $2.5 billion facility are expected to produce 2,200 million metric tons of green ammonia per day. If those targets are realized, Oman can be a leading regional center for producing and exporting green hydrogen.

Finally, low-carbon technologies also are playing a pivotal role in the transition. These technologies include hydrogen, electric vehicles, CCS, and energy efficiency, as well as upskilling of labor in said technologies.

Morocco

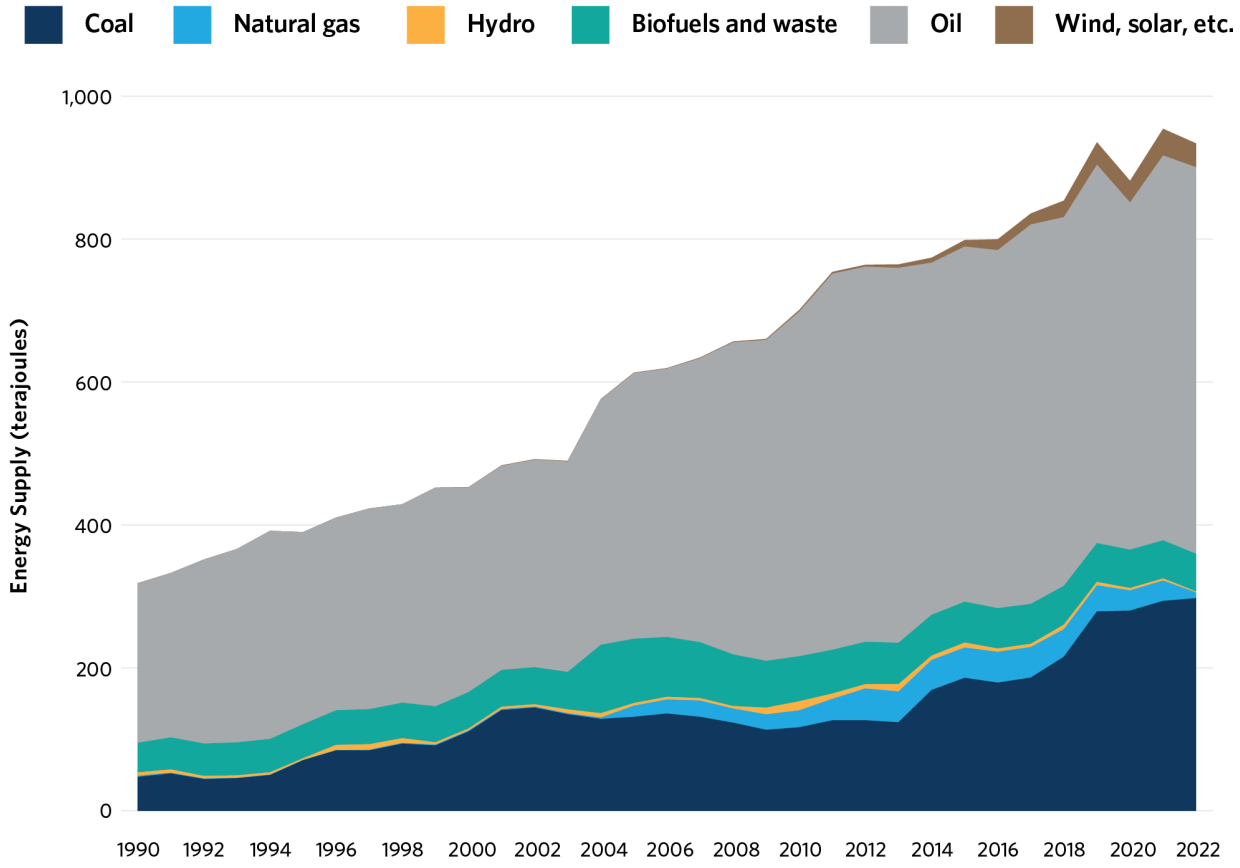
A hydrocarbon-importer, Morocco boasts a diverse economic structure that nonetheless is dependent on natural resources. The industrial sector contributes around 26 percent of GDP, agriculture 12 percent (but one-third of the labor force), and mining 10 percent. The mining sector mostly is dominated by phosphate, a critical mineral of importance to the decarbonization and energy transitions. Tourism, another key industry, contributes around 7 percent of GDP (as of 2019), owing to Morocco's central location, relative affordability, rich wildlife, deserts, ecotourism, and natural attractions.

In 2022, Morocco faced interconnected challenges that caused a 7 percent decline in real GDP growth (down to 1.3 percent). They included severe droughts, a global economic slowdown during the coronavirus pandemic, and escalating international commodity and food prices following Russia's invasion of Ukraine. Despite the destructive Al Haouz earthquake in September 2023, the economy rebounded in 2023, driven by the recovery of agricultural production, a resurgence in the tourism sector, positive contributions from net exports, and declines in global commodity prices (reducing local inflation).

Morocco's 2030 National Strategy of Sustainable Development, and the subsequent New Economic Development Plan (established by the Special Commission on the Development Model), outlines economic, energy security, and renewables targets. The government implemented various reforms, such as the Mohammed VI investment fund and enhancements of state-owned enterprises governance, to attract foreign direct investment, bolster the private sector, expand employment, and strengthen human capital. Another target is boosting tourism to drive economic growth through various measures, such as the government's comprehensive reconstruction plan for the High Atlas Mountain region.

Morocco imports about 90 percent of its hydrocarbon energy supply. Its energy mix in 2022 included coal (37.25 percent), hydroelectricity (16.70 percent), fuel oil (7.03 percent), natural gas (17.72 percent), wind (13.48 percent), and solar (7.82 percent). As seen in figure 3, Morocco's total primary energy consumption consistently has increased by 5 percent annually since 2004.

Figure 3. Total Energy Supply Mix in Morocco



Source: Author using data from the International Energy Agency Key Energy Statistics (2022), https://www.iea.org/countries/morocco.

Energy transition priorities, outlined in the National Climate Plan 2020–2030, include growing a diverse renewable energy sector and the development of new indigenous resources. One of the first Arab countries to adopt renewable energy, Morocco successfully increased total installed capacity from renewable energy sources, which is currently 38.2 percent (4,031 MW) of total installed electrical capacity—the highest among Arab countries. The expansion was motivated by energy security and the reduction of import costs and dependence. It was aided by enhanced legislative and regulatory frameworks governing renewable energy projects by the private sector and various amendments in existing laws on renewable energy, self-production of electrical energy, and electricity sector regulation. The National Agency of Electricity Regulation was established and launched various energy reforms that supported renewables expansion. Morocco's National Plan for the Development of the Use of Natural Gas aims to completely replace coal-fired plants by 2050. Thanks to these measures, natural gas imports were reduced by 86 percent between 2017 and 2022 (down from 1,150 million to 160 million standard m3). Notable projects include Noor complex, with its Noor Ouarzazate concentrated solar power plants (operating since 2016); the Ain Beni Mathar and the Tarfaya wind farms (operational since 2009 and 2014, respectively); and the Abdelmoumen pumped-storage hydroelectric plant.

The National Office of Electricity and Potable Water targets an installed electrical capacity of 10 gigawatts (GW) from renewable energy by 2030 (4.5 from solar, 4.1 from wind, and 1.3 from hydropower) and to raise renewables' share in power to 52 percent by 2050. To support these expansions, Morocco is concurrently expanding its power grid infrastructure. Other targets include reducing GHG emissions in other sectors—such as transport, building, industry, agriculture, and energy efficiency—to reduce energy consumption by 15 percent from 2016 levels by 2030.

A notable success in Morocco's energy and economic diversification is becoming a net exporter of electricity in 2019 (928 GW), compared with 3,374 GWh of imports the previous year. With an electricity system interconnected with Algeria and Spain, it is the only Arab state with a power cable linking it to the European grid. Morocco aims to export additional electricity to Europe.

Green hydrogen is potentially Morocco's largest energy transition ambition. The Roadmap to Green Hydrogen, published in 2021 under the National Hydrogen Commission, expected demand of up to 30 terawatt hours (TWh) by 2030 and 307 TWh by 2050. A $27.2 billion investment in green hydrogen was announced in the Dakhla-Oued Ed-Dahab region. If the necessary renewable energy infrastructure is available, Morocco could produce 1.2 million tons of green hydrogen annually by 2030 (about 4–5 percent of projected global demand) and 2.7 million tons annually by 2040. The strategy sees output as future exports in the international market of hydrogen, green ammonia, and synthetic fuels, especially to Europe. Also, in the long term, it sees uses in local decarbonization—including green ammonia feedstock for local agriculture, industry, residential heating, and transport. If these targets are realized, Morocco, like Oman, can become a leader in the green hydrogen market.

Environmental Targets in Energy Transition Plans and Nationally Determined Contributions

Key to climate-resilient energy transitions is prioritizing the environment in economic development and energy transition plans and the supporting regulations and policies. Importantly, from an institutional perspective, both Oman and Morocco incorporate the environment and promote low-carbon economic growth in their energy transitions and development plans.

In the original version of the published *Visions*, Oman was the only GCC state with environment-specific targets. Oman's *Vision*'s objectives explicitly state ensuring a "balance between environmental, economic and social requirements, according to sustainable development guidelines." Its main pillars are people and society; economic development (with environment performance indicators, such as the Environmental Performance and Water indices); government and institutional performance; and sustainable environment. Oman adopted plans for carbon neutrality, such as the Carbon Control Target Plan (rooted in the *Vision*) and a net-zero National Strategy. In 2018, Oman adopted the National

Strategy for Adaptation and Mitigation to Climate Change for 2020–2040, to identify strategic actions to address negative impacts on vulnerable sectors and transition to a low-emissions economy. As part of its climate-resilient development, Oman also adopted the 2020–2040 National Spatial Strategy to anticipate climate change impacts on urban areas and integrate adaptation and mitigation into new developments.

Similarly, Morocco has environment-specific objectives in its 2030 National Strategy of Sustainable Development. The strategy also proposed a national plan to prevent and respond to climate risks, including the promotion of innovative technologies. The subsequent New Development Model also emphasized reducing climate risks and energy costs (through renewables and low-carbon energy) and increasing competitiveness. The National Energy Strategy and Climate Plan and Climate Change Policy outline guidelines for building climate resilience in water constraints, agriculture, fisheries, health, biodiversity, and transport infrastructure. Morocco's National Adaption Plan 2020–2030 was adopted in 2022 to enhance local adaptive capacity. Similarly, the National Strategy for Natural Disaster Risk Management 2020–2030 was created to promote risk prevention and improve long-term preparedness.

Nationally Determined Contribution (NDC) submissions to the United Nations Framework Convention on Climate Change are another important road map to align decarbonization and energy transitions efforts with environmental sustainability. In these submissions, mandated by the Paris Agreement, parties communicate their objectives for GHG emissions reduction and successively update them. Yet here, as in the case of renewable energy, Oman lags behind Morocco in relative terms, despite its significantly higher emissions and net-zero targets by 2050. In its 2021 Second NDC report, Oman has committed to a 7 percent reduction in GHG emissions by 2030 (compared to the Business-As-Usual—BAU—scenario), reducing approximately 125.25 MTCO2eq. Meanwhile, in its 2021 Second NDC report, Morocco aims to reduce its GHG emissions by 45.5 percent by 2030 (compared to the BAU scenario), the equivalent of 77.5 $MtCO_2eq$.

One key environmental concern for Morocco is the large land requirements for its renewables and hydrogen ambitions, a consideration that can affect its agricultural resources and impose on Indigenous peoples' land. To demonstrate these requirements, a 1 GW plant, set on about 0.17 square kilometers (km^2) of land, would need 1,000 GW of electrolysis and occupy an area equivalent to the island of Manhattan in New York City. Morocco already has faced significant opposition and conflicts over energy and tensions regarding extractive industries' access to land in various renewable energy projects, such as Noor Ouarzazate and in the disputed Western Sahara. The ensuing effects include increasing land grabs, displacement, and additional vulnerabilities for people in already vulnerable situations, especially agricultural workers and Indigenous peoples. These green hydrogen, phosphate, and renewable energy projects along with their export targets to Europe have generated strong opposition to Morocco's energy transition, citing green colonialism.

It is not surprising that Oman and Morocco are ahead of most other Arab states in efforts pertaining to the environment; environmental attractions drive tourism in both countries. Nevertheless, relative to economic considerations, some environmental targets are vague and require further specificity to protect the environment and ensure climate-resilient energy transitions. Development plans in both countries would benefit from additional, specific targets beyond reducing carbon footprints and pollution. Examples include efficient resource management as well as the protection of water resources. Such targets will be important because the plans for Oman's economic diversification and Morocco's economic development aim to expand certain industries—notably energy transition, tourism, and industrial exports—that can have negative impacts on the environment.

Challenges to Achieving Energy Transitions and Emissions Targets

Indeed, both Oman's and Morocco's ambitious energy transition projects can contribute to equally ambitious targets for emissions reduction, domestic decarbonization, and energy sustainability. Yet an assessment of current trends points to challenges in each country's ability to realize its emissions targets.

Significant Water Requirements of Renewable Hydrogen Production

Water is the main natural resource that is potentially at risk in energy transition plans, particularly green hydrogen. Viable green hydrogen production requires production at scale using electrolyzers on large areas of land and ample water. The massive water requirements will exacerbate existing water scarcity in Morocco and more so in Oman.

To demonstrate these water requirements and their impacts, for every kilogram of hydrogen produced, 9 kilograms of water must be consumed, based on the electrolysis reaction stoichiometry. Oman's planned capacity to produce no less than 1 million metric tons of hydrogen annually by 2030 would require 9 million metric tons of water. And its target to produce no less than 3.25 million metric tons by 2040 would require 29.25 million metric tons of water. Similarly, Morocco's planned capacity to produce 2.7 million metric tons of green hydrogen per year by 2040 would require 24.3 million metric tons of water.

For hydrocarbon-importing economies, there are additional vulnerabilities in the relatively large agricultural sector, in which water is a key input. Morocco's renewable energy projects in the agricultural-rich Guelmim-Oued Noun region have depleted its water and impacted its water-rich crops. Similarly, potable water resources have been depleted in cleaning and cooling down solar panels in the Noor Power Station. Future expansions of renewable-based green hydrogen can affect farmers, consumers, agricultural products, poverty levels, and the local biodiversity.

The water intensity of green hydrogen stresses limited water resources, which already are being depleted by rising water demand and climate change. Further constriction of water availability would increase the vulnerabilities of local communities and compound the environmental and financial costs to address them. All of the Arab countries' green hydrogen ambitions face this risk, but the vulnerabilities are significantly higher in the Gulf states and Jordan, which are more water stressed than countries in North Africa. As such, seawater desalination offers the only potential suitable solution for green hydrogen production in Morocco, Oman, and the MENA region—but this technology is not without its own challenges.

Impacts of Seawater Desalination for Renewable Hydrogen Projects

Indeed, seawater desalination plants will be the most suitable option to achieve scale in green hydrogen projects, especially if multipurpose desalination facilities are deployed. At present, the cost of desalinated water remains relatively low, around $1 per m^3. Yet this use can have significant challenges and environmental impacts.

Two challenges are immediately apparent. First, hydrogen plants might compete with domestic water needs that are met by desalination, especially in Oman. Second, water desalination is an energy-intensive process, and because it often relies on fossil fuels, it will generate high emissions unless it is powered by renewable energy (excluding emissions of the construction and maintenance of renewable energy). Saudi Arabia recorded the world's lowest energy-consuming desalination plant, operating at 2.27 kilowatt hours (kWh). By comparison, wastewater treatment plants require, on average, 0.13–0.79 kWh/m^3 of treated water. Even state-of-the-art desalination plants produce more than 1 kilogram of CO_2 for each cubic meter of freshwater produced.

The third challenge is cost: desalination is very expensive and will require massive amounts of renewable electricity in a net-zero world. Even though new technologies have reduced desalinated water costs to as low as $0.50-$1/m^3, seawater desalination plants and infrastructure (of different types) are still expensive to construct and maintain, and the technology is expensive to acquire. In the MENA region, which is home to 43 percent of global desalination processes, desalination expenses were expected to reach $4.3 billion by 2022.

Fourth, and potentially most risky, is that seawater desalination has serious environmental and ecological considerations, especially increased water salinity. The process of disposing of the brine resulting from the desalination process back in the sea or ocean increases the existing salinity level of sea or ocean water. Even state-of-the-art desalination plants result in more than 1 m^3 of brine for each cubic meter of freshwater produced. Owing to desalination, the small, almost landlocked Persian Gulf has seen a relatively rapid rise of salinity concentration and is now about 25 percent saltier than typical seawater. Although this level might be sustainable under present brine discharge activity and current salinity level in the present climate, it will not be sustainable in the future with higher desalination plus the evaporation caused by climate change. Thus, the Gulf of Oman, despite its varying

salinity, is therefore significantly at risk. Moreover, the resulting brine that is disposed back in the water has toxic levels of concentrated salt and chemical residue, thus seriously harming the ecology and marine and coastal ecosystems where it is disposed. This risk is detrimental for both agricultural sectors and seawater in Oman and Morocco.

Even though Morocco has greater availability of water than Oman, the quality of Morocco's water also suffers increased salinity from its agricultural dependence. Salinity is one of the greatest concerns over water quality in Morocco, along with increased water pollution resulting from substantial use of fertilizers and pesticides. Increased salinity is a threat to already fragile water resources—whether freshwater or brackish water, as well as the bottom of rivers and oases—owing to overuse of water and overexploitation of some aquifers. This threat is critical given its indirect effects on health, agricultural employment, agricultural products, and food security. That said, the increasing salinity of seawater is not as problematic for Morocco as it is for Oman; Morocco's access to the Atlantic Ocean ensures larger movements of water and currents, thereby dispersing the brine at faster rates than in Oman.

Finally, and as a consequence of the aforementioned four challenges, reliance on water desalination will require securing appropriate brine-cleaning technology—which, like renewable energy infrastructure, is costly. This task is complicated by the difficulty in estimating the resulting brine component, because the amount of water produced from desalination plants depends on the source (such as fresh or brackish) and the technology employed. Arab states must also incorporate wastewater recycling with desalination for a more sustainable water use.

Mismatch Between Emission Targets and Energy Transition Plans

For energy transitions to be climate-resilient and achieve emission reduction targets, energy transition plans must reflect sources of emissions and the planned NDCs. Renewables and green hydrogen can indeed contribute to both Oman's and Morocco's decarbonization efforts. Differences in emissions structures should ideally mirror and drive each country's emissions reduction strategy. Yet Oman lags behind Morocco in emissions reduction targets by 2030 despite its higher emissions and its net-zero targets by 2050. Also for Oman, as for other Arab hydrocarbon exporters, there is a mismatch between announced energy transition plans and emissions targets, compared with the hydrocarbon importer Morocco.

As evidence of this mismatch, the energy sector (which includes electricity) generates around 64 percent of emissions in Oman (see figure 2), yet the announced efficiency and targets of renewable energy targets (20 percent of total electricity) by 2030 can reduce emissions by only 7.4 percent. This reduction matches the 2030 targeted emissions reduction (7 percent of the 2030 emissions levels). However, it is very minimal, given the country's emissions and its projected net-zero target date. Oman's National Strategy for Orderly Transition yields a substantial reduction of approximately 97 $MTCO_2e$ by 2050, yet even the strategy indicates that those projections are insufficient to reach net-zero emissions by 2050, leaving around 10 percent of emissions unaccounted for. Closing the large gaps in emissions reductions

requires substantial decarbonization to reduce GHG emissions' intensity in oil and gas operations, both upstream and downstream, and in other industries. Oman's commitment to achieve Zero Routine Flaring by 2030 is a step in the right direction. But, according to the abovementioned strategy, one of the country's emissions reduction pathways is using carbon capture for enhanced oil recovery: the marginal (per unit of output) emission would decrease, but the total would increase. As green hydrogen is intended to meet only 5–10 percent of Oman's domestic decarbonization needs, a large part of the sultanate's industrial decarbonization, especially in the hard-to-abate sectors, cannot be realized without producing and using green inputs or CCS/CCUS technology, both of which have financial and technological constraints.

Morocco's mismatch between targets and transition plans is much smaller, predominantly because its emissions are significantly lower than those of Oman and because it has a well-established renewables sector. Reaching emissions targets would require expanding the percentage of renewables' share in electricity to 52 percent by 2030 (20 percent solar, 20 percent wind, and 12 percent hydropower). This goal is possible based on historic trends and current investment plans. Yet a lack of access to finance and land could prove to be a hindrance. Beyond renewables, Morocco's planned addition of 3,900 MW of natural gas generation capacity can help reduce emissions if it replaces coal, which produces significantly higher emissions than gas. Morocco's plans also include emissions-reducing measures—in forestry, land use, waste, and agriculture—using green ammonia. Given its high production cost, the use of green ammonia, however, could drive up the prices of agricultural goods. Without costly subsidies or local low-cost green fertilizers, local farmers and farming communities as well as poor consumers could be harmed as a result. The ensuing negative impacts are substantial and could exacerbate existing poverty: in 2021, an estimated 6.4 percent (2.38 million) of Morocco's population was multidimensionally poor, and an additional 10.9 percent (4.03 million) was vulnerable to multidimensional poverty. These trade-offs suggest that decarbonizing the agricultural industry would come at the cost of a just transition and socioeconomic development.

To mitigate this issue, decarbonizing agriculture should focus on local and low-cost technologies, while more expensive decarbonization methods should support larger transportation infrastructure (despite lower emissions than agriculture) to drive a larger-scale reduction in emissions along with socioeconomic benefits.

Limited Renewables

Achieving green hydrogen export and local decarbonization targets requires sufficient renewable energy infrastructure. Beyond water scarcity, this issue is the main challenge for Oman and other MENA hydrocarbon exporters, given the slow expansion of renewable energy infrastructure (see tTable 2. Installed Renewable Energy Capacity in Select MENA Countries Compared with
National Targets (2022) below) coupled with a simultaneous rise in electricity demand (among the highest globally). In contrast, hydrocarbon importers like Morocco have readily

available renewable energy resources.

Country	Share of renewable energy in total electricity capacity	National renewable energy targets
Hydrocarbon exporting GCC economies		
Bahrain	0.1%	5% by 2025 and 10% by 2035 of electricity generation
Kuwait	0.4%	15% by 2030 of electricity generation
Qatar	0.1%	200–500 MW of solar by 2020
Oman	0.4%	10% by 2025 and 30% by 2030 of electricity generation
Saudi Arabia	0.2%	3.45 GW by 2020; 9.56 GW by 2023 (10% of cap), and 30% of electricity generation from renewables, nuclear, and others
UAE	7.0%	Abu Dhabi 7% of capacity by 2020; Dubai 7% of electricity generation by 2020; Ras al-Khaimah 20–30% clean energy by 2040; total UAE 27% clean energy by 2021, 44% of capacity by 2050
Select hydrocarbon importing MENA economies		
Egypt	20%	42% by 2035 of electricity generation
Jordan	21%	35% by 2035 of electricity generation
Morocco	34%	42% by 2020 and 52% by 2050 of installed capacity
Tunisia	8%	30% by 2035 of installed capacity

Table 2. Installed Renewable Energy Capacity in Select MENA Countries Compared with National Targets (2022)

Source: Updated from Table 1 in Manal Shehabi, "The Hurdles of Energy Transitions in Arab States," in Frederic Wehrey (ed.), "Disruptions and Dynamism in the Arab World," Carnegie Endowment for International Peace, May 3, 2023, https://carnegieendowment.org/2023/05/03/hurdles-of-energy-transitions-in-arab-states-pub-89518. Author's calculations using data from the International Renewable Energy Agency (2018, 2023); national official documents of visions and development plans in GCC countries; U.S. International Trade Administration; the *Jordan Times*; and discussions with officials in Jordan in October 2023.

Oman will require approximately 50 TWh of renewable electricity to achieve its 2030 green hydrogen targets—an amount that exceeds its entire electricity system and current infrastructure. Similarly, for Morocco to meet its 2040 green hydrogen export targets, it would need to expand its capacity eightfold to 78.7 GW by 2040 through new additional capacity of solar photovoltaics (26 GW), wind (10 GW) and concentrated solar power

(10 GW) by 2040, along with 36–38 GW of electrolyser capacity. Its Green Hydrogen Roadmap would require 2 GW in renewable energy sources. Additional capacity will be needed for electricity exports. Thus, both Oman and Morocco will require substantial additional renewable energy infrastructure simply to be ready to produce green hydrogen.

Green hydrogen production can provide momentum and incentives to expedite renewable electricity infrastructure. Oman has impressive existing infrastructure to support green hydrogen exports, but its renewable energy challenge is steeper than Morocco's. Oman is significantly behind its target for local consumption: 0.4 percent of total production compared with a 30 percent target in 2030. There is a risk as to whether construction of hydrogen-supporting renewable energy for exports will be prioritized over local needs.

Securing the required renewable infrastructure requires access to funding (currently insufficient in both countries), access to land, and infrastructure development. Moreover, both countries—but Oman in particular—will need to determine the renewable energy and hydrogen share required to decarbonize certain domestic industries and increase renewable energy targets to a level that meets both rising local electricity demand and green hydrogen export demand, while reducing conventional hydrocarbon consumption in industries.

Technology-Dependent Targets With Consistent Low Research and Development on Low-Carbon Energy

Achieving the planned shift toward a low-carbon economy at an economically viable scale necessitates access to and adoption of clean technologies. Green hydrogen specifically is currently not economically viable. Green hydrogen prices need to drop from current levels of $5 to $12 per kilogram of hydrogen (kg H_2) to $1.5 to $2/kg H_2 to compete with "dirty" hydrogen (absent carbon taxes). In fact, one of the pillars in Morocco's hydrogen plans by 2050 is the reduction of production costs for hydrogen and hydrogen-based fuels. In Oman and Morocco, renewable energy costs are among the lowest globally, so reductions in costs of green hydrogen production will be driven mostly by electrolyzers' technology and efficiency. To mitigate the aforementioned negative impacts of desalination, Oman and Morocco will need access to technologies that can produce hydrogen from splitting seawater, currently a nascent technology.

For other energy transition targets, Oman and Morocco will require decarbonization solutions and technologies that include lower-cost desalination, brine-cleaning technology, batteries, energy efficiency, and negative emissions solutions. Strategic integration of low-carbon and carbon removal technologies is especially fundamental for hydrocarbon exporters. Oman's net-zero strategy explicitly emphasizes the need for advancing research and development in these sectors, which must go beyond the enhanced oil recovery in which it led the region for decades.

However, a key challenge across the Arab world is low levels of investment in carbon removal and clean energy technologies. Research and development spending as a share of GDP in

2021 was equally negligible in Oman (0.3 percent) and Morocco (0.71 percent). These shares were lower than the 3–4 percent average in advanced economies with per capita income levels comparable to GCC states, and they were also lower than other hydrocarbon exporters such as Australia (1.8 percent), Norway (2.3 percent), and the United States (3.45 percent). Therefore, the required technologies must be delivered from external investors or corporations.

Both Morocco and Oman have improved the overall investment climate to attract partners in hydrogen projects, a point that will help in technology acquisition. Oman seeks to invest in carbon reduction and other technologies. A key source for Morocco will be to leverage climate finance and Article 6 of the Paris Agreement to facilitate carbon mitigation technology transfer and deliver sustainable development co-benefits. Nevertheless, even if technology transfer is ensured, the required technology (especially in batteries and carbon capture technology) is currently not viable at scale or affordable in current market conditions. For Oman, as for other hydrocarbon exporters, meeting decarbonization targets requires the adoption and deployment of viable carbon-removal technologies at rates significantly higher than those of current markets.

Finance and Regulation Gaps

Gaps in financing and in industrial and decarbonization regulations are likely to challenge Oman's and Morocco's ambitious energy transition targets. Oman's NDC submission proposes to fill these gaps through access to finance and technology, capacity building (also included in Morocco's submission), and institutional strengthening.

Infrastructure, technology, and decarbonization efforts all require massive amounts of funding. To demonstrate, Oman's hydrogen targets require additional investments of approximately $230 billion, mostly from the private sector and foreign direct investments. Morocco's renewable energy and gas targets by 2027 will require investments of $9 billion to $13 billion and more than $104 billion for its hydrogen plans. The use of local funds for energy transitions will be limited and can divert funds from other urgent development priorities. Thus, both countries will find it critical to secure external funding. In fact, Morocco's NDC makes its emissions reduction targets conditional on access to finance and support from the international community. External funding sources will vary, ranging from foreign investments to climate finance to the private sectors, into which both countries have tried to tap. For example, Oman sought to improve its investment climate, and Morocco requested a Resilience and Sustainability Facility from the International Monetary Fund in 2023 to "address climate vulnerabilities, bolster its resilience against climate change, and seize the opportunities from decarbonization."

The private sector is expected to play an important role in energy transitions, especially in technologies in Oman and in renewables in Morocco. Yet the oligopolistic nature of the private sector, most notably in the case of Oman, reduces competition, economic efficiency, and resilience. Institutional strengthening, private sector and microeconomic reform, and

competition regulation will thus be key to increasing economic resilience and productive capacity. Finally, despite both countries' impressive reforms in renewable electricity and orderly transitions, significant regulatory gaps exist pertaining to decarbonization, as discussed below.

Policy Insights for Climate-Resilient and Just Energy Transitions

Based on the cases of Oman and Morocco, this study has four key takeaways. First, even in the more environmentally friendly Arab countries, the environment remains a secondary thought after economic considerations in energy transition plans—which at their heart are climate change mitigation solutions. Second, both Oman and Morocco offer important examples of institutional frameworks that incorporate the environment in energy and development plans and, thus, have capacity to advance climate-resilient energy transitions. Third, the main challenge facing Arab states' ability to achieve climate-resilient and just energy transition pathways is bridging large gaps and minimizing trade-offs among environmental sustainability, socioeconomic development, and energy transitions. Finally, bridging these gaps requires integrative policy and comprehensive, actionable reforms with deliberate long-term policy solutions and access to technology and finance.

The economic opportunities of energy transitions, which have motivated Arab states, are important for these states' economic sustainability. Green economic development and hydrogen opportunities can advance economic diversification, boost non-oil revenue, and create new export revenue sources. Nevertheless, energy transitions have large socioeconomic and environmental trade-offs. Funding them can reduce the available funding for competing, urgent development priorities, especially in the more constrained fiscal spaces of hydrocarbon importers and poorer hydrocarbon exporters. Targeted energy transitions are also water intensive and threaten further depletion of water resources that are already stressed due to climate change, overexploitation, pollution, evaporation, and increased salinity. Other potential negative (environmental and other) impacts of targeted energy transitions exacerbate climate vulnerabilities through fiscal, economic, social development, and inflationary pressures. As such, energy transitions will have direct negative impacts on people in vulnerable situations, especially the poor, women, Indigenous peoples, the youth, the elderly, and workers in impacted industries (especially agriculture and hydrocarbons).

Energy transition pathways also offer environmental opportunities for Arab states. These opportunities go beyond industrial decarbonization and effective emissions reduction, both of which must be leveraged to foster environmental sustainability. Oman and Morocco are both well-positioned to realize these opportunities as the environment features in their development and energy transition plans, and they have promising legislative and regulatory frameworks governing energy projects. But energy transitions, especially green hydrogen plans, can both enable and hinder the achievement of climate-resilience and just energy transitions. The challenges of green hydrogen production are not insurmountable, yet overcoming them is a very steep challenge.

Although these challenges are common for all Arab states with hydrogen aspirations, hydrocarbon exporters have more financial ease but otherwise steeper challenges and, therefore, are at risk to lag behind hydrocarbon importers. This risk results from their intended ongoing dependence on and use of hydrocarbons in their energy mix and pro-export energy transitions, which depend predominantly on carbon removal technology as their main decarbonization pathway. Even in Oman, where the main energy transition pathways are renewables and green hydrogen, carbon removal is key for industrial decarbonization.

Further policy measures will be essential to achieving a just energy transition that is also climate resilient. Based on the analysis of Oman's and Morocco's energy transitions, the following are key policy insights applicable to both countries and to Arab states at large.

First, positioning the environment and climate resilience in both development and energy transitions is an imperative. Doing so requires establishing specific sectoral action plans and targets. Those targets must be designed in a way that would significantly enhance a sustainable approach to energy transitions (and other mitigation policies) and enhance adaptation and resilience to maximizing economic and energy sustainability and socioeconomic development.

Second, renewable energy for domestic energy and decarbonization needs must be prioritized over export-oriented green hydrogen production. To that end, a valid first policy option is to dedicate existing renewable energy targets or projects to meet local power demand and to use any incremental renewable power generation to decarbonize the grid. Separate hydrogen-related renewable targets can be set and met subsequently or in parallel.

Third, Arab states need to strengthen resource governance as well as limited or weak climate, decarbonization, and competition regulatory frameworks. They need to fill regulatory gaps and inadequacies, especially pertaining to emissions classifications and carbon removal, capture, storage, and transportation. Filling these gaps is especially critical for hydrocarbon exporters where hydrocarbon industries and CCS/CCUS will play a larger role than in hydrocarbon importers. Microeconomic and competition regulation will also be necessary.

Fourth, given the massive water requirements of energy transition plans, Oman and Morocco (like the rest of the Arab states) must adopt significantly high rates of wastewater recycling, better water retention technology, and climate-smart technologies for agriculture. These efforts must involve more than merely desalination if these countries are to ensure water sustainability and a just energy transition.

Fifth, poverty-reducing measures are required, especially for farmers and low-income households that will be impacted by reduced water or higher agricultural and other products.

Sixth, governments must undertake climate risk and impact assessments in the energy sector to quantify the financial, environmental, and socioeconomic impacts of the transition. These assessments must be accompanied by regionwide cooperative frameworks, enhanced

social dialogues, and the inclusive participation of locals. The measures derived from these assessments can drive evidence-based policies and solutions to manage the trade-offs between economic and energy targets.

Finally, access to finance must be a priority for achieving a climate-resilient and just energy transition, for which many Arab states will require external funding and climate finance. Sources can include grants, concessional financing, and (as in the case of technology transfer) foreign investors. Arab states can also leverage existing efforts and avenues for climate finance, such as the Arab Initiative for Mobilizing Climate Finance for Water. Further, a just transition in Arab states is not possible without access to climate finance, especially in middle-income hydrocarbon importers. Not only do those states have low historical and actual emissions, but also they are largely harmed by climate change and have the ambitions for and potential to meet global demands of green energy. Climate finance will therefore contribute not only to adaptation and mitigation but also to ensuring that those countries do not bear the brunt of energy transitions. Failure to address these challenges will hinder efforts to secure climate-resilient, just, and equitable energy transitions. Such failure will accelerate existing political, economic, and environmental challenges and will perpetuate the ongoing existential threat that short-sighted energy policies pose to the MENA region as a whole.

Acknowledgments

The author thanks Ritheka Sundar for research assistance.

CHAPTER 7

Climate Vulnerability in Libya: Building Resilience Through Local Empowerment

Frederic Wehrey

A vast, arid, oil-dependent country of nearly 7 million people, Libya is acutely exposed to the deleterious effects of climate change. These problems include soaring temperatures, declining rainfall, rising sea levels, extended droughts, and sand and dust storms of increasing frequency, duration, and intensity, to name a few. The Notre Dame Global Adaptation Initiative Country Index ranks Libya 126 of 182 states, just after Iraq, in the lower-middle tier denoting most vulnerable countries.

The diminishing availability of water is Libya's most pressing climate-related risk. Eighty percent of the country's potable water supply is drawn from nonreplenishable fossil aquifers through a network of pipes known as the Great Man-Made River (GMMR), which suffers from deteriorating infrastructure, evaporation in open reservoirs, unsustainable extraction rates, and uneven service to Libya's far-flung towns. The lack of a national water strategy or integrated water policy, along with heavily subsidized water tariffs, has further exacerbated the effects of this scarcity. The provision of clean water increasingly has become a source of regional, communal, and political competition. Electricity is similarly threatened by climate disruptions, particularly temperature spikes, due in no small part again to eroding infrastructure and heavy subsidization, which contributes to exorbitant consumption rates and outages.

Oil dependence is yet another vulnerability. Libya, which has the largest proven reserves in Africa, has long relied on oil exports as its primary source of revenue. This pattern of reliance has resulted in a disproportionately large public sector, which employs 85 percent of the population and leaves the country severely exposed to future declines in oil prices caused by the transition to renewable energy and net-zero carbon pledges. Oil is also used to generate electricity, which is not only costly but contributes—along with the wasteful "flaring" or venting of gas during oil production—to Libya having the highest per-capita carbon emission rate in Africa.

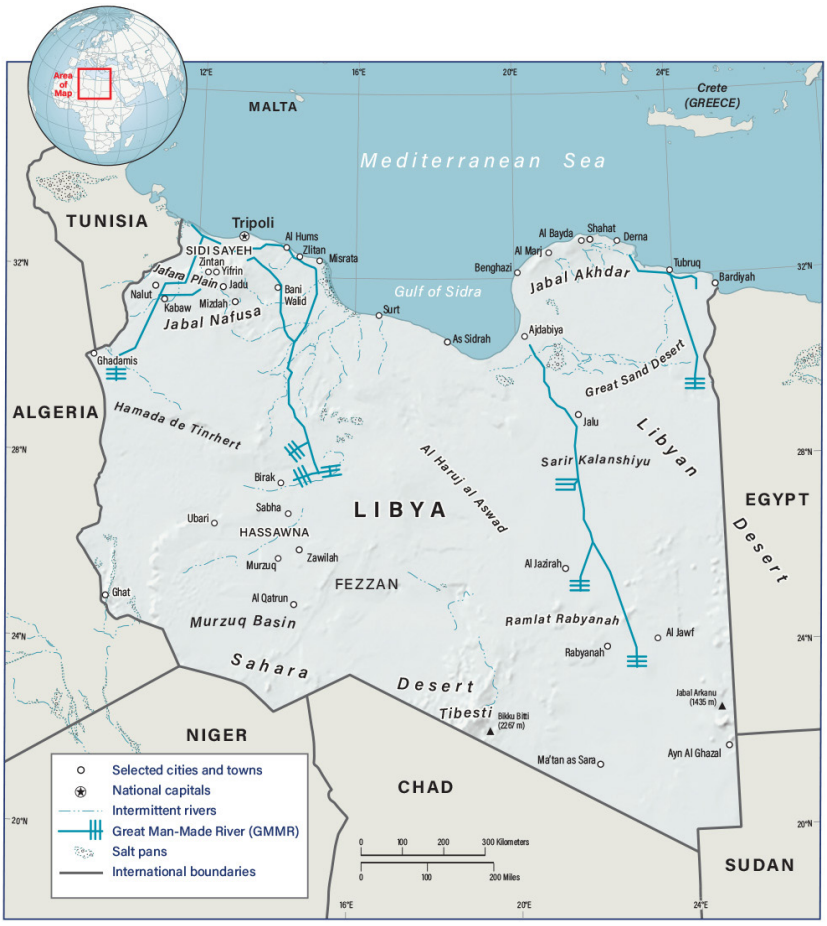
At the height of the dictator Muammar Qaddafi's ambitions, arable land comprised only 1.2 percent of the country's territory and has since shrunk to less than 1 percent**.** The agricultural sector itself has been contracting steadily since the 2011 revolution, owing to the cumulative effects of conflict, supply chain disruptions, rising costs of agricultural supplies, and the lack of renewable water supplies. And while it contributes to a miniscule portion of the country's gross domestic product (GDP), estimated at less than 2 percent in 2022, the agriculture sector continues to be a source of income for a not-insubstantial percentage of its inhabitants—estimated at 22 percent in 2020. Libya's low agricultural output means that it is forced to import three-quarters of its foodstuffs, making the country extremely vulnerable to disruptions in global food supplies, including those resulting from climate change. Endemic government inattention to the agricultural sector has only worsened this dynamic. "They don't prioritize it because they think it doesn't contribute to the gross income," noted a Libyan soil scientist in a telephone interview. "But if we lose local food production, we have food insecurity."[29]

These vulnerabilities present an especially dire threat to the well-being and human security of people living in the sparsely populated regions of the Jabal Nafusa (Nafusa Mountains), also known as Jabal Gharbi, west of Tripoli; the southern Fezzan region; and the Jabal Akhdar (Green Mountains) in eastern Libya (see map 1). Here, climate shocks are being aggravated not only by environmental degradation but also by socioeconomic marginalization, political and intercommunal conflicts, and collapsing infrastructure. The cumulative impacts of these factors on food security and subsistence farming are a particular concern in these three areas, given that the Jabal Akhdar region produces half of all of Libya's crops and the Jabal Nafusa region, its adjacent Jafara Plain, and the Fezzan grow the other half. Farmers interviewed in these regions were acutely aware of how climate change combines with political and socioeconomic problems, especially poor governance, to threaten their livelihood.

"The main factor is neglect," noted one farmer in the Sidi Sayeh area south of Tripoli. "There is no oversight, no support, no investment in growing our capacity as farmers. Climate change adds another layer, but it is the juxtaposition of its effects with the lack of institutional oversight and support that will push farmers like me to leave behind their ancestral practices."[30]

It is not only farmers who are threatened in these areas. Migrants and refugees are especially at risk, given the proximity of some of these agricultural areas to borders and their resultant role in hosting displaced persons. So too are Libyan ethnolinguistic minorities, for whom climate change compounds preexisting grievances of discrimination. Workers in the informal sector, women, and children are also imperiled.

Understanding how climate change is affecting the well-being and livelihood of these at-risk populations is therefore essential for the crafting of a viable, more inclusive climate strategy, one that mobilizes local resources and knowledge to build better pathways for resilience—for all of Libya's inhabitants.



The Climate-Governance-Misgovernance Nexus in Libya

Long-standing problems of governance, institutional fragmentation, political tensions, and recurring armed conflict have sharpened Libya's vulnerability to climate change and also impeded a coherent government response to climate mitigation and adaptation.

The roots of the country's climate fragility are found in Qaddafi's poor management of resources and inefficient state-owned monopolies managing water and electricity. Added to this were Qaddafi's overly ambitious agricultural schemes that saw the rapid depletion of coastal aquifers and a dependence on his much-touted megaproject, the GMMR. He often used the project politically, prioritizing access for favored communities and excluding others who were deemed less loyal. His peculiar brand of socialist rule oversaw the collectivization of land in the mid-1980s, a process that removed existing legal safeguards on nature preserves and hastened the deforestation of the Green Belt around Tripoli and other cities, which for decades had contributed to a beneficial microclimate, slowed desertification, and stopped soil erosion.[31]

Since Qaddafi's death in 2011, a worsening spiral of factional conflict, corruption, infrastructural decay, and predation has left ever-greater numbers of people exposed to climate shocks. The chaos has also produced a profound lag in the country's official response to climate change. Of the 196 signatories to the 2016 Paris Agreement, only Libya has not signed a Nationally Determined Contribution. And even though the country has established a renewable energy plan and has enormous potential for solar and wind energy, it has made little progress on these fronts, in part because of a lack of competitiveness in the private sector and bureaucratic resistance from state-owned monopolies.

Political fissures and elite rivalries are in no small measure to blame for this paralysis. The country is nominally ruled by a Government of National Unity (GNU), but in practice it is split between the Tripoli-based administration and Khalifa Haftar's increasingly militarized administration in the east. Despite some climate-related cooperation and exchange of information, this split continues to hobble progress. Even within the GNU, there has been competition over control of climate policy, most evident between the Ministry of the Environment and a climate authority within the prime minister's office—though the two bodies have reportedly improved their collaboration and coordination.[32]

Increasingly, key ministries and institutions have been taken over by armed groups, in both the east and west, which have further contributed to climate vulnerability through environmental predation, converting tracts of forests into more profitable money-laundering schemes like apartments, malls, and resorts, while also selling chopped-down trees as charcoal.[33] The effects of such predation, particularly acute in the western Jafara Plain and in the eastern Jabal Akhdar, have only worsened the effects of climate change, particularly for those Libyan citizens who make a living off the land. "The consequences of climate change became more acute ever since they started breaking down the forests into smaller units, cutting the trees, and selling off the land," noted a farmer in the southern environs of Tripoli.[34] And although the agricultural police department that operates in both the east and west has publicized its crackdown on illegal clearing, it does not cross the red lines of dominant armed groups.

Elsewhere, Libya's ability to build climate policy is hobbled by a dearth of qualified personnel, insufficient technical capacity, poor local data collection, poor collaboration between the government and universities, and a lack of local-level participation and activism.[35] Libyan municipalities in particular have important roles to play on climate change advocacy and awareness, but they have been frustrated by a lack of administrative, budgetary, and political support from the capital.[36] Libya's civil society is similarly constrained by a lack of support and increasingly repressive security measures from authorities in both the east and the west. This lack of support has had a chilling effect on climate activists.

These daunting structural and political problems will have profoundly negative consequences for the country's ability to surmount the challenges of climate change—and they are felt acutely in the mountainous zone just west of the capital.

The Jabal Nafusa

Rising to 900 meters above sea level (nearly 3,000 feet), the Jabal Nafusa are a rugged mountainous plateau that arcs around the Jafara plain west of Tripoli and stretches over 400 kilometers (about 250 miles) to the Tunisian border. Historically, the region has been of marginal political and strategic significance, though this changed with the 2011 revolution, given the range's role as a base for anti-Qaddafi rebels and its location alongside routes into the capital. The divisions within the Nafusa region that emerged during that period—as some towns supported the uprising and others opposed it—reflected in many instances the Qaddafi regime's exploitation of intercommunal tensions by granting favored communities grazing land, employment in the security services, and even access to water.

Roughly speaking, the most prominent division today in the region is an ethnolinguistic one between Arab communities, who historically were pastoralists, and the Amazigh people, who were predominately settled farmers (*hadhar*). That said, neither the Amazigh nor the Arab communities in the Nafusa region behave today as a monolithic bloc: allegiances and alliances among their respective towns often straddle the ethnolinguistic line and are constantly shifting. Against this backdrop of fragmentation, climate change and its attendant worsening of water shortages has sharpened intercommunal tensions in the Nafusa region and tensions between Nafusa communities and the Tripoli government.

Historically farmed since antiquity, the eastern portions of the Nafusa range are the most fertile and productive, particularly for the cultivation of olive, fig, and almond trees. And even though the region has always grappled with droughts, sandstorms, and erratic rainfall, anthropogenic climate change and global warming are causing a different sort of threat.[37] Local farmers have noticed that winters are getting warmer while summers have become drier and hotter, without the usual cooling-off in the evening, leading to outbreaks of wildfires that required the dispatch of firefighting equipment from outside the country. Rainfall appears less frequently, and sandstorms are changing in seasonality and increasing in intensity, the result of both global warming and local factors such as declining plant cover and soil erosion.[38] Desertification—a direct result of climate change—is increasing as well, with expanding sand reducing the area of cultivable land (see figure 1).

Figure 1. Recent Desertification in the Jabal Nafusa.

Source: Author's photograph, July 2023

The impact of these stressors has been magnified by the aforementioned inefficiencies in water supply and political marginalization. Qaddafi's historical mistrust and suppression of the Amazigh people led him to deny predominantly Amazigh towns in the Nafusa region access to the GMMR network, forcing a reliance on wells and water tanks that continues to this day. The GMMR's discontinuity continues to plague the predominately Amazigh towns of Yifren, Nalut, Jadu, and Qala'a, as well as some Arab towns like Zintan, which was scheduled to be connected to the pipeline system before the 2011 revolution interrupted that work. Consequently, a significant number of Nafusa communities have been forced to rely on water shipments delivered by tanker trucks. But these trucks, which haul water up steep mountain roads from a reservoir at the base of the Jabal Nafusa, are too few in number to service the entire region and often are prohibitively expensive for many families. Accessing deep groundwater aquifers through excavation and well-digging is another option, but this too is a costly and often unsuccessful endeavor. Moreover, wells in some locales often are too few to cover the population's needs or have fallen into disrepair (see figure 2). Even in communities that the GMMR reaches, the water supply is often limited and inconsistent.

In the face of such infrastructural and climate challenges, some Amazigh communities in Nafusa have taken to reviving ancestral adaptation and stewardship mechanisms including agroforestry, terracing techniques, and water management practices. One such method, *agdal*, is a communal approach to land utilization characterized by the cyclic utilization of grazing areas, a mindful approach to water consumption that prioritizes sustainable sustenance, and, most importantly, a profound set of social and ethical principles centered around the responsible management of fertile and water-abundant lands. Traditional customs like *agdal* enable Amazigh communities to gather and preserve water during the rainy seasons and thrive amid challenging environmental circumstances.

Figure 2. A Broken Water Well in the Jabal Nafusa.

Source: Author's photograph, July 2023

Elsewhere, municipal leaders in Nafusa are leading grassroots efforts on climate adaptation, focusing on rationalizing water and electricity consumption and combating desertification. They are pushing for greater local empowerment while soliciting services from the GNU in Tripoli and support from foreign states and donors. But such efforts remain hampered by meager budgets from authorities in the capital. In one notable case, the mayors of three Nafusa towns—Jadu, Yifren, and Kabaw—reportedly diverted the 150,000 dinar allotment from the Tripoli government for the purchase of an official car to fund environmental services and to address their towns' water scarcity problems. More broadly, though, municipalities suffer from Libya's aforementioned lack of political and fiscal decentralization, a shortcoming acutely felt by people in other parts of the country grappling with climate change, especially those in Libya's underdeveloped desert south.

Fezzan

The southwest region of Fezzan, stretching over 200,000 square kilometers (nearly 125,000 square miles), is Libya's driest, hottest, and most inhospitable area, marked by a Saharan topography of sand dune seas, gravel-strewn plateaus, volcanic mountains, dry riverbeds, and oasis depressions. Climate change is thus a particular concern for its inhabitants. As it has been for millennia, water continues to be a prized and contested commodity in this region, evident in Fezzan's role in supplying the aquifer-fed water to the GMMR pipeline, a quality that has only grown in importance as Libya's northern groundwater supplies are depleted by salinization. Water has also aggravated a deepening sense of socioeconomic exclusion by Fezzan's inhabitants, who comprise 10 percent of Libya's population.

Today, Fezzan is Libya's poorest region, even though it is home to important oil fields that produce one-quarter of the country's total crude output. Though Qaddafi set up thousands of hectares of state-owned farms in the south, the infrastructure has fallen into disrepair since the 2011 revolution. Moreover, the Qaddafi regime rewarded favored Arab tribes with preferential access to the smuggling trade and other privileges and marginalized non-Arab ethnolinguistic minorities, such as the Tabu and the Tuareg. The Tuareg, however, were slightly better off because they had been included in the security services and had access to agricultural land.[39]

Those disparities are felt today in outbreaks of violent conflict between and within these groups, often over access to increasingly important fixed economic streams derived from the cross-border smuggling of people and goods as well as access to the region's oil fields. Climate change, with its attendant effects of water scarcity, expanding desertification, and extended droughts, will further inflame these fissures and also amplify the grievances the people of Fezzan feel toward the north. Already, Fezzan's importance as a source of water has been leveraged as a means of conveying those grievances, with tribes and protesters dismantling or otherwise sabotaging pumps along the GMMR network, at one point at a rate of four pumps per month.[40] In the vital Hassawna area of Fezzan, which supplies Libya with 60 percent of its water, vandalism of wells diminished water output by over 30 percent, causing shortages in the north. Rapidly diminishing groundwater is yet another problem,

especially in the Murzuq Basin, where a major aquifer provides water to towns and farms in the southwest portion of Fezzan not connected to the GMMR. According to one projection, the aquifer may be depleted as soon as 2037, causing severe socioeconomic damage throughout the area.[41]

In the Tuareg and Tabu communities of the south, the perception of municipal neglect is magnified by deeply entrenched feelings of ethnolinguistic discrimination by Arab elites in the north. In the southwest municipality of Ubari, for example—home to substantial agricultural land and Libya's largest oil field, and the site of fierce intercommunal and political conflict from 2014 to 2016—Tuareg residents have long complained about the diversion of water and petroleum wealth to the north. Some believe that this diversion, and the attendant exodus of youth from the region, will pose an existential crisis for their survival as a distinct minority.[42] "The Tuareg will disappear," noted one Tuareg activist from the area, who served as a former deputy minister of water. He described a proposal by a young local Tuareg engineer to purify sewage water and use drip-irrigation to cultivate a tree line from Ubari to Sabha in order to counter desertification without endangering future water access. "As long as there are people there is sewage, so it is sustainable," he maintained.[43] But the engineer's plan remained unrealized, he stated, owing to a lack of support from Tripoli.

The effects of water scarcity, compounded by climate change, will disproportionately affect Fezzan's most vulnerable inhabitants. Even with the deterioration of agriculture infrastructure through conflict, theft, and neglect since 2011, many still depend on farming for their livelihood. Displaced persons and migrants—whose numbers in Fezzan are likely to grow in the face of climate shocks and slow-onset climate pressures—are especially reliant on agricultural work, sometimes in forced labor conditions under armed groups and smugglers.[44] Though men provide the primary labor, women often assist in the rearing of livestock, and children under the age of sixteen provide farming labor, especially during school vacations. Given its remoteness, the south also faces challenges of transporting crops to northern markets. Road networks are especially vulnerable to worsening sandstorms, which raise transportation costs.[45]

Throughout Fezzan, there are often fruitful exchanges between private and public entities in towns and cities. One such meeting took place at a workshop on the challenges and prospects of sustainable development in southern Libya, convened in February 2023 between Tripoli University, Sebha University, Sahara and Sahel Observatory, and the Libyan Center for Studies & Researches for Environmental Science and Technology. An agricultural research center in the northern coastal city of Misrata, as another example, is teaching farmers in the south to grow crops using less water and to use water with greater salinity, while also introducing newer, more durable seed varieties that are better adapted to the increasingly arid conditions.[46]

Even with these indicators of progress, municipal officials in Fezzan have complained vociferously about the lack of appropriate central government legislation, authorization, and funding, which would empower them to act as agents for climate adaptation rather than

simply as providers of services such as water and waste removal.[47] They also face outmoded laws that prohibit direct interaction with foreign companies and officials, which prevent them from obtaining outside expertise and equipment. Partly as a result, local-level efforts to harness the region's great potential in solar and wind remain sporadic and unrealized.

These same concerns about sustainability in the face of government inertia are also present in Libya's third climate-affected periphery, the mountains of the east, where historically abundant rainfall is rapidly diminishing.

The Jabal Akhdar

With its thickly forested slopes and bucolic meadows, the aptly named Jabal Akhdar seem a world away from Fezzan. Rising 800 meters above sea level (about 2,600 feet) and stretching 350 kilometers (about 215 miles) from Benghazi in the south to Derna in the north, the mountains are Libya's wettest region and home to its densest concentration of trees and its most arable land. It is also rich in biodiversity: though it constitutes just 1 percent of Libya's surface area, Jabal Akhdar accounts for anywhere from 50 to 75 percent of its plant species, leading one climate activist from the area to dub the mountains and their forests "the lung of Libya."

Though its populace lacks significant communal divides, the mountains have been the site of political instability and grievances against the government, especially given eastern Libya's perception of relative decline after Qaddafi's 1969 coup toppled the eastern-based Senussi dynasty. During the 1990s, these grievances informed a fierce Islamist insurgency against the regime that used the fortress-like gorges and caves of the Jabal Akhdar as a haven. Since the fall of Qaddafi, successive rounds of violence in eastern Libya, particularly during the 2014–2018 war that wracked Benghazi and Derna, only worsened the region's environmental deterioration and vulnerability to climate change.

Today, the region is firmly under the control of Haftar and his Libyan Arab Armed Forces (LAAF), who are nominally part of the GNU in Tripoli but who in practice govern eastern Libya as a separate administrative territory. Although Tripoli and the east have working-level coordination and collaboration on some issues, such as meteorological data collection and the exchange of research on seed varieties, steps toward more national-level climate cooperation invariably fall victim to the same elite rivalries and factionalism that plague other aspects of Libya's governance.[48] Simultaneously, Haftar's kleptocratic rule is exacting a severe toll on environmental protection in the Jabal region. Nowhere is this more evident than in the activities of the LAAF Military Investment Authority. This organization is a profit-making enterprise for the Haftar family and has been involved in predatory illicit enterprises such as fuel smuggling and scrap metal harvesting. Reportedly, some of the illegally acquired scrap metal (which often is sold abroad) comes from equipment and components of the GMMR.

The inhabitants of the Jabal Akhdar acutely feel the nexus of governance, climate change, and environmental devastation. As elsewhere, farmers in the area suffered from problems like electrical outages, supply chain disruptions (particularly seeds), rising costs of drilling for groundwater, and soil erosion caused by overgrazing and poor land management. All of these issues have been compounded by climate-induced temperature spikes and declining rainfall.[49] Furthermore, the region's beekeepers—a niche but important industry, especially in the east, where honey is particularly prized for delicacies and traditional remedies—have seen their honey output decline drastically as climate change has pushed temperatures to ranges that are inhospitable for bees.

But the most catastrophic environmental affliction in the mountains is the rampant loss of tree and vegetation cover. Between 2005 and 2019, the Jabal Akhdar lost over 14,000 hectares of forest, with the rate of deforestation accelerating after 2011 as insecurity and lawlessness encouraged people to sell wood for charcoal and to embark on unchecked construction. Government efforts to crack down on such illegal practices have been uneven, with better-armed militias and criminal groups sometimes responding to enforcement efforts with heavy gunfire. Conflicts in the east and elsewhere have also exacerbated deforestation as urban areas have expanded and new settlements have emerged to accommodate displaced persons.[50]

Regardless of reason, the effects of deforestation have been uniformly harmful for citizens' livelihoods, health, and properties. Deprived of tree cover, the average mean temperature in the area has risen, which in turn has made outbreaks of wildfires more likely. Already, soaring heat waves have sparked outbreaks of such destructive blazes, like the ones in 2013 and 2021 that swept through forests near Shahat and Al-Bayda, respectively. The absence of tree cover has also contributed to soil erosion and decreased agricultural outputs, while also increasing the prevalence of dust storms originating from the region.[51]

More broadly, the human-caused transformation of the region's natural environment, along with widespread corruption and decaying infrastructure, has worsened the damage from climate-induced floods like those that hit the eastern city of Al-Bayda in late 2020, displacing thousands. Most tragically, the city of Derna at the foothills of the Jabal Akhdar suffered a catastrophic loss of life—an estimated at 11,200 people—after two aging dams collapsed during Storm Daniel in early September 2023. The same storm also displaced more than 40,000 people from Derna and other locales. The impact of Storm Daniel underscores how the malignant effects of politics and militia rule magnify climate shocks in Libya: in the case of Derna, Haftar's military regime had long targeted and isolated the town because it had a history of opposition to his authority. This animosity contributed to the municipality's unpreparedness and to the storm's staggering death toll.

The aftermath of the Derna tragedy has made it clear that local actors need to have both the capacity and the freedom to tackle climate adaptation and environmental stewardship. Municipalities in and around the Jabal Akhdar, as elsewhere, have taken some commendable steps on these fronts, with campaigns on water rationalization, well-digging, recycling

drives, electricity conservation, and other actions toward sustainability. On the crucial problem of deforestation, local civil society, journalists, and bloggers have been especially active. Reforestation initiatives in particular have proven enormously popular, with groups like the Libyan Wildlife Trust and the Boy Scouts planting millions of seedlings and sponsoring awareness campaigns in schools. Yet according to several observers, these efforts, while laudable, are not enough: Libyan civil society has not yet been able to realize its full potential as a bridge between the public and private sectors and as a voice for vulnerable communities.[52] The activists themselves admit that their efforts cannot keep pace with environmental devastation, and they point to the need for a better-equipped and more robust response from official law enforcement entities.

Moreover, in the east in particular, activists face restrictions from the area's security forces. Though these forces do not directly target environmental and climate groups as long as their activities do not cross certain political red lines (like corruption or the role of the Haftar family), their presence still has a chilling effect.[53] "Young people are willing, but they are afraid," noted one official from the region. "There is no state support."[54] In a September 2023 interview, a member of a volunteer climate action group in eastern Libya gave an example of such interference, stating that their organization's efforts to import weather monitoring equipment—to compensate for what this person believed was the inadequacy of the official meteorological service—were blocked by Haftar's government because of supposed security concerns.[55]

Relatedly, policing bodies in both the east and the west often have a distinctly ideological bent deriving from the Salafi current of Islam, evident in arrests that are not rooted in codified law but rather are against transgressions deemed to be un-Islamic. These arrests have included crackdowns on environmental activism like an "Earth Hour" event in Benghazi in 2017 and, more recently, in the arrests of animal rights defenders in the same city. In such an environment, it is not surprising that many climate activists operate from abroad or solely in the virtual space, while others confine their engagement to politically "safe" activities. Separately, Haftar's governing apparatus could try to coopt climate action as a form of legitimation, or greenwashing—especially as the issue attracts great funding and support from outside donors. Arab autocrats elsewhere have pursued similar tactics by focusing mostly on technical solutions, renewable energy plans, and ambitious net-zero pledges while sidelining the society-focused governance reforms and grassroots partnerships that effective climate adaptation requires.[56] The urgency of such local-focused reforms is nowhere as apparent as in Libya's vulnerable peripheral regions.

Conclusion: Building Grassroots Climate Resilience in Vulnerable Regions

The sheer scale of Libya's climate fragility demands a radical departure from the status quo. In many respects, climate change accelerates and amplifies preexisting deficiencies in governance and inequalities that predate the chaos of the 2011 uprising and its aftermath. It

also introduces new shocks, like heat waves, fires, and extended droughts. These impacts are worsening the health and livelihood of already at-risk populations—those in the agricultural sector, for instance—while creating new stresses on comparatively better-off citizens.

Endemic insecurity and successive rounds of national-level internal conflict starting in 2014 have understandably impeded concerted climate and environmental action by governments and citizens alike. "It's hard to garner public support for trees when people's lives are in danger," admitted an environmental activist in 2013. But the peace that has emerged since a United Nations–brokered ceasefire in 2020 is one in which armed groups dominate the political and economic life of the country as dynasties of venal elites in both east and west carve up the spoils while stifling free expression and civil society. Such circumstances are hardly cause for optimism on climate adaptation.

At the most basic level, that adaptation should prioritize solving Libya's water crisis by extending the GMMR to communities in need, halting the decay of its infrastructure, and rationalizing the use of the water it delivers. Among consumers, this rationalization can be accomplished principally through tariffs. Farmers can support the process through more efficient practices like the introduction of new seed varieties, a shift toward less water-intensive crops, and more sustainable techniques like hydroponic farming. In tandem, Libya should explore alternate sources of freshwater, like desalinization. Today, most of Libya's sixty desalination facilities are not operational, and the industry itself faces a lack of support owing to these maintenance issues and perception of its prohibitive cost. Yet with the rapid depletion of the country's aquifers, that perception needs to change. Various innovative domestic proposals have been advanced for making desalinization in Libya more economically feasible; one proposal advanced by a Tuareg activist and former official would use dune-generated heat in Fezzan to power coastal desalinization plants.[57] Underpinning all these potential options is the pressing need for a national water strategy and an integrated water policy that will rationalize and safeguard its distribution across the sprawling country.

That need, in turn, speaks to another urgent imperative for Libya's climate adaptation: vision and will at the top. As noted, the challenge of fiscal and political decentralization in Libya is deeply entrenched. On climate change, municipalities are hindered by legal and funding restrictions, such as the lack of legislative empowerment to tackle climate adaptation and the need to seek preapproval for revenue expenditure instead of having climate change measures built into their budgets.[58] Beyond this consideration, municipalities need greater authority and leeway and fewer bureaucratic obstacles to expeditiously access foreign funding, equipment, and expertise, such as the U.S. Agency for International Development's Taqarib project and the European Union's Tamsall effort. For their part, both the Libyan government and foreign donors should work to coordinate and "bundle" municipal-level projects, more efficiently identify best practices, more easily access outside funding, and scale-up successes.

Beyond town-level empowerment, interlocutors across all three regions surveyed in this article spoke about the need for greater space, protections, and support for civil society actors working on environmental protection and climate adaptation. Many acknowledged that, despite the groundswell of enthusiasm, such activism is still in its infancy. They suggested the need for greater education and acculturation of Libya's youth on climate change, starting in schools. These efforts are encouragingly underway by UNICEF in eastern Libya, but they need more buy-in from Libya's authorities.[59] More pressingly, though, Libyan authorities in the west and the east need to grant greater freedoms for independent civil society groups to operate freely and with foreign support, ending the restrictive laws that prevent them from doing so.

Relatedly, the dominance of Libya's predatory armed groups over nearly every aspect of its political and economic life needs to transition to a law-based, accountable security sector—a Herculean problem that will not be solved anytime soon. Still, the urgency of tackling Libya's climate adaptation and environmental devastation adds one more compelling reason for doing so. In all three of the regions surveyed, interlocutors were unanimous in pointing to the militias as the primary culprits for the weakening of climate resilience, through predation on the environment and, indirectly, through the perpetuation of violent conflict and the resulting population displacements, disruptions to services, and damage to infrastructure and the economy.

Lastly, while the Jabal Nafusa, Fezzan, and the Jabal Akhdar share certain commonalities in their climate vulnerabilities, they are also distinctive subregions with their own communal and ethnolinguistic identities, histories, economic resources, and other factors that militate against the one-size-fits all approach encouraged by foreign states and organizations. Addressing climate fragility in each of these areas therefore necessitates a multifaceted approach that recognizes and harnesses these local specificities, integrating on-the-ground knowledge, community-driven initiatives, and partnerships with civil society organizations. Ultimately, though, these bottom-up actions need to be accompanied by top-level will and resolve by Libyan elites, who must set aside self-aggrandizement and the pursuit of spoils to address the looming climate crisis.

Acknowledgments

The author is grateful to the numerous Libyan interlocutors who shared their views. He would also like to thank Muadh Krayem, Muadh Sharif, and Andrew Bonney for their research assistance and Matthew Brubacher and Manal Shehabi for their comments on a draft of this article.

CHAPTER 8

What Tunisia's Municipalities Can Contribute to Climate Adaptation

Sarah Yerkes and Joy Arkeh

Tunisia is facing a rapidly escalating climate crisis. Last summer, the government was forced to implement water rationing to address a severe drought. And the country's most vulnerable residents—many of whom rely on agriculture and fishing for their income—are being hit the hardest by worsening water and food scarcity and rising temperatures. Despite Tunisia being a globally recognized climate hot spot, President Kais Saied's government has failed to prioritize climate adaptation and mitigation, instead focusing on a political program that centralizes power into the leadership's hands and removes local agency. This political shift has had real and serious implications for the ability of local communities to address climate change. This piece will discuss the main climate challenges facing Tunisia today, the ways in which these challenges contribute to the country's socioeconomic inequality, and the measures the Tunisian government (as well as other actors, such as civil society organizations and the international community) are taking to address climate change.

Major Climate Challenges Facing Tunisia

Tunisia is facing myriad challenges that have been either brought on or exacerbated by climate change. According to the World Bank, a combination of political, geographic, and social factors have made Tunisia "one of the Mediterranean countries most exposed to climate change." Furthermore, according to the World Wide Fund for Nature, temperatures in the Mediterranean Sea are rising 20 percent faster than the global average.

The challenges facing Tunisia vary by region. The country has three different climate zones: a Mediterranean zone in the north, a steppe zone in the center of the country, and a desert zone in the south. Each zone faces its own unique climate-related challenges. In the north, sea level rise is already leading to erosion, flooding, and contamination of the coastal aquifers. Both the central and southern zones face water scarcity caused by rising temperatures and drought.

But one thing that unites the three zones is the overall dissatisfaction with the Tunisian government's efforts at addressing climate change. In 2022, Tunisians were, globally, the population most dissatisfied with efforts to preserve the environment (tied with Lebanon), according to a Gallup poll. And only 19 percent of Tunisians said they are satisfied with the quality of water in their city or area—the lowest number Gallup has recorded at the country level since 2005. In the south of the country, only 7 percent of residents were satisfied with water quality—a dramatic drop from a 48 percent satisfaction level in the south in 2015.

Water Scarcity

Tunisia has already reached the threshold of water scarcity, and rising temperatures combined with decreasing rainfall will only exacerbate the situation in the coming years. The World Resources Institute's aqueduct water risk measuring and mapping project ranks Tunisia as the twentieth-highest country in the world in terms of water stress. Owing to a continuing decline in rainfall, the country experienced a three-year drought from 2017 to 2020. Between September 2022 and March 2023, Tunisia saw only around 110 million cubic meters of rainfall, compared to an annual average of 520 million cubic meters prior to the drought. In 2023, Tunisia's share of water per capita has fallen to 400 cubic meters per year, far below the 1,000 cubic meters per year that the United Nations considers water poverty.

Tunisia is predicted to lose 75 percent of its total coastal water resources by 2050 because of a combination of increasing demand for water, overexploitation of groundwater, declining water stocks, and degradation of water quality in coastal aquifers. The United Nations predicts that while demand for drinking water in Tunisia could increase by 38 percent by 2100, Tunisia's renewable water resources will decrease between 31 and 61 percent by 2100 due to climate change.

In 2023, Tunisia faced historic water shortages, leading to government-enforced water rationing in some regions of the country for the first time in its history. The water rationing has impacted the capital as well as several other areas, including Hammamet, Sousse, Monastir, Mahdia, and Sfax. In the north of the country, residents rely on dams and artificial lakes to meet 80 percent of their water needs, and dams continuously have fallen below adequate levels. The regions with the highest "thirst" levels, according to the Tunisian Water Observatory, are the northeastern areas of Nabeul and Ben Arous. During June 2023, Nabeul and Ben Arous residents reported nearly a quarter of all of the country's water-related problems, such as poor water quality, leaks, cutoffs, and water-related protests.

On March 31, 2023, the National Company for the Exploitation and Distribution of Water (called Sonede) began instituting water quotas due to extremely low water levels in Tunisia's thirty dams. At the time, the Sidi Salem Dam, a 1980s construction project that provided what was once the country's largest freshwater reserve, had fallen to just 16 percent of its capacity—an historic low.

The water scarcity problems have a particularly major impact on agriculture, which made up 10 percent of Tunisia's gross domestic product (GDP) in 2022 and employed 14 percent of the workforce. Seventy-seven percent of Tunisia's water is used for irrigation. Many farmers can no longer meet their water needs for irrigation and are experiencing crop loss. In a January 2023 poll, 73 percent of Tunisians said they were either somewhat concerned or very concerned about their household's access to food over the next six months. Alongside looming government mismanagement, the country is also expected to experience an increase in droughts that could decrease cereal production by 40 percent and olive production by 32 percent by 2050. In May 2023, the Tunisian government said that the wheat harvest was expected to reach only 250,000 tons of grain this year, compared to an average of 1.5 million tons annually. This shortfall has forced the cash-strapped country to import 95 percent of its grain, which has led to bread rationing and forced many bakeries to shut their doors.

Other industries that are experiencing job loss due to water scarcity include low-income jobs like house and office cleaners and car washers. Furthermore, while wealthier families can afford to purchase bottled water, lower-income Tunisians also suffer from having to rely on unclean sources of drinking water.

Tunisia's water scarcity is attributable not only to climate change but also to poor governance and poor maintenance of Tunisia's water infrastructure. Hydrogeologist Radhia Essamin, a member of the Tunisian Water Observatory, told *Le Monde*, "There has been a lack of strategic vision for years. There are leaks that no one cares about, and as soon as there is a drought, citizens are the first to be affected by cuts."

Temperature Rise

A second major climate challenge facing Tunisia is temperature rise. The United Nations Development Programme's Human Climate Horizons project estimates that Tunisia will see an average annual temperature of 69.3°F in 2040–2059, above the global average of 61°F. This includes an annual average of seventy-one days above 95°F and an average of one hundred days above 95°F in 2080–2099, a dramatic increase from just thirty-one days above 95°F in 1986–2005. Overall, this temperature rise could lead to a tenfold increase in Tunisia's climate-related death toll. These numbers will vary by region, however: Nabeul, a northern coastal region, is predicted to increase from zero climate-related deaths between 2020–2039 to twenty-seven climate-related deaths in 2080–2099 while Tozeur, an interior southern region, is predicted to increase from twenty-two climate-related deaths between 2020–2039 to 118 climate-related deaths in 2080–2099.

The Tunisian National Institute of Meteorology predicts a temperature rise of up to 1.8°C by 2050 and up to 3°C for 2100. This disproportionately affects the interior regions, which are predicted to see temperature rises up to 2.3°C and 5.2°C by 2050 and 2100, respectively. These regions, which are home to much of Tunisia's agricultural economy, will face serious threats from heat waves that have the potential to decimate crop production. Rising temperatures can also lead to the evaporation of surface water, further exacerbating water scarcity.

Rising Sea Levels

A third climate threat is rising sea levels. Tunisia has experienced rising sea levels that have led to coastal erosion and contamination of the coastal aquifers on which farmers rely for irrigation. A majority of the Tunisian coastline (68 percent) is classified as moderately to very highly vulnerable. In Cap Bon, an aquifer experienced such high levels of seawater contamination that local farmers were forced to abandon their farming plots and wells.

Sea levels are expected to rise 30 to 50 centimeters along the Tunisian coastline, which could exacerbate existing saltwater intrusion into groundwater and cause loss of arable land and soil degradation. The tourism industry is also threatened by rising sea levels, as much of the tourism sector is located along the coastline. Over a quarter of the Tunisian coastline is considered very highly vulnerable to submersion and erosion, particularly the beaches of Hammamet and Tunis; 40 percent of Hammamet's beaches and 30 percent of Tunis beaches are classified as very highly vulnerable.

How Climate Change Contributes to Inequality

Across the globe, climate change contributes to inequality and disproportionately impacts poorer communities. Wealthier countries tend to consume more energy and contribute to climate change at higher rates, while poorer countries pay the price for these wealthier countries' higher fossil fuel consumption. Furthermore, wealthier people have a higher adaptive capacity to climate change. For example, as temperatures rise, higher-income individuals are more likely to be able to access air conditioning, while lower-income individuals are more vulnerable to heat-induced cardiovascular and respiratory ailments and death.

Climate change has the potential to send poorer populations into a vicious cycle of persistent poverty exacerbated by climate, such as the negative impacts on agriculture from rising temperatures, heat waves, decreasing rainfall, and desertification. All of these effects can trap agricultural workers in poverty as climate change continues to increase food, housing, and healthcare costs. As Lucas Chanel and his colleagues argue, "vulnerability to numerous climate impacts is strongly linked to income and wealth, not just between countries but also within them." They note that "poverty and vulnerability to climate hazards are correlated and mutually enforce each other." In the Middle East and North Africa region, the top 10 percent of earners are responsible for more than 15 times the carbon footprint of the bottom 50 percent of earners.

In Tunisia, climate change is already impacting the traditionally marginalized interior and southern regions, where residents are more likely to work in jobs associated with climate stress (such as agriculture) than in the coastal regions. A third of the population of Kasserine receives their income from agriculture, compared to a national average of just 16.5 percent. And unemployment rates, particularly among women, are significantly higher in the interior.

This trend has led to rural-to-urban migration, which is likely to increase with climate change according to the World Bank. Currently, 69 percent of the Tunisian population resides in urban areas, and that number is expected to reach 80 percent by 2050.

Tunisia's north, where much of the country's cereal production takes place, also faces threats from rising sea levels and temperature increases, further aggravating economically disadvantaged groups and contributing to food insecurity. Food import dependency has especially exposed Tunisia's population to shocks in the food market and agricultural sector. As conveyed by Layla Riahi—a researcher, activist, and member of the Tunisian Platform for Alternatives—"In Tunisia we have economic policies that exacerbate environmental problems." She points to an economy that relies on extraction and is a "primary source of pollution."

Climate migration could also further harm Tunisia's most vulnerable residents. Sub-Saharan African migrants who move to Tunisia are likely to put additional stress on the country's poor infrastructure and add to an already overstretched employment market. Tunisia could also see internal rural-to-urban migration, leading to increased levels of urban poverty that is gendered, as more men migrate for employment and leave behind women and children in climate-vulnerable conditions. Existing migrants and refugees are also vulnerable as they often live without social safety nets. Additionally, lower-income housing has become increasingly threatened by the growing number of extreme weather events. Less-wealthy communities tend to spend a much larger fraction of their income than their wealthier neighbors on food and other basic necessities, making them more vulnerable to food and energy price shocks brought on by climate change and natural disasters.

Tunisia is also predicted to experience a dramatic drop in labor productivity because of climate change (measured as annual hours worked per worker). High-risk sectors (such as agriculture, mining, construction, and manufacturing) likely will see a national average of –29.4 hours by 2080–2099. These sectors tend to be concentrated in the traditionally marginalized regions in the interior of the country. Low-risk sectors (all other industries) will see a change of only –7.2 hours.

Additionally, Tunisia is experiencing unequal effects of climate change across genders. Women, especially poor and rural women, tend to face a variety of challenges such as "access to resources, opportunity for improving existing livelihoods and developing alternative livelihoods, and participating in decision making." Women are therefore less able to adapt to climate change, which can cause "exacerbated welfare impacts on individuals, households and communities."

Scholars have also documented links between climate change, epidemics, and socioeconomic inequality. Climate change is likely to increase more severe epidemics. Archibong and Annan note that "climate change and associated global warming may cause epidemics through changes in climate variables like temperature, precipitation and wind speeds, and indirect effects, where adaptive behavior to these direct effects by human populations

through strategies like migration may more easily facilitate the spread of disease." They also show that "epidemics can worsen outcomes for groups in already relatively economically precarious circumstances, like women around the world, thereby widening group-based, socioeconomic inequality."

Tunisia's Efforts to Address Climate Change: Climate Adaptation Through Economic Resilience

The Tunisian government, on paper, is quite advanced when it comes to addressing climate change. Tunisia was the third country in the world to introduce climate protections as a right in their constitution—a measure that was carried over from the 2014 to the 2022 constitution, which explicitly states that "the state guarantees the right to a healthy and balanced environment and the right to participate in the protection of the climate." The government of former president and dictator Zine El Abidine Ben Ali ratified several international conventions related to the environment, and Tunisia was the first North African state to ratify the 1993 United Nations Framework Convention on Climate Change (UNFCCC), the 2002 Kyoto Protocol, and the 2017 Paris Agreement. Following the 2011 revolution, the Tunisian Ministry of Local Affairs and the Environment developed a National Climate Change Strategy (known by its French acronym SNCC) in 2012 that includes both adaptation and mitigation measures.

Tunisia has since adopted a macroeconomic-focused climate adaptation framework that acknowledges the need for economically and socially inclusive climate policy solutions. Most recently, the Tunisian government issued a National Strategy for Ecological Transition that "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."

Notably, Tunisia is targeting a 45 percent decrease in carbon intensity from 2010 to 2030. Decarbonizing energy supplies would yield lower energy costs for companies and households and has the potential to slash poverty by 12 percent. Tunisia's decarbonization policies also call for creating climate-resilient, green urban development plans that are specific to each Tunisian municipality, a demonstration of a climate adaptation method proportional to climate risk exposure levels.

As recognized in Tunisia's Nationally Determined Contribution and National Adaptation Plan, the consequences of inaction are particularly pronounced in the agri-food sector in terms of livelihood and production losses. As a result, Tunisia has prioritized efforts to establish food resilience for farmers, smallholders, and women. Plans to digitize food production systems and strengthen information sharing mechanisms between agricultural stakeholders, in addition to collaborating with economic actors on developing financial risk assessment methods, are underway.

By marrying economic and sustainability initiatives, Tunisia is embracing cross-sectoral and interministerial coordination as a climate response strategy, as evident in its national strategy for the development of green hydrogen. The strategy, beginning in 2022, is being developed by the Ministry of Industry, Mines, and Energy in cooperation with the German development organization GIZ with the aim of producing green hydrogen by 2025. Tunisian government partners include the Ministry of Energy, the Tunisian Company for Electricity and Gas (STEG), National Agency for Energy Management, Ministry of Agriculture, Ministry of State Domains and Land Affairs, Ministry of Environment, the Instance for Public Private Partnerships of the Ministry of Higher Education and Research, and the Groupe Chimique Gabes.

Through support from the international community, greater private sector and multistakeholder involvement is also at the forefront of Tunisia's climate strategy. Diversifying investment streams can be highly beneficial in helping Tunisia meet its climate financing needs. In July, the Tunisian Private Sector Energy Transition Support Program (known as Power Tunisia) launched to promote the adoption of renewable energy in the country. This five-year program, funded by the U.S. Agency for International Development, is meant to support private sector companies in transitioning to green energy through technical assistance and subsidies. It specifically seeks to "increase renewable energy deployment, reduce CO_2 emissions, reduce electricity consumption, mobilize external capital in clean energy investments, and engage and support Tunisian firms." As the initiative's website notes, nearly all (98.1 percent) of Tunisia's electricity is derived from natural gas, two-thirds of which is imported from Algeria, which leaves the country "especially vulnerable to the volatility of international oil and gas price shocks." Power Tunisia has three tiers of support: large projects of $2 million or more, medium projects of $20,000 to $2,000,000, and small projects of less than $20,000. Targets of support range from small businesses and private residences to industrial Tunisian and international firms.

As a result of these initiatives, Tunisia has improved dramatically in the Ibrahim Index of African Governance on environmental policies, defined as "the extent to which environmental concerns are effectively taken into account in both macro and microeconomic terms." The country went from 42.9 out of 100 in 2012 to 71.4 out of 100 in 2021. However, in the same index, in terms of the enforcement of environmental regulations it decreased from 62.1 in 2012 to 51.4—a signal of the disconnect between commitments on paper and action in practice and therefore the need to reconcile policy, projects, and plans with structured, tenable implementation mechanisms.

How Structural Gaps in Governance Shape Inequality and Vulnerability

Scholars point to several challenges the Tunisian government and people face in dealing with climate change, including fragmented government coalitions, a prevailing rent-economy, financial constraints, a feeble institutional foundation for climate action, limited decentralization, the lack of a functional local government structure, and limited involvement of relevant stakeholders.

Municipalities and Civil Society Organizations

As Adel Ben Youssef argues, "cities are at the forefront of the fight against climate change." The Local Collectivities Code (Law 29 of May 9, 2018) outlines the roles of Tunisia's municipal governments in addressing environmental challenges and sustainable development. However, that law was not carried over under Saied's Third Republic; the comprehensive decentralization plan put forward by the Caid Essebsi government was essentially erased under Saied. This is highly problematic. As Ben Youssef notes,

> "municipalities in Tunisia have different bioclimates, which need specific action varying from one municipality to another. Therefore, municipalities in Tunisia experience extreme climatic events differently: loss of coastline in Djerba and Bizerte; food insecurity in Nabeul, a governorate with one of the highest poverty rates; forest fires in Boukarnine or Aïn Draham, municipalities with poor infrastructure and few social and economic opportunities; and marine intrusion in Radès."

A centralized climate strategy devoid of a municipal-level approach does not adequately address local climate challenges and needs and is unlikely to be successful or improve preexisting socioeconomic disparities.

A 2022 study on the role of municipalities in addressing climate change in Tunisia found that only 12 percent of municipalities had implemented climate adaptation measures and only 9 percent had implemented mitigation measures. This relative inactivity is attributable to a combination of a lack of prioritization by municipalities, the centralized nature of the Tunisian state, and the serious financial constraints faced by municipalities. Local officials must rely on international and private sector funding to develop climate adaptation and mitigation programs. Institutional incapacities brought about by a lack of local data, low climate awareness, and poor technical knowledge at the municipal governance level present additional obstacles. To promote climate governance that equitably addresses the challenges of poorer and less-functional municipalities, Tunisia will have to streamline national level strategies—such as the SNCC, low-carbon strategy (SNBC 2050) and the Energy Efficiency Strategy—into municipal-level frameworks.

Similarly, if mobilized and enforced institutionally at a multinational level, Tunisian civil society organizations' efforts to step in and fill in the gap left by ineffective government attention on climate change will no longer go unnoticed. For instance, one Tunisian civil society organization, the Tunisian Water Observatory, has undertaken a mapping project that allows citizens to report water shutoffs, poor water quality, and water-related protests. In 2022, the organization collected 2,300 alerts, the vast majority of which were related to water shutoffs. The governorates reporting the highest number of alerts were Ben Arous, Gabes, and Sfax. However, while this example suggests how civil society organizations often possess knowledge about climate change and expertise in developing adaptation and mitigation measures equal to (if not more than) local officials, civil society actors

have described roadblocks put in place by the central government that prevent them from carrying out their projects. For example, Tunisia's green hydrogen national strategy has, thus far, failed to include civil society organizations, scientists, and affected communities within the strategic discussions.

Civil society organizations' exclusion from climate policy negotiations and policy action fundamentally can be traced to budget and funding limitations, which delegitimizes organizations looking to participate in project implementation in a meaningful and official capacity. Consequently, less civil society involvement can mean the further disadvantaging of vulnerable groups exposed to climate risks, in ways that could have been avoided through risk-informed training and workshops on climate mitigation and adaptation, such as technology use in the agricultural sector at the local and municipal level or data analysis at the ministerial level. A study on Tunisia by the Economic Research Forum demonstrated that the exclusion of nongovernmental organizations (NGOs) from law drafting decreased NGO climate training involvement by as much as 40 percent.

Despite these obstacles, civil society has been effective in raising awareness of climate issues and putting pressure on officials. But, even when civil society actors are able to convince local officials to act, the centralized nature of the Tunisian state often prevents these local officials from carrying out their plans, owing to a lack of prioritization and structure at the federal level.

The danger that centralization will perpetuate climate-induced structural inequalities in Tunisia can be more clearly understood when analytically applied to the climate-sensitive sectors of energy and water.

Implications of Centralized Governance in Energy and Water Sectors

The highly centralized nature of the government writ large, and the energy sector in particular, is a serious impediment to the necessary reforms to reduce Tunisia's reliance on fossil fuels in a manner that also protects vulnerable segments of the population. Although Tunisia's energy subsidy reforms have scaled back the extent of fossil fuel dependency, subsidies have eaten up 5.3 percent of GDP in 2022 and heightened national fiscal deficits—and yet have failed to shield lower-income households from the resultant energy price increases. More importantly, in a more structural lens, the centralized monopolization of state-owned energy companies that control Tunisia's energy supplies, STEG and the Tunisian Company for Refining Industries (STIR) has hampered Tunisia's access to affordable and clean energy. The subsidy campaign has affected these companies' capacity to invest in decarbonization, therefore jeopardizing affordable and clean energy supplies on a national scale.

STEG, the country's national utility, generates 81 percent of Tunisia's electricity, distributes all energy generated in Tunisia, and "exercises effective control over the strategic evolution of the [electricity] sector." Under Tunisia's recent democratic governments, STEG prevented the government from establishing an independent authority to oversee the electricity sector. The water sector is also highly controlled but faces considerable influence from the main labor union, the Tunisian General Labor Union (UGTT). In 2015, the Tunisian government tried to introduce a new public water code to address climate change but faced significant pushback from the UGTT, which sought to prevent privatization of the water sector.

To better align water supply and demand, the Tunisian government is also developing a 2050 Water Vision and Strategy. However, this process requires a "paradigm shift," including "administrative and institutional reforms." In response to the water scarcity issues in summer 2023, the Ministry of Agriculture issued a ban from March until the end of September 2023 on the use of potable water for washing cars, irrigating green spaces, and cleaning streets and public spaces. The Tunisian government also introduced a water curfew in April 2023, in which Sonede cut off the main water supply each night between 9 p.m. and 4 a.m.

Aside from the low-risk, short-term solutions that have failed to effectively tackle preexisting and imminent climate hazards, as seen in the water scarcity enabled by drought and mismanagement, the Saied government, elected in 2019, has done little to address climate change and its impacts. A 2021 report by the Tunisian Ministry of Agriculture, Water Resources, and Fisheries notes that there is a "weakness" of governance mechanisms to address these issues, partially due to an "outdated" regulatory framework and poor coordination.

In addition to alleviating public budgetary pressures and expanding financing measures for climate projects, private sector involvement as a function of decentralization can immensely improve resource security in Tunisia. In the case of water governance, studies have reported that "even in developed countries public systems perform with lower competency than private systems" in water management. Pivoting away from centralization and institutionalizing private sector engagements would likely yield healthier water quality and more abundant water supplies, especially in areas disproportionately experiencing water scarcity, by allowing for more efficient project implementation processes, including operations, maintenance, regulation, and enforcement.

Similarly, a lack of privatization in Tunisia's energy sector has restricted its financial and renewable energy production capacities. As suggested by the United Nations Food and Agricultural Organization, private sector involvement—in coordination with relevant stakeholders like international organizations, financing institutions, academia, and NGOs—will likely generate more advanced food and energy security systems. As it is, already vulnerable groups like rural farmers suffer from insufficient energy sources that have undermined their livelihoods. For example, a lack of access to cooling leads to lower-quality produce, which in turn forces farmers to sell at a lower price immediately after a harvest, consequently diminishing profits.

The government has adopted a largely reactive approach toward climate mitigation, but progress is being made through the Ministry of Environment's Draft Environmental Code, launched in June 2023. The code is the first of its kind in Tunisia and is an attempt to coordinate among the myriad legislative and regulatory documents covering the environmental sector, some of which have been in place for 30 years. The Draft Code draws on a document first produced in 2013 through a participatory approach, including civil society input. But in the highly centralized Saied government, the code risks falling prey to the interests of STEG and the UGTT, who have traditionally opposed private investment in renewable energy production. Furthermore, most private sector–led renewable energy projects are managed by foreign companies. Since 2015, there have been twenty-two renewable energy projects, only half of which have had Tunisian project leaders and only four of which have been led exclusively by Tunisian firms. To ensure an inclusive and just climate transition with the tools to seal inequality gaps, there is a need for local- and multinational-level engagement in decisionmaking as a means of decentralization beyond privatization.

Tunisia has a goal for 35 percent of its energy to be renewable by 2030 and for the country to be carbon neutral by 2050. In 2022, only 3 percent of the electricity produced in Tunisia was from renewable sources. The Tunisian government has a poor track record when it comes to renewable energy. In the 2000s, the Directorate General of Forestry forcibly annexed land for the country's first wind farm in Borj Essalhi from local residents who had used the land for agriculture. Residents were so incensed by the Ben Ali regime's takeover of their land that they protested by refusing to pay their electricity bills. And more recently, the Tunisian government seized 150 hectares of land from Segdoud in Gafsa for a solar farm run by French company Engie and Moroccan energy company Nareva, which the Redeyef collective land management council is seeking to reclaim. The TuNur solar project in the desert regions in southern Tunisian is another example of what has been described as "green extractivism." The power generated is expected to be exported to Italy, Malta, and France via underground cables. It not only takes over Tunisian land for the solar farm but also requires significant water usage in an already water-scarce region, as discussed earlier, which further entrenches the resource shortages borne by already marginalized regions. Localized production and local community involvement is also much more conducive to satisfying local energy demands at a lower cost and higher efficiency level that is, most importantly, adaptive to local climate conditions.

Similarly, in December 2020, the Tunisian government signed a €31 million (almost $34 million) agreement with Germany to develop the North African country's green hydrogen sector. However, it plans to export the majority of the green hydrogen it produces, rather than commit it to local use. This arrangement further underscores the need for Tunisia to mobilize local empowerment as a means to achieving equitable climate adaptation outcomes.

Saied's approach has largely been to shift blame away from his own government and to exploit Tunisia's various climate crises as a chance to attack his opponents. In response to the wheat crisis, the Tunisian government raised the purchase price for 100 grams of wheat from

130 to 140 dinars, but this increase has not had the anticipated positive effects for Tunisian farmers. To adequately address the roots and repercussions of bread shortages and general climate-induced shortages in a manner that essentially protects vulnerable groups, Saied will have to move past blaming shortages on "criminal networks."

Conclusion

Tunisia is facing urgent threats from climate change that are impossible to ignore. Nevertheless, the Saied government has failed to prioritize climate adaptation and mitigation, and instead of taking responsibility for addressing these challenges it has exploited the outcomes of climate change, such as water and food scarcity, to put false blame on the president's political opponents. Today, it is impossible to extricate Tunisia's climate challenges from its governance challenges and vice versa. However, even within this extremely difficult political situation, there are several steps that can be taken to address Tunisia's most urgent climate challenges.

The first step is in communication. Civil society organizations and the international community can work together to help make Tunisians more aware of the problem and the connection to the economic challenges and instability they are facing in their daily lives. Too often, addressing climate change is characterized as a "luxury" that poor and rural populations cannot afford to address. However, the opposite is true. The most vulnerable populations are not only the ones feeling the brunt of the effects of climate change but are also the most likely to benefit economically from climate adaptation and mitigation measures, particularly those targeting the agriculture sector. Such measures could include shifting to permaculture as an alternative to traditional industrial agriculture as a way to prevent soil erosion, lower costs, and decrease emissions.

International donors should also work with the Tunisian government to strengthen the social safety net for the most vulnerable and those most affected by climate change. Key programs and services can include cash transfers, access to credit, affordable housing away from flood zones and high drought areas, and affordable basic services such as healthcare and education. Donors are already increasingly including climate adaptation and mitigation measures in their development assistance programs, but they can do more to ensure that development is explicitly addressing climate and targeting the most vulnerable populations. Additionally, the Tunisian government can partner with international donors and the private sector to create a more sustainable renewable energy plan by focusing on solar and wind energy, which Tunisia has in abundance. And to address coastal aquifer salinity and water scarcity, donors can support the desalination project started in 2022.

However, none of the ongoing climate adaptation and mitigation plans will succeed without addressing the ongoing political and economic instability plaguing Tunisia. Failing to decentralize the government or empower local government to address local

climate challenges will be a massive roadblock toward progress. And continued repression and scapegoating only serves to create additional societal unrest that makes cooperation on climate more difficult. Finally, by failing to push back on the electricity and water monopolies that are a major impediment toward privatization of these industries, the government is doing itself a disservice. Overall, Tunisia's climate challenges require local solutions, and the best actors to devise and implement those solutions are those most impacted by the damages climate change is inflicting on Tunisia.

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Notes

1 Interviews have been anonymized throughout to protect the identity of individuals and organizations—attributing characteristics and descriptors will be kept general and high level.

2 Ragia El Gerzawy, *Khareetat al-Nashat al-Beye'ay fe Masr* (Cairo: Egyptian Initiative for Personal Rights, 2016).

3 Author's estimation.

4 Interview with social enterprise climate change program manager.

5 Interview with makerspace founder, based and operating in Alexandria, Egypt.

6 Interview with rights-based environmental educator.

7 Interview with pioneering environmental NGO founder.

8 Interview with rights-based environmental advocate.

9 Interview with program manager in rights-based organization.

10 Interview with program manager in rights-based organization.

11 Interview with rights-focused environmental researcher.

12 Interviews with a project manager and a second climate-focused researcher.

13 Interview with project manager.

14 Interview with long-term activist and environmental adviser.

15 Interview with long-term activist and environmental adviser.

16 Author interview, Zoom, September 18, 2023.

17 Author interview, Zoom, September 18, 2023.

18 Author interview, Zoom, September 20, 2023.

19 Author interview, Zoom, September 19, 2023.

20 Author interview, Zoom, September 20, 2023.

21 Author interviews, Zoom, September 19 and 20, 2023.

22 Author Interview, phone, September, 2023.

23 Author Interview, phone, September, 2023.

24 Author interview, phone, September 8, 2023.

25 Author interview, FaceTime, September 6, 2023.

26 Greater Amman Municipality, "Climate Change Risk Assessment for Amman City," 2024 (submitted for publication).

27 Greater Amman Municipality, "Climate Change Risk Assessment for Amman City."

28 Greater Amman Municipality, 2023. Interview with the head of Amman Resilience Unit at GAM.

29 Telephone interview with Jalal Al-Qadi, director of the Misrata Agriculture Research Center, based in Misrata, Libya, October 2022.

30 Interview with Libyan farmer Bashir Alafrak in Sidi Sayeh, Libya, September 2022.

31 Interview with a Libyan agricultural consultant, Tripoli, Libya, May 2022.

32 Observations and interviews with Libyan climate officials, Tripoli, Libya, May 2022 and July 2023.

33 Interviews with Libyan activists in Tripoli, Libya, July 2023.

34 Interview with Libyan farmer Bashir Alafrak in Sidi Sayeh, Libya, September 2022.

35 Interview with personnel from the National Meteorological Office, Tripoli, and telephone interview with a climate activist based in eastern Libya, July 2023. "We can't depend on the government because of the east-west rivalry, low capacity, and seven to eight government climate entities," stated the activist, who noted the exception of the staff of the Great Man-Made River.

36 Interview with Libyan local governance expert Otman Gajiji, Tripoli, Libya, July 2023.

37 Author visit to Amazigh communities in the Jabal Nafusa, Libya, July 2023.

38 Author interviews with Amazigh farmers in and around Yifren and Qala'a, Libya, July 2023.

39 Interview with a Tuareg notable, Ghat, Libya, March 2016. "After the Fateh Revolution, Qaddafi gave us agriculture, he made us go to school. The state took care of the Tuareg," this individual noted.

40 Telephone interview with climate consultant Matthew Brubacher, based in Geneva, Switzerland, October 2022.

41 Telephone interview with climate consultant Matthew Brubacher, based in Geneva, Switzerland, October 2022.

42 Interviews with Tuareg residents of Ubari during a visit to the town, March 2016.

43 Interview with Tuareg activist and former official, Tripoli, Libya, July 2023.

44 Interviews with African migrants at detention facilities in Tripoli and Zawiya, March 2016.

45 PowerPoint briefing, "Sand and Dust Storms in Libya," provided to the author by the National Meteorological Office, Tripoli, Libya, May 2022.

46 Telephone interview with Jalal Al-Qadi, director of the Misrata Agriculture Research Center, based in Misrata, Libya, October 2022.

47 Interview with Libyan local governance expert Otman Gajiji, Tripoli, Libya, July 2023.

48 Interviews with environmental and climate officials in Tripoli and Misrata, May 2022 and July 2023.

49 Interview with an eastern-based Libyan official in the National Meteorological Office, Tripoli, July 2023.

50 Telephone interview with an eastern-based Libyan climate activist, July 2023.

51 Telephone interview with an eastern-based Libyan climate activist, July 2023; and interview with officials from National Meteorological Office, Tripoli, Libya, May 2022.

52 In-person and telephone interviews with Libyan officials and activists from eastern Libya, July 2023.

53 Telephone interviews with European diplomats and Libyan activists from eastern Libya, 2022 and 2023.

54 Interview with a Libyan official from eastern Libya, location undisclosed, July 2023.

55 Telephone interview with a Libyan climate activist, name and location undisclosed, September 2023.

56 As noted by Middle East climate scholar Jeannie Sowers, "The degree to which states are tolerant of local-level initiatives and mobilization will become only more important as climate impacts intensify." Jeannie Sowers,"The High Stakes of Climate Adaptation in the Middle East and North Africa," *Current History,* December 2017, 348–354, https://doi.org/10.1525/curh.2017.116.794.348.

57 Interview with a Tuareg activist and former official, Tripoli, Libya, July 2023.

58 Interview with Libyan local governance expert Otman Gajii, Tripoli, Libya, July 2023.

59 Telephone interview with a Libyan climate activist based in eastern Libya, July 2023.

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