MIDDLE EAST AND
NORTH AFRICA

YEMEN

World Bank Group

COUNTRY CLIMATE AND DEVELOPMENT REPORT

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Acronyms and Abbreviations

ACLED	Armed Conflict Location and Event Data Project
BCM	Billion Cubic Meters
CAMA	Civil Aviation and Meteorology Authority
CBY	Central Bank of Yemen
CCCM	Climate Change Coordination Mechanism
CCDR	Country Climate and Development Report
CCGT	Combined Cycle Gas Turbine
CCU	Climate Change Unit
CDA	Civil Defense Authority
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EPA	Environment Protection Authority
EPM	Electricity Planning Model
EWS	early warning systems
FAO	Food and Agriculture Organization
FCV	Fragile, conflict and violence
GCF	Green Climate Fund
GDP	Gross Domestic Product
GHG	Green House Gases
GHI	Global Hunger Index
GW	Giga Watt
HDI	Human Development Index
HLO	Higher Level Objective
IDP	internally displaced population
INDC	Intended Nationally Determined Contribution
IPC	Integrated Food Security Phase Classification
IRG	Internationally Recognized Government
LCOE	Levelized Cost of Energy
MCM	Million Cubic Meters
MENA	Middle East and North Africa
MW	Meg Watt
MWE	Ministry of Water and Environment
NAPA	National Adaptation Programme of Action
NCCC	National Climate Change Committee
ND-GAIN	Notre Dame Global Adaptation Initiative
NWRA	National Water Resources Authority
PV	Photo-voltaic
RCP	Representative Concentration Pathway
SLR	Sea Level Rise
SSP	Shared Socioeconomic Pathway
TNC	Third National Communication
UNFCCC	United Nations Framework Convention on Climate Change
WASH	Water, Sanitation and Hygiene
SAM	Social Accounting Matrix
CEM	Country Economic Memorandum
WEAP	Water Evaluation And Planning
YHDS	Yemen Human Development Survey
MFI	Micro-Finance Institutions
WFP	World Food Programme

Yemen © Dmitry Chulov

Executive Summary

The Economic Impacts of Yemen's Development-Conflict-Climate Nexus

Yemen is facing a complex set of challenges around the nexus of development, conflict, and climate that exhibit significant regional variation. Yemen has long been the poorest country in the Middle East and North Africa and has the highest population growth rate globally, increasing pressures on water, food, and essential infrastructure and services. Prior to the onset of the conflict in 2015, the economy was caught in a jobless slow growth cycle leading to stagnant per capita income and rising levels of youth unemployment that have been on a downward trajectory. The population living in poverty had increased from 35 percent in 2005/2006 to 48.6 percent in 2014, the last year for which poverty data are available. The outbreak of the conflict has subsequently had devastating effects on the country's social and economic development, fragmenting the country and exacerbating pre-existing vulnerabilities, with 80 percent of households in need of humanitarian assistance in 2023. Fragile, conflict and violence (FCV) affected countries like Yemen are not only disproportionally exposed to climate change, but they also lack the capacity to cope with its impacts, suffering more severe and persistent GDP losses than other countries due to climate shocks.

Today, Yemen is one of the most vulnerable and least prepared countries to deal with the outcomes of climate change. By 2050, aggregate temperature could rise by up to 1.69°C under more pessimistic climate scenarios, with coastal regions experiencing the highest increases in temperature during winter and spring, and highland and eastern interior regions during other seasons. Precipitation is projected to increase under all climate scenarios, with significantly wetter conditions expected across large parts of the country. These are projected to be as much as 43 percent under the more optimistic scenarios, with even the pessimistic scenarios projecting a 15 percent increase in precipitation by 2050. These changes are accompanied by increased variability and more intense precipitation events, leading to longer, hotter dry periods. These long-term climatic shifts manifest through complex pathways but present potential opportunities for parts of Yemen, while posing severe risks in the absence of appropriate investments, particularly for water and food security. The increasing intensity and frequency of climate shocks also increases the risk of floods, particularly in urban areas, and damage to critical infrastructure, all while compounding the challenges for Yemen's human capital.

Yemen's economic prospects will be significantly influenced by future climate conditions and political developments. Annual GDP is projected to decline by an average of 3.9 percent by 2040 compared to baseline estimates under a more pessimistic climate scenario that is characterized by increased temperatures and longer dry periods. These losses are primarily driven by reductions in crop production and fisheries, limitations on labor productivity, and the deterioration of health and connectivity infrastructure. In contrast, an optimistic climate scenario characterized by increased temperatures and precipitation could lead to higher crop yields and less severe impacts on other channels, resulting in a modest projected average annual GDP growth of 1.5 percent by 2040, even without adaptation investments. However, this growth would be insufficient to improve incomes and deliver benefits to the population. The degree of vulnerability to climate change will depend on the broader political environment, as well as the policy environment and investments in adaptation. Heightened conflict puts limitations on investment planning, shrinks market access, and thereby climate adaption takes place in an ad hoc manner as part of the broader humanitarian assistance. As Yemen moves towards peace, the economy becomes more resilient to climate change, with higher growth and market diversification enabling investments in climate adaptation. With peace and targeted adaptation investments, Yemen could realize GDP growth 2.6 percentage points above the baseline projections.

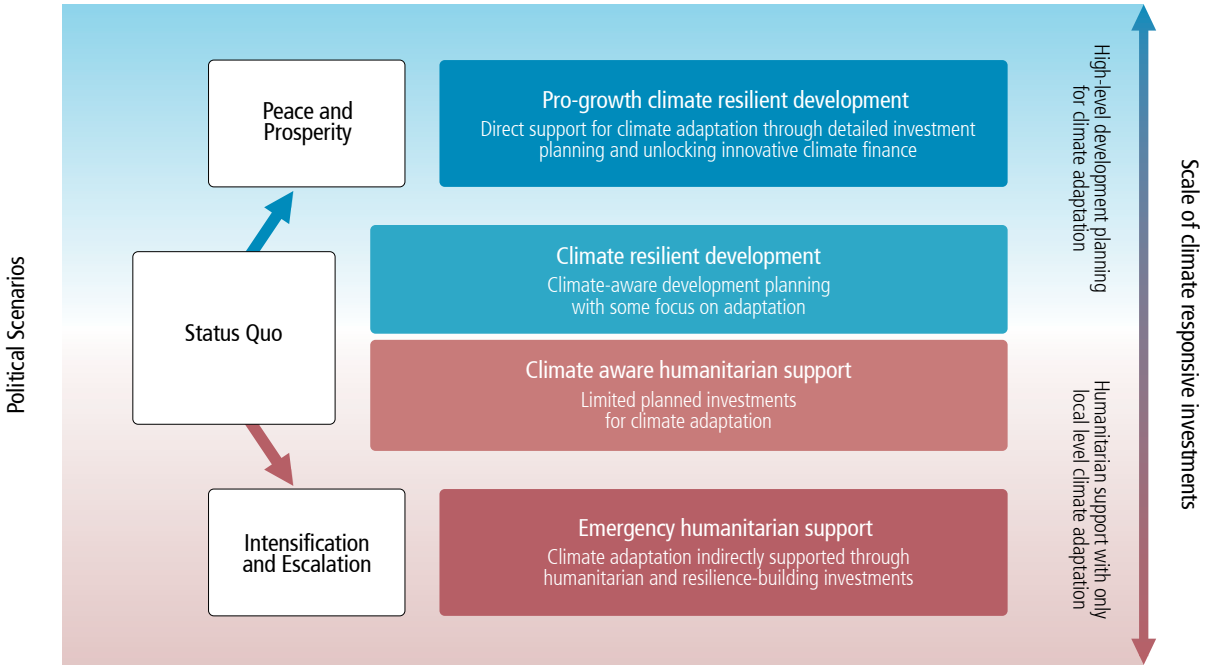
Uncertainty around the nexus of development, conflict, and climate requires a risk-informed approach that can respond to shifts in political scenarios to scale up climate actions.

The Yemen Country Climate and Development Report (CCDR) proposes a scenario-based framework that overlays different levels of fragility and capacity of climate action. The analysis and recommendations

have been tailored to the country's unique context, with the impacts of climate change and potential adaptation measures framed around three potential pathways for Yemen's future development (Figure 1). These scenarios reflect different trajectories that allow for risk-informed decision-making and include future pathways framed around "Peace and Prosperity", "Status Quo", and "Escalation and Intensification". Each scenario is categorized by a set of assumptions on the development narrative, average annual growth in GDP per capita for the next 20 years (2023-2040), the fiscal capacity to adapt, and the scale of actions from local, to regional, to national levels. These scenarios are not intended to be realistic predictions but rather to capture the range of possibilities that are informed by the nexus between development, conflict, and climate. This approach allows for a nuanced exploration of how different levels of adaptation and conflict resolution efforts can shape the country's future.

The possible interventions to manage climate risks in Yemen depend on the broader enabling context, with "Peace and Prosperity" providing a significant dividend. While the magnitude of the physical climate-related hazards under these three scenarios is the same, the impact of these hazards and Yemen's level of vulnerability is different, as are the interventions and response mechanisms. Under "Status Quo", continued political instability limits the implementation of the full set of adaptation measures. This is due to a number of contributing factors, including security concerns, competing humanitarian demands, limited access to financing, and limited human capital. In this context, preserving the foundations for future development can take the form of strategically selected rehabilitation of infrastructure assets with immediate policy objectives, notably water, food security, and protecting people from emergent climate hazards. Under a more optimistic scenario of "Peace and Prosperity", scaling up adaptation interventions and strategic infrastructure facilities would help adapt Yemen's economy to the changing climate. The framework highlights that the intensity and effectiveness of climate action are directly proportional to the shift away from conflict and instability. In the more pessimistic scenarios, the situation can range from basic humanitarian support in emergencies, to a Status Quo with adaptation indirectly supported through broader humanitarian investments aimed at building resilience among local communities. Conversely, Peace and Prosperity will allow for greater levels of climate adaptation, leading to resilient development and economic expansion, with a significant peace dividend (Figure 1).

Figure ES1: Risk-informed approach for scaling climate responsive investments in response to changes in the enabling environment.



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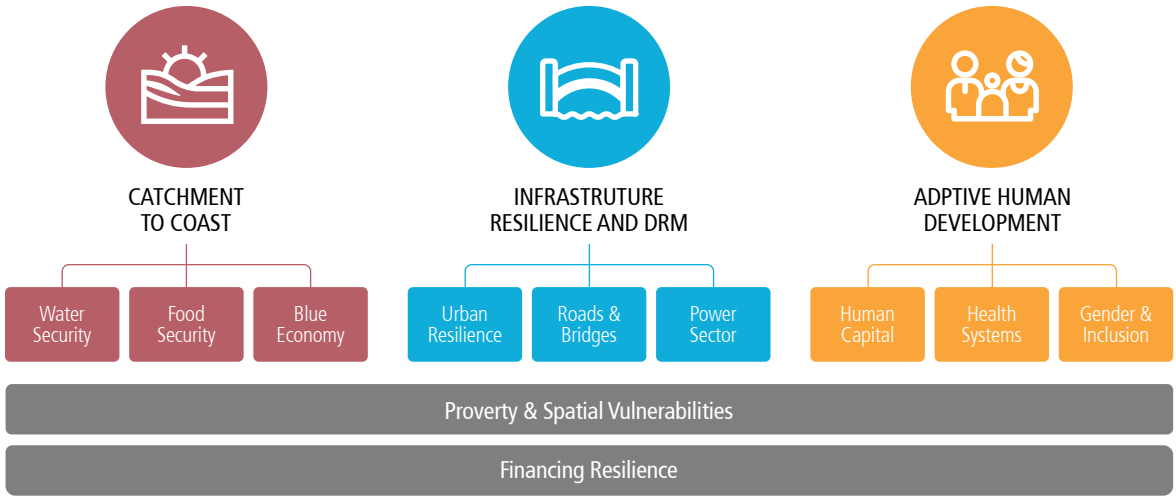
The CCDR presents a series of recommendations that are grouped under five scalable High-Level Objectives (HLOs) that retain agility of action under three indicative scenarios. These HLOs reflect: (i) the priority pillars and analytical findings of the CCDR (Figure 2), (ii) feedback and needs communicated by Yemeni experts from various agencies and institutions, and (iii) extensive multi-stage consultations and workshops with different social groups, including policy makers, civil society, women, and academic experts, among others. The five HLOs build on the foundations of the humanitarian response and provide a baseline for an adaptive development agenda that responds to the priority impacts of climate change in Yemen, accounting for the level of political stability. Yemen could potentially leverage climate change for economic gains as increased rainfall, combined with strategic investments, may boost water availability, alleviate unmet water demands, and create positive spillovers on all sectors of the economy.

Figure ES2. Priority Pillars and Sectors for the Country Climate and Development Report.



High-level Objective 1: Develop spatially targeted, scalable and people centered area-based approaches to build resilience and reduce multidimensional poverty.

Half of Yemenis, about 16.7 million people, are exposed to at least one climate hazard of either extreme heat, drought, or flooding, exacerbating the multidimensional elements of poverty, with strong regional concentrations. Half the population was also exposed to acute food insecurity in 2022, with 26 percent of all Yemenis living in areas subject to the food security crisis and exposed to at least one extreme climate-related hazard. An estimated 7.2 million people are exposed to extreme heat, mostly concentrated along the western and southern coastal plains, 7.4 million people in the south-western part of the highlands are exposed to flooding, and 6.7 million are exposed to drought in the north-western coastal plains and the south-eastern leeward side of the highlands. The levels of vulnerability are even higher when considering exposure to conflict related events. The districts that see the largest number of individuals affected by potential compounding shocks are Marib city in Marib governorate, Abs in Hajjah governorate, Bani Al Harith and Sanhan wa Bani Bahlul in Sana'a governorate, and Bayt al Faqih in Al Hodeidah governorate. Combined, these districts are home to more than one and a half million Yemenis exposed to compounding shocks.

Managing uncertainty in Yemen's climate resilience requires an area-based approach that can target the most vulnerable households, while responding to the enabling environment and be scaled according to the availability of financial resources. Roughly 40 percent of the population now live in five governorates which account for nearly 70 percent of GDP. Sana'a and Aden alone account for an estimated 40 percent of GDP and 15 percent of the population. Exposure exhibits significant spatial differences, with more than 90 percent of the population and 95 percent of GDP concentrated within water management areas in the western and

south-western parts of the country. These regional differences, coupled with the limited resources, and emergent examples of bottom-up and localized climate actions substantiate the need for an area-based approach that can adapt to changes in the enabling political environment. Such approaches should be targeted based on objective technical criteria, but scaled in response to the enabling environment as well as changes in resource availability, local capacity, taking into account community needs and perspectives.

Geographically focused packaging of climate investments can maximize impact and enable scaling-up across sectors. The correlation between the incidence of conflict and precipitation with food insecurity suggests that there are significant spatial differences and that investments in adaptation to climate shocks are more important in areas with higher conflict incidences. An area-based approach for short- and long-term interventions across the humanitarian-development nexus delineates geo-physical boundaries and takes a multi-sectoral approach accounting for capacity for action, access to services, and an inclusive strategy to address the needs of vulnerable population groups. Equity considerations necessitate geographically targeted packages of interventions to prioritize synergies across the portfolio and maximize results. This will be critical for alleviating water scarcity, agricultural production and food security, as well as infrastructure and disaster risk management, impacting economic prospects and the multi-dimensional elements of poverty in Yemen.

High-level Objective 2: Improve water and food security and build a resilient fisheries sector amid uncertainty.

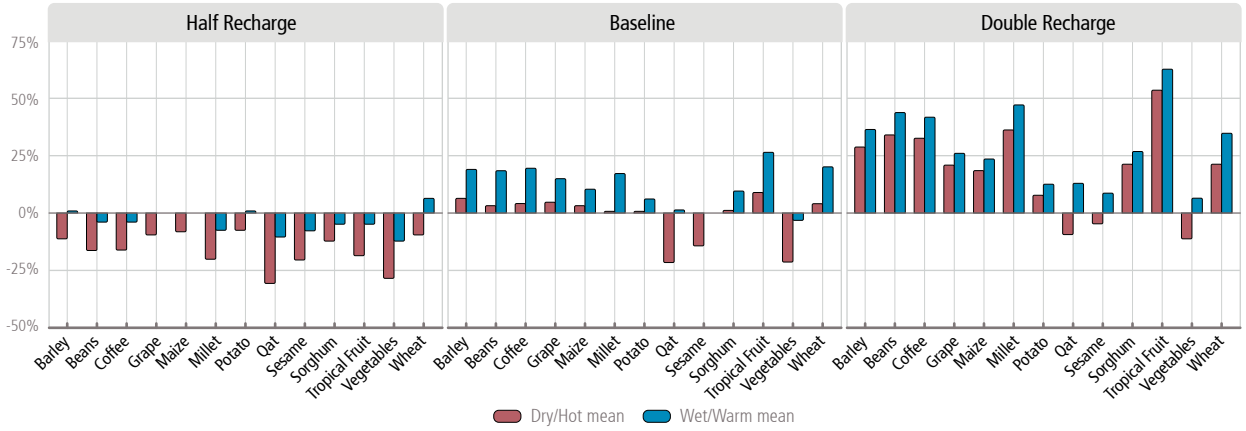
Yemen's projected future climate has the potential to reduce, but not alleviate, water scarcity in the world's poorest, most water scarce country. Most water management areas experience acute water shortages, with unmet water demands expected to rise to 50 percent by 2050 in the absence of climate change. Unmet demands are concentrated in the northwestern and eastern-central basins (e.g. western Rub Al Khali, central Red Sea, eastern Arab Sea), and could reach as high as 90 percent in certain basins due to high irrigation demands. Both the optimistic and pessimistic climate scenarios are projected to result in a decline in unmet demands across all sectors by mid-century. Unmet municipal demands are projected to reduce from around 20 percent to between 14 and 16 percent by mid-century, depending on the climate scenario, while unmet demands in the irrigation sector are projected to decline from 48 percent to between 39 and 45 percent.

Harnessing the potential associated with increased precipitation will require targeted investments, failing which the impacts of more intense rainfall and longer dry periods will have devastating impacts. Yemen relies heavily on groundwater, which is affected by a complex array of climate-related factors that can increase or decrease permeability of the landscape, infiltration of water and recharge of aquifers. Interventions that increase recharge, such as terracing, percolation ponds, sand dams, and injection wells, can significantly decrease unmet water demand. Doubling the rate at which groundwater resources are recharged reduces unmet irrigation demand by more than 10 percent across both the no climate change and the future climate change scenarios. However, if such investments are not realized, and groundwater recharge rates are halved, unmet irrigation demands could increase by nearly 30 percent in some water management areas.

Rainfed and irrigated crop production show a potential aggregated increase of 13.5 percent under optimistic climate projections. Rainfed crop production could increase by as much as 11.9 percent under an optimistic scenario, although some high revenue crops, like qat and vegetables, exhibit higher vulnerabilities to climate change and may experience sizable production declines, with impacts estimated at -19 and -25 percent under a more pessimistic future. However, other high revenue crops such as tropical fruits may experience production gains under both climate scenarios, with impacts potentially reaching upwards of 30 percent. The heat effect due to increasing temperatures on rainfed crops results in negative impacts, particularly for qat and vegetables, while the precipitation effect is generally positive for all rainfed crops. Irrigation exhibits similar production gains, with the doubling of groundwater recharge rates resulting in production gains ranging from +8 to +52 percent under the pessimistic scenario and from +6 to +61 percent under the optimistic scenario, with tropical fruit, millet, beans, and coffee exhibiting the greatest production

improvements (Figure 3). Some residual negative shocks remain for qat, sesame, and vegetables, but only under the more pessimistic scenario. Failure to increase groundwater recharge rates is projected to result in negative impacts on production for all crop types.

Figure ES3. Irrigated crop production shocks from 2041 to 2050 under different adaptation scenarios reflected in groundwater recharge rates.



Source: Original for this publication.

Climate change poses significant threat to Yemen's fishing sector, with losses reaching 23 percent by mid-century, affecting the blue economy, food security, and livelihoods in coastal areas. The maximum catch potential is projected to decrease between around -16.6 percent and -23.1 percent between 2041 and 2050. Assuming that current fishing rates continue to 2050, the loss of revenue in response to changing sea surface temperatures relative to 2020 could have a one percent impact on real GDP. Climate impacts on the sector are projected to grow incrementally towards mid-century and vary depending on the climate scenario considered. However, the magnitude of impacts is highly uncertain, with the physical effects of climate change on fish stocks and fisheries manifest through a complex array of potential pathways. On-shore processing and value chains are also vulnerable to increasing sea level rise and inundation of coastal areas, requiring integrated approaches to coastal zone management. Coastal infrastructure, including that essential for the fisheries sector, is also at risk of sea level rise and will need protection to enable sustainable livelihood and food security under future climate scenarios.

High-level Objective 3: Promote disaster risk management and climate-resilient power service provision centered around renewable energy.

The increasing frequency and intensity of climate related hazards requires effective disaster risk management to minimize the damages, which can be more than 2.7 percent of GDP. Limiting development in flood-prone areas and operationalizing early warning systems (EWS), coupled with disaster risk insurance and social transfer, are critical to reducing vulnerability to climate hazards, particularly flooding. Yemen lacks an integrated disaster risk management strategy, with outdated planning and regulations hindering efforts and resulting in reactive responses. Limited coordination and capacity among authorities has led to fragmented efforts, outdated EWS, and inadequate preparedness, resulting in costly inefficiencies, confusion over mandates, and weakened capacity to respond to disasters. Long-term territorial planning must be reevaluated to enhance resilient development of critical infrastructure such as electricity, telecommunications, and transport, with nature-based solutions offering local level, short term solutions for climate-resilient planning, which not only provide cost effective mitigation for flood risks but have co-benefits, such as protecting and/or restoring biodiversity, that can enhance climate regulation and ecosystem services, as well as supporting livelihoods.

Climate change damages in the logistics and transport sectors are projected to increase by as much as 45 percent by 2050 without adaptation, exacerbating disruptions in access to essential goods, services, and markets. Yemen's large rural population rely mostly on unpaved dirt roads that are constantly disrupted due to climate-related hazards that affect access essential services, such as health and education, as well as access to markets. The country's roads have been severely damaged due to decades of neglect, continued conflict, and increasing climate hazards, with disruptions estimated to average 27 days per year, due mainly to inundation and landslides. Climate-induced annual damages are projected to increase by as much as US$90 million, driven predominantly by flooding impacts. Similarly, annual costs due to increased road repair and maintenance are projected to total US$100 million between 2041 and 2050. Damages to bridges from 25-year storm events show a 13-fold increase to US$172.9 million by mid-century. Given the magnitude of the needed investment to rehabilitate the logistics and transport infrastructure, climate-resilient rehabilitation works can be prioritized based on their network criticality toward economic reconstruction and resilient recovery. Only 7 percent of roads carry 75 percent of food traffic imported from ports and distributed across the country, hence warranting an area-based prioritization of rehabilitation works. These impacts on roads and bridges are expected to be more prominent in eastern governorates such as Al Mahrah, as well as Sana'a and Dhamar governorates, and other western-center areas of the country. Generation of fuel fee revenues should be strengthened to fund rehabilitation works, complemented with capacity building to employ contract modalities that enable predictability and sustainability of logistics and transport infrastructure rehabilitation programs.

Distributed renewable energy is vital for climate resilience in Yemen, particularly to restore power and ensure stable electricity for essential services like water, healthcare, and livelihoods. This is particularly needed under the "Status quo" and "Intensification and Escalation" scenarios. Electricity is crucial for maintaining cold storage for vaccines, perishable goods, and for supporting water and sanitation facilities. Moreover, Yemen's electricity infrastructure and fossil fuel supply is highly vulnerable to conflict and climate shocks, necessitating investments in off-grid renewable systems to reduce dependency on fuel imports. However, regulatory bodies and emergency management systems are underfunded, and the lack of maintenance increases the vulnerability of grids, especially in coastal areas. To address these risks, there is a need to refurbish infrastructure, improve regulatory frameworks for climate risk, and build institutional capacity for disaster resilience. In the "Peace and Prosperity" scenario, the early and rapid development of new utility-scale renewables would result in the lowest system costs and total emissions, despite having increased growth in demand.

High-level Objective 4: Foster adaptive human development by advancing health and human capital, prioritizing women and vulnerable groups.

The increasing severity and frequency of health problems are estimated to cost more than US$5 billion in excess costs due to mortality and morbidity from diseases exacerbated by climate change. Climate change is imposing additional strain on Yemen's health services, increasing risk of disease burden, diminishing labor productivity, and leading to long-term impacts on human capital development for vulnerable groups at risk due to the conflict. Climate shocks would put 433 health facilities at risk of at least 15 centimeters of floodwater depth in a 1-in-100-year flood event by 2050, degrade the quality of water, sanitation, and hygiene services, and increase transmission of vector-borne diseases. Poor water, sanitation and hygiene infrastructure are projected to combine with changes in projected precipitation to exacerbate the associated health challenges of water-borne diseases, with more than 200 additional deaths and more than US$120 million in excess health costs attributable to diarrhea projected in 2050. Illnesses related to extreme heat are projected to increase ten-fold from 2020 to 2050, with 25 percent directly attributable to climate change especially in major coastal cities like Al Hodeidah, Aden, and Mukalla. Considering a wet-bulb temperature, which measures how well one can cool themselves by sweating, in a 100-year return period, there are over five million Yemenis exposed to temperature over 35 degrees Celsius, with most of these concentrated in Al Hodeidah governorate, Aden and Hadramawt. Developing preventive healthcare system will help counteract the impact of water-borne diseases.

Emphasizing the roles of women and youth in Yemen could be key to developing effective climate-responsive policies as these groups are disproportionately impacted by displacement and extreme events. There are approximately 400,000 children under five years of age exposed to wet-bulb temperatures of 35 degree Celsius. The combination of increased hot days and tropical nights disproportionately effect the elderly, pregnant women, children and newborns, people with chronic illnesses and disabilities, as well as outdoor workers. Due to limited electricity access (74.9 percent as of 2021), the population is not well-equipped to adapt to extreme heat driven by climate change. Young people remain among the most impacted by the on-going conflict as 2,426 schools were reportedly non-functional due to damages or use as shelter or other purposes. In 2023, 4.5 million children did not attend school, and 1.3 million must deal with overcrowded classroom and overburdened teachers. This limit on human capital accumulation for the young and productive engagement for women hinders the full impact of adaptation to climate change. Prioritizing these groups in climate policy and financial provision—by enhancing employment opportunities in sectors such as agriculture and blue economy value-chain development—can empower them to become long-term leaders of change in Yemen, addressing both climate and human development challenges.

High-level Objective 5: Scale up innovative climate finance and empower the private sector through people centered approaches.

Yemen receives 80 to 90 percent less climate finance than countries with the lowest climate vulnerability despite high needs. There are a number of barriers to scaling up climate finance for Yemen, including low absorptive capacity and weak appetite among financing institutions due to high perceived and real risks, as well as the lack of effective coordination mechanisms at the national and sub-national levels. These factors, individually and collectively, deter climate investments, despite Yemen's disproportionate vulnerability to the impacts of climate change. Strengthening the capacity of the private sector, which has already been crucial to economic development under increasing fragility, can advance a climate resilient future. Providing comfort to the private sector through guarantee instruments and facilities could provide the path toward increasing investment and insurance products, while a peace agreement has the potential to unlock a range of innovative climate financing tools, including access to global funds, debt swaps and diaspora bonds. There are also emerging instruments, such as climate resilient debt clauses, that are aimed at supporting vulnerable countries against economic shocks. While these are focused primarily on fiscal crises due to natural disasters and climate related hazards, they could be adapted to provide a range of co-benefits and incentives linked to milestones within the peace process for FCV countries.

Securing a lasting peace agreement is critical to unlocking the full potential of adaptation strategies and tapping into new financing streams, including those from the private sector. Projected investment needs are subject to the prevailing conditions, with the basic humanitarian needs under the "Status Quo" scenario estimated at US$2.71 billion in 2024, of which roughly 30 percent has been secured. While enduring peace remains elusive, a climate responsive recovery and reconstruction will need to account for the historical infrastructure deficit due to persistent development challenges and the accumulated reconstruction costs associated with damages due to the conflict. There are a number of "no regret" measures that can be implemented under the status quo to increase resilience to exogenous shocks, such as climate, with a number of development co-benefits. These incremental costs of climate responsive investments are estimated to be less than 3 percent of the basic humanitarian needs, although could range between 1 and 5 percent of GDP annually. All scenarios for Yemen's future development will require significant commitments from national factions and the international community, and while humanitarian and peacebuilding efforts have the potential to indirectly support the ability of households to cope with climate shocks and build broader resilience, securing sustainable peace will be required to unlock new and innovative sources of financing in the amounts needed to build resilience to climate change. While climate change adds a layer of uncertainty to Yemen's developmental trajectory, strategic investments in priority areas, underpinned by reliable data and robust monitoring and evaluation frameworks, present multiple opportunities for a brighter and more resilient Yemen.

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1. Development, Conflict and Climate Context

1.1. Development Amid Conflict and Fragility

Yemen has long been the poorest country in the Middle East and North Africa and faces a number of persistent development challenges. Since unification in 1990, the country has experienced a series of external shocks and domestic upheavals, resulting in a turbulent development trajectory driven by its reliance on oil production and marked by fragility and escalating conflict. The Human Development Index (HDI) has shown minimal change since 1990, slightly increasing from 0.383 in 1990 to 0.424 in 2022, ranking it 186th out of 193 countries.[1] Prior to the onset of the conflict in 2015, the Yemeni economy was caught in a jobless slow growth cycle leading to stagnant per capita incomes and rising levels of unemployment, particularly among the youth. The country had one of the highest population growth rates globally, at three percent, and there was an increasing demand for educational and health services, drinking water, and employment opportunities. Oil production and reserves, which historically accounted for 75 percent of public revenues, were declining, with severe fiscal consequences, and the population living in poverty had increased from 35 percent in 2005/2006 to 48.6 percent in 2014, the last year for which poverty data are available. While poverty had reduced in urban areas it was more widespread and persistent in rural areas, with large gender disparities and significant gaps in women's access to economic, social, and political opportunities. Many of these conditions persist today.

The protracted conflict has exacerbated the country's development challenges, resulting in one of the world's worst humanitarian crises. The conflict that has raged since early 2015, dividing the country into separate areas of control (Figure 1.1), has devastated the economy, resulting in unregulated use of scarce natural resources, like water, leading to severe food insecurity, destroying critical infrastructure, disrupting essential services, education and healthcare systems. The conflict has also led to high absenteeism and an exodus of human resources, with many skilled professionals leaving the country in pursuit of safer and more stable conditions. Socioeconomic conditions have deteriorated rapidly due to declining remittances, trade disruptions, severe fuel supply shortages and reduced humanitarian operations. The reduced focus on development efforts has led to severe impacts on livelihood resilience and increased competition over natural resources, particularly water. The conflict has contributed to, and has been accentuated by, multiple shocks, including rising prices, food insecurity, floods, the COVID-19 pandemic, a cholera epidemic, and a locust invasion. Yemen's heavy reliance on food imports, particularly rice and wheat, coupled with the ongoing conflict and economic instability, makes it particularly vulnerable to disruptions in the global markets, posing severe challenges to Yemen's trade, inflation rates, external balance, and food security. All these factors have exacerbated pre-existing vulnerabilities for Yemeni households, with model estimates suggesting poverty may have increased to 74 percent in 2022, while 80 percent of households are now in need of humanitarian assistance.[2]

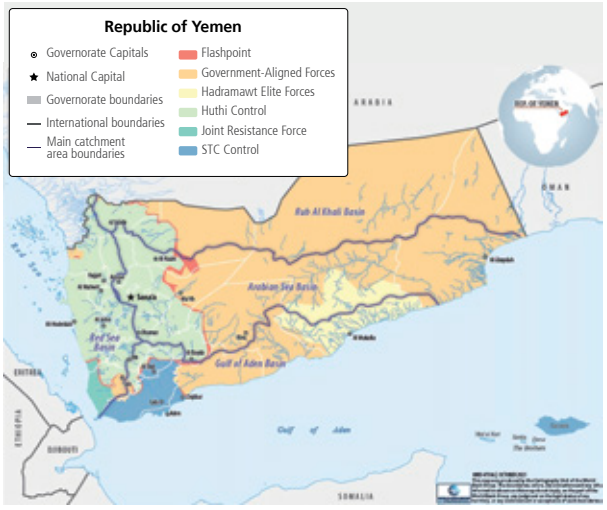
Persistent development challenges, continued conflict and violence, along with fragmented macroeconomic policies have added strain to the already fragile economic conditions. The country experienced a staggering 54 percent decline in real GDP per capita from 2015 to 2023, leaving 23.4 million individuals in dire need of humanitarian assistance. However, fragmented institutional capacity and diverging policy decisions across control lines have created significant distortions that compound the crisis. The redirection of imports to Houthi-controlled ports has led to a substantial decrease in customs revenues for Aden, with continued fiscal pressures and economic fragmentation between Houthi and Internationally Recognized Government (IRG) controlled areas threatening to deepen the divide. Inflation rates vary significantly across regions, with Sana'a experiencing deflation at -11.8 percent and Aden facing elevated inflation at 7.0 percent due to currency depreciation. Additionally, the

1 UNDP (2024). Human Development Insights. Accessed October 2024. [link]

2 Lofgren, H., Cicowiez, M., and Mele, G. (2023). Alternative Paths for Yemen up to 2030 : A CGE Based Simulation Analysis. 10599. Policy Research Working Paper. Washington D.C.: World Bank [link].

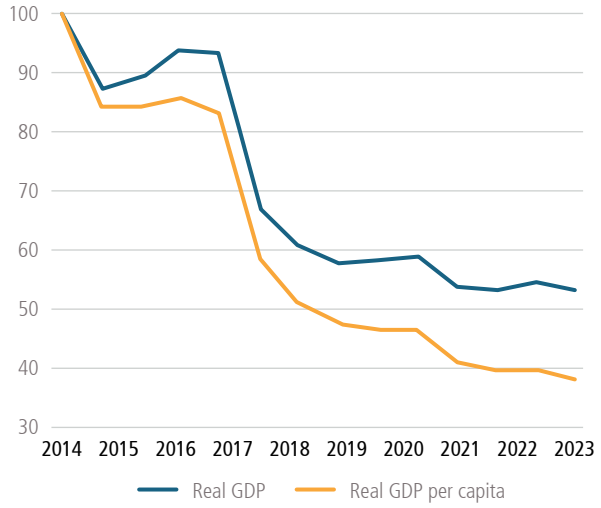
cost of essential goods has surged in Aden, with many families now spending over 60 percent of their income on food alone. Yemen's fragile economy faces uncertain prospects, owing to constraints on oil exports and ongoing political instability, with a need for structural reforms that can address the immediate financial needs, rectify macroeconomic imbalances, and counter the erosion of human capital to support a sustained recovery.

Figure 1.1. Areas of Control in Yemen.



Source: Original for this publication based on data from the International Crisis Group (2023)[3]

Figure 1.2. Real GDP and Real GDP per Capita Index.



Source: Source: Original for this publication based on World Bank (2024)[4]

Yemen's humanitarian and development prospects are deeply entrenched in its intricate and conflict-influenced political and economic landscape. The division of the country into separate economic zones, each governed by distinct institutions and policies, perpetuates disparities. In 2022, a temporary UN-backed truce between Yemen's IRG and the Houthis provided some economic relief yet failed to secure a lasting political resolution. The truce expired in October 2022 and, although an informal truce remained, the situation deteriorated due to a Houthi-imposed oil export blockade. This blockade poses significant challenges to Yemen's economy, severely impacting foreign reserves and exacerbating existing economic difficulties, including the IRG's fiscal position. Following the onset of the conflict in the Middle East in October 2023, regional tensions have escalated, and the Houthis were designated a Specially Designated Global Terrorist group by the United States on January 17, 2024. Such designation has potential negative effects on the financial sector, imports, and humanitarian operations across Houthi controlled areas, where about 70 percent of the population lives, and knock-on effects across all of Yemen.

1.2. Climate Trends and Future Projections

Yemen's climatic conditions have historically imposed significant constraints on economic development, determining population distributions and land use opportunities. The arid and semi-arid environment is characterized by high temperatures and low rainfall that is strongly influenced by the country's topography. The densely populated mountainous regions in the west have more temperate climates and receive more rainfall, with two monsoonal rainy and dry seasons annually, while the coastal and sparsely populated desert

3 International Crisis Group (2022). Brokering a Ceasefire in Yemen's Economic Conflict. Middle East Report N°231 [link]

4 World Bank (2024). Yemen Economic Monitor: Navigating Increased Hardship and Growing Fragmentation. Spring 2024. Washington, D.C. [link]

areas in the east experience more extreme heat and aridity. Historical temperatures generally exhibit wide ranges with annual temperatures averaging 25.54 °C (1991-2020). Average seasonal temperatures range from a minimum of 22.45°C in September to a maximum of 36.50°C in June, whereas average seasonal temperatures in the coolest months (November – February) range from a minimum of 12.93°C in January to a maximum of 28.90°C in November. Annual precipitation averages 189.81 mm at the national level but there are a range of regionally and seasonally distinct precipitation regimes. The western highlands receive the most rainfall, with an average of 200 to 600 mm per year, supporting the primary agricultural producing areas, while the coastal plains and eastern deserts often receive less than 50 mm annually, leading to arid conditions with scarce vegetation. As a result, Yemen is among the world's most water scare countries.

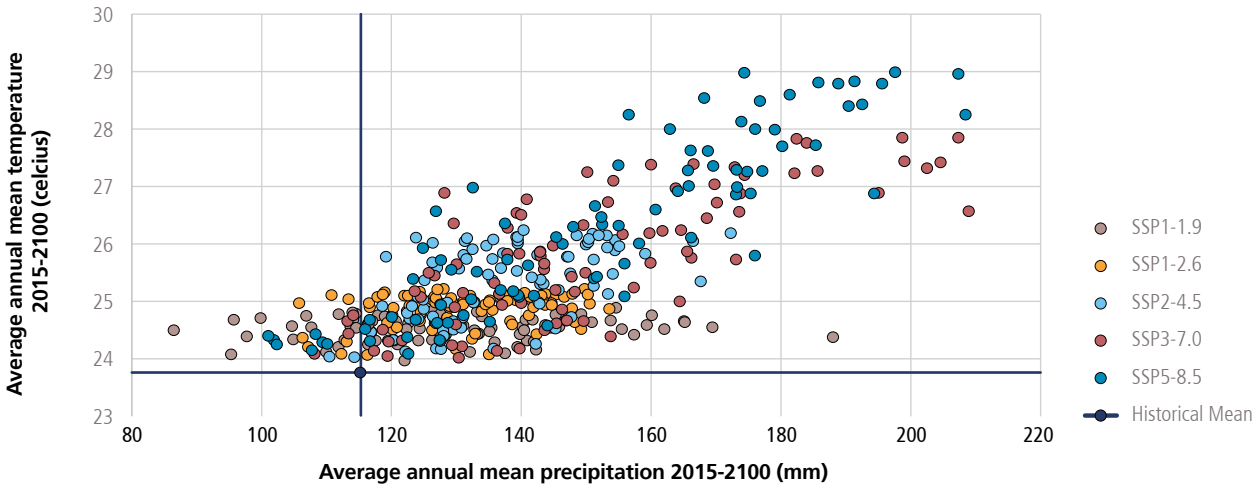
The higher elevation areas in the north and west of the country not only face higher average rainfall that the south and east but have also exhibited higher variation in rainfall anomalies. Precipitation data suggest that April to May and August to September are the two wettest seasons. In the past decade, the areas in the north and the west have experienced much higher variation in rainfall during the August to September season, most prominently in 2022 when the mean of 10-day rainfall in the north was over 90 mm compared to about 25 mm during the same months in the previous year. Similar trends are seen for the Palmer Drought Severity Index, which is much more severe in the northern and western areas, while the index oscillates around the mean in the south and east. These precipitation changes have led to severe droughts in Yemen with tens of lives lost in 2024 alone. Rainfall anomalies put pressure on areas like Marib where the water infrastructure is under increased pressure due to the influx of internally displaced people, increasing the population at risk downstream of critical infrastructure, such as the Marib Dam.

Historical trends suggest that Yemen's climate is already changing, with strong regional differences. Between 1971 and 2020, Yemen's mean annual temperature increased by 0.42°C per decade, although with large regional and seasonal differences accompanying a significantly increasing number of hot and humid days and nights. The northern interior regions observed the greatest temperature changes over this period during summer and fall months, with Al Jawf recording the highest annual average mean temperature increase (0.58°C per decade). By comparison, Aden observed the lowest average temperature increases. Over the same period, annual precipitation decreased (-6.25 mm per decade), although the lack of significance at the national level underscores the role of high annual and interannual variability. Trends also show strong regional variation, with the western and southwestern coastal regions observing significant decreases, mostly during summer and fall months. Al Hodeidah on the Red Sea has observed the largest total decreases in precipitation per decade (38.25 mm), although governorates outside the coastal Tihama zone and east of Abyan have not exhibited any significant annual or seasonal precipitation trends.

Yemen faces significant climate impacts, including increased temperatures and variability in precipitation, with significant regional variation. Model projections show a high degree of consensus around both increased temperatures but also increased precipitation compared to historical means (Figure 1.3). The national-level mean annual temperature is projected to increase by as much as 1.69°C by 2050 under more pessimistic scenarios (SSP3-7.0), with coastal governorates projected to experience greater mean temperature increases during winter and spring months, highland governorates during spring months, and eastern interior governorates during summer and fall. The island of Socotra has a mean anomaly of 1.18°C for 2040-2059. National-level annual precipitation totals are projected to increase by a median of 2.76 percent (-3.73 percent, 18.85 percent) under SSP3-7.0, although governorates in the Tihama and parts of the highlands are projected to experience precipitation increases between 5-10 percent annually by midcentury, with the highest being Aden at a median of 9.70 percent (-10.16 percent, 48.28 percent) above the historical reference period. Under the more optimistic scenarios (SSP2-4.5) precipitation is projected to increase by as much as 43 percent, with significantly wetter conditions expected across large parts of the country. Governorates tend to experience their greatest seasonal precipitation percent increases around their wettest months at median rates higher than 10 percent, with many seasonal shifts already occurring

during 2020-2039, except in Al Jawf, Marib, Hadramawt, and Al Mahrah. Hajjah in the Tihama is projected to experience the largest median increase by midcentury of 26.30 percent (3.93 percent, 52.79 percent) during summer months. Several governorates with high elevations, such as Sana'a, are expected to endure conditions characteristic of different climatic zones by midcentury.

Figure 1.3. Multi-Model Ensemble of Temperature and Precipitation Projections for Yemen



Source: Original for this publication based on World Bank Climate Knowledge Portal data

The changes in temperature and precipitation are predicted to be accompanied by increased variability, with longer, hotter dry periods and more frequent, intense precipitation events. The number of hot days above 35 °C is projected to increase in coastal and interior regions, particularly during spring and fall months. Greater mean temperature increases are expected in coastal governorates during winter and spring months, and during summer and fall in the eastern interior governorates, while governorates in the highlands are projected to experience the greatest year-round increases in summer days. Al Hodeidah is projected to experience the greatest increase in hot days, by 46.29 (16.24, 71.89) by mid-century. More frequent, extreme precipitation events are also expected by the mid-century, with all governorates except the easternmost governorates projected to be at least twice as likely to experience an increase in 5-day cumulative precipitation amounts and 100-year historical return periods by mid-century, while the central and southern highlands are expected to experience the largest changes in average largest 5-day precipitation by midcentury. Such changes in extreme events have implications for water and food security, pose risks for flood-related safety and critical infrastructure, while also exacerbating challenges for human capital.

Yemen's contributions to global emissions are minimal, accounting for an estimated 0.05 percent of total emissions. Total GHG emissions have halved from a peak of nearly 53 MtCO2e in 2009 to an estimated 26.61 $MtCO_2e$ in 2021, placing Yemen 119th in terms of the country's contribution to global emissions.[5] Emissions per capita have also shown a significant reduction due to the conflict, having reduced from a peaked of 2.14 tCO_2e per person in 2003 to an estimated 0.82 tCO_2e per person in 2021, significantly lower than the global average. The energy sector represented approximately 53 percent of total GHG emissions in 2021, primarily from fossil fuel use for electricity and transportation, down from a peak of 80 percent in 2009, with the contribution from agriculture having increased from 14 percent in 2003 to 30 percent in 2021. The Interim NDC includes GHG-related targets, with Yemen having set both an unconditional and conditional target of 1 percent and 14 percent reductions below BAU projections by 2030, respectively. Both targets

5 WRI (2022). Climate Watch: Historical GHG Emissions. Washington, DC: World Resources Institute. [link]

cover the energy-related categories only. In pursuing these targets, Yemen has prioritized energy efficiency and renewable energy as means to support economic development and fulfil these targets, representing an estimated total cumulative GHG reduction of about 35 $MtCO_2e$ from 2010 through 2030 under the conditional scenario compared to the BAU scenario.[6]

1.3. The Development, Conflict, and Climate Nexus

The cascading effects of climate change are compounding the challenges facing Yemen, creating a complex nexus around development, conflict, and climate. Fragile, conflict and violence (FCV) affected countries are not only disproportionally exposed to climate change, but they also lack the capacity to cope with its effects. Underlying fragilities amplify the impact of shocks, in particular in agriculture, with FCV affected countries suffering more severe and persistent GDP losses than other countries due to climate shocks. Cumulative GDP losses are estimated at about 4 percent after three years of a disruptive extreme weather event in FCV affected countries, compared to about 1 percent in other countries, with worsening drought conditions having a larger and more persistent impact in FCV than non-FCV countries over the longer term.[7] In Yemen, the increasing frequency and severity of exogenous shocks has eroded the resilience of local communities and their ability to recover from climate related events, such as floods and droughts. Having depleted savings and sold off assets, and with fewer options left to deal with adverse shocks, many households cannot afford to re-invest in low-value crop production following droughts and are adopting last-resort—often destructive—coping strategies.

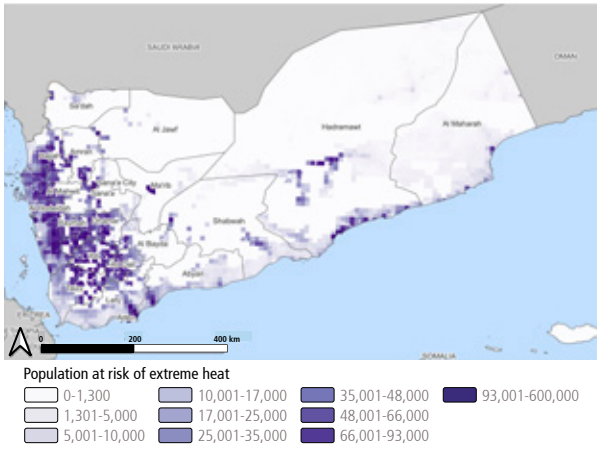
Climate shocks also have the potential to worsen underlying fragilities, exacerbating existing tensions, grievances, and inequalities, leading to forced displacement and increasing competition over natural resources. While climate shocks may not trigger the onset of new conflict, they can exacerbate conflict intensity where it already exists and fuel existing FCV dynamics, especially when social exclusion, poor governance, a lack of basic services, and other contextual factors are present.[5] Prior to the conflict, local competition over land and water resources were responsible for up to 4,000 deaths annually in Yemen.[8] Climate induced changes in temperature and precipitation, coupled with internal displacement, can add pressures on land and water resources, host communities and urban infrastructure, exacerbating community level tensions and increasing the risk of conflict. In 2023, over 50 percent of survey respondents were aware of conflicts relating to the scarcity, access, and distribution of natural resources,[9] with community consultations for the CCDR highlighting disputes over well locations and water for irrigation. In contrast, an increase in cumulative precipitation can act as a catalyst to decrease the risk of conflict with more potential for rainfed agriculture, with global estimates suggesting a 10 percent increase in monthly rainfall is likely to decrease the risk of conflict incidence by 0.03 percent[10] as the population engages in economic activities ushered in by this increase in water resources. An analysis of the correlation between the incidence of conflict and precipitation changes with food insecurity in Yemen suggests that there are significant spatial differences and that investments that help adapt to climate shocks are more important in areas with higher conflict (Box 1.1).

Half of the population in Yemen are exposed to at least one climate hazard with significant regional variations, with 2.2 million people in 20 districts exposed to at least three climate hazards. The majority of individuals exposed to either extreme heat, drought, or flooding are concentrated in the western coastal plains and the south-west highlands (Figure 1.4), with 38 districts in 13 governorates making up 50 percent of the

6 EPA (2022). Climate Change Mitigation Profile. Yemen Environment Protection Authority.
7 IMF (2023). Climate Challenges in Fragile and Conflict-Affected States. IMF Staff Climate Note 2023/001, International Monetary Fund, Washington, DC. [link]
8 IMF (2023). Climate Challenges in Fragile and Conflict-Affected States. IMF Staff Climate Note 2023/001, International Monetary Fund, Washington, DC. [link]
9 Hales, G. 2010. Under pressure: Social violence over land and water in Yemen. Yemen Armed Violence Assessment (YAVA): Issue 2 October. [link]
10 Coulibaly, T.Y, and Managi, S. (2022). Identifying the impact of rainfall variability on conflicts at the monthly level. Sci Rep. 2022 Oct 28;12(1):18162. [link]

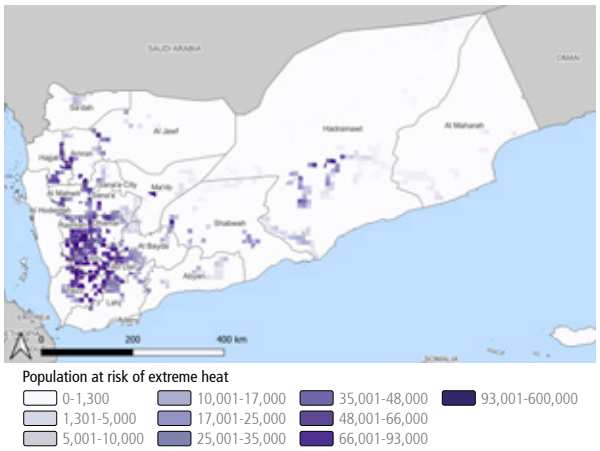
people exposed to climate hazards. Al Hodeidah, Ibb and Taizz governorates exhibit the highest exposure. An estimated 7.2 million people are exposed extreme heat, mostly concentrated along the western and southern coastal plains (Figure 1.5), with 7.4 million people exposed to flooding concentrated in the south-western part of the highlands (Figure 1.6) and 6.7 million are exposed to drought in the north-western coastal plains and the south-eastern leeward side of the highlands (Figure 1.7). There is geographical overlap in areas where people are exposed to extreme heat and drought, implying that the average probability of a compound shock involving extreme weather events is likely to be much higher in some areas, particularly along the north-western coastline. When also considering exposure to conflict related events, the vulnerabilities levels are likely to be even higher.

Figure 1.4. Distribution of Population Exposed to One Climate Related Hazard



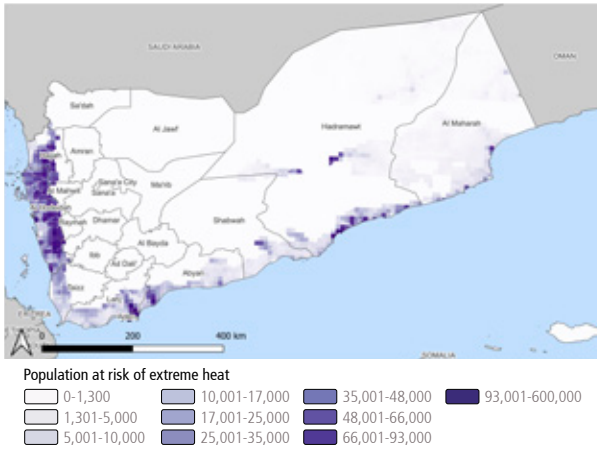
Source: World Bank (2024)[11]

Figure 1.6. Distribution of Population Exposed to Flooding



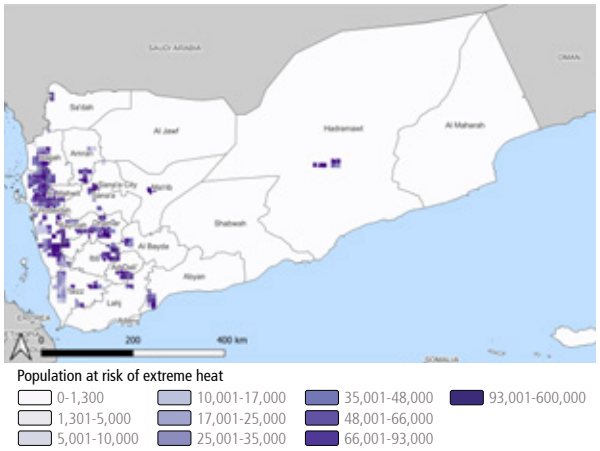
Source: World Bank (2024)9

Figure 1.5. Distribution of Population Exposed to Extreme Heat



Source: World Bank 2024[9]

Figure 1.7. Distribution of Population Exposed to Drought



World Bank 2024[9]

11 World Bank (2024). Yemen Poverty and Equity Assessment: Living in Dire Conditions. Washington D.C. World Bank. [link]

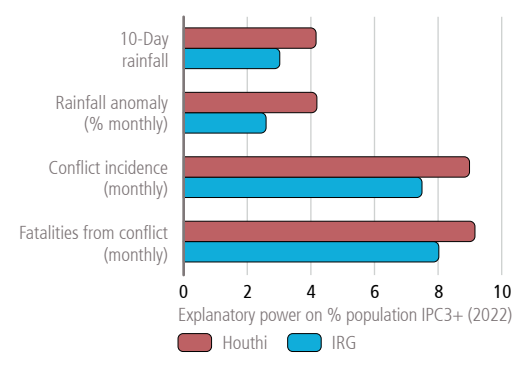
Box 1.1. Unpacking the Development-Conflict-Climate Nexus – the Role of Conflict and Climate Shocks in Development in Yemen?

An analysis was carried out to explore the relative sensitivity to conflict and climate shocks in Yemen. This uses granular monthly, governorate-level data from 2015-2021 to examine the links between the roles of conflict, climate, and development. Satellite and remote-sensing data (nighttime lights and precipitation), data on conflict incidences at the local level (ACLED), in combination with random forest machine learning algorithms were used to test how strongly the three elements of the nexus are connected. Although the results of this analysis do not represent a causal relationship, they are important to quantitatively understand the presence of any relationship.

Conflict fatalities and incidences, and precipitation variations, are significant predictors of extreme food insecurity in Yemen. Figure B1.1 compares the relative influence of the intensity of conflict and precipitation on percentage of food insecure population (IPC3+) in Houthi and IRG governorates. Development indicators like food security are the culmination of multiple factors that range from financial, structural, to institutional; they are also impacted by conflict and climate shocks. By comparing the two factions on the relative importance of conflict and precipitation on development indicators, the results help explain their vulnerability. Both conflict and precipitation have relatively higher influence on food insecure populations in Houthi governorates as compared to IRG governorates. It also shows that human development in Yemen is more sensitive to deviations in conflict than it is to climate shocks. Meaning that the damages the conflict is leading to are greater than those of the climate since the onset of the conflict. The influence of precipitation in the Houthi areas has more predictive power over development than IRG area, likely because of fewer coping strategies due to the ongoing conflict and despite the more productive higher elevation land that should make them more resilient.

This substantiates why climate adaptive investments in Yemen need to be resilient to the conflict scenario. Investments that help adapt to climate shocks are far more important in areas with higher conflict, as Houthi governorates have higher sensitivity to precipitation. This is positive for the country as Yemen has limited capacity to mitigate climate change at a global scale. If development was highly sensitive to changing climate, there was little Yemen could do to moderate local level challenges. But since conflict has higher explanatory power, it means that investments in infrastructure, institutions, and information systems that account for the political scenarios and are conflict resilient can boost development overall, even more so in Houthi areas.

Figure B1.1. Importance of Conflict Incidence and Precipitation Changes in Explaining Food Insecurity in Houthi and IRG Governorates.



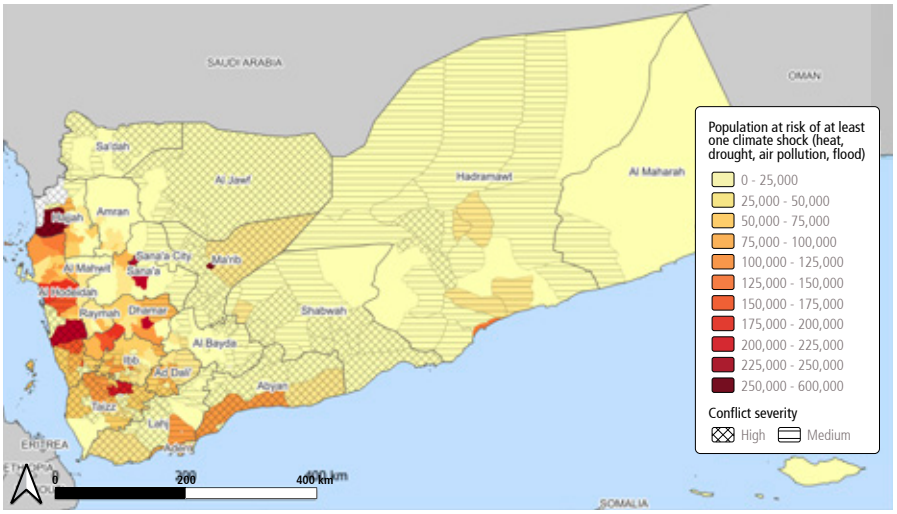
Note: Random forest model using monthly data from 2015-2021 and share of governorate population food insecure IPC3+ in 2022.

Source: Original for this publication based on data from NTL, IPC, WFP, ACLED.

The vulnerability of almost 10 million people exposed to climate hazards is compounded by effects of food insecurity and has a strong spatial dimension. On average, 51-percent of the population were exposed to acute food insecurity (IPC Phase 3+) in 2022, with 26 percent of Yemenis living in areas subject to food

security crisis and exposed to at least one extreme climate-related hazard (Figure 1.8). Those individuals exposed to both one climate related hazard and food insecurity are largely located in the western coastal plains and the central highlands. The top five districts that see the highest number of individuals affected by potential compounding shocks are Marib city in Marib governorate, Abs in Hajjah governorate, Bani Al Harith and Sanhan wa Bani Bahlul in Sanaa governorate, and Bayt al Faqih in Al Hodeidah governorate. Combined, these districts are home to more than one and a half million Yemenis exposed to compounding shocks. These spatial vulnerabilities to climate are compounded by conflict-driven displacement and damage to infrastructure. These conditions pose risks to human safety, health, and critical infrastructure, accentuated by the large-scale displacement of vulnerable populations who have moved to urban areas in large numbers that far exceed the service capacity. Most of the districts that see the highest exposure to at least one climate-related hazard and food insecurity are also heavily affected by the conflict. More than half (28) of the 50 districts with the highest populations exposed to climate shock and food insecurity are also considered to be high or medium intensity conflict districts based on ACLED recorded conflict events.

Figure 1.8. Individuals Exposed to One Climate-Related Hazard and Food Insecurity, with District Level Conflict Intensity



Source: World Bank (2024)[12]

1.4. Dealing With the Uncertainty of Yemen's Development Model

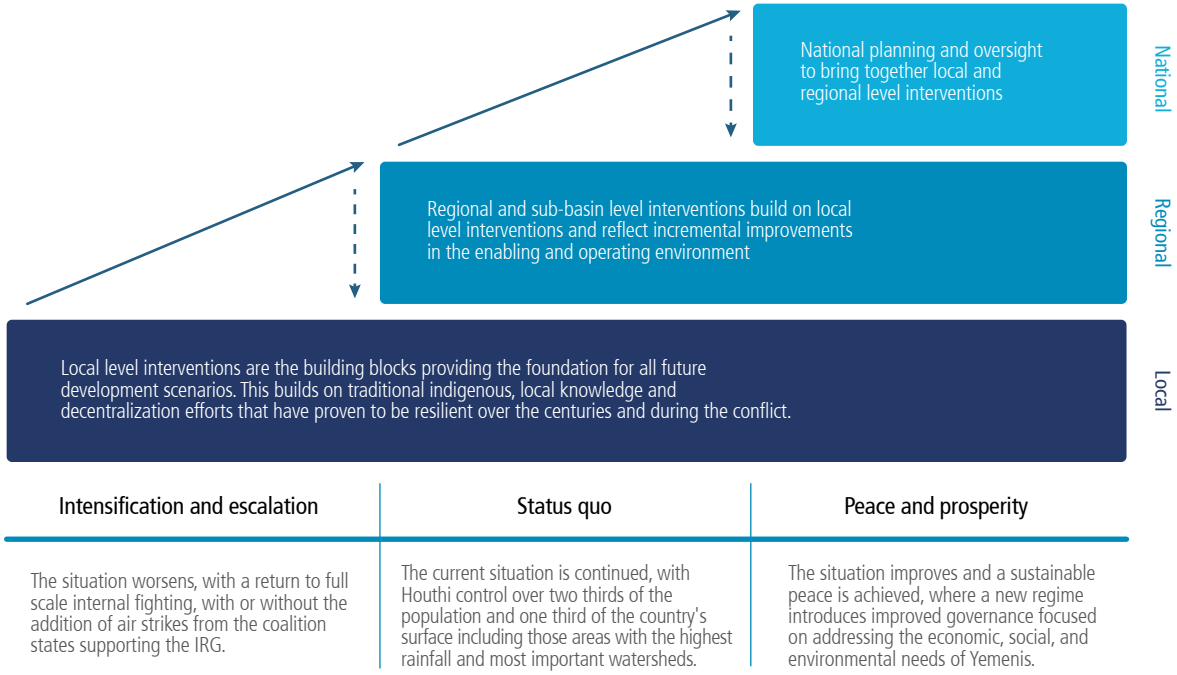
Given the uncertain future facing Yemen, there is a need for robust and adaptive, risk informed decision-making. The continued lack of clarity around Yemen's political future, as well as the evolving social expectations coupled with the implications of climate change, make for a highly unpredictable operating environment. Given future prospects are unlikely to follow a simple linear trajectory, it is necessary to rely on risk-informed decision-making processes that can adapt to the dynamic nature of the conditions in Yemen. Such a scenario-based approach is structured around a range of different, potentially plausible, future scenarios. These can lay the foundations for a risk-informed investment framework that can support an incremental process of rehabilitation and reconstruction, that has the potential to leverage green, resilient, inclusive development. Informed decision making needs to factor in considerations around the enabling political context, implications on financial resources and their mobilization, the likelihood of private sector engagement, human capacity and development, among others.

12 World Bank (2024). Yemen Poverty and Equity Assessment: Living in Dire Conditions. Washington D.C. World Bank. [link]

A scenario-based approach built around three potential pathways for Yemen's future development has been developed to address the uncertainty. These scenarios reflect different trajectories that allow for risk-informed decision-making and include "Peace and Prosperity", "Status Quo" and "Escalation and Intensification". While the magnitude of the physical climate-related hazards under these three scenarios is the same, the impact of these hazards and Yemen's level of vulnerability is assumed to be different, as will the potential interventions and response mechanisms. Each scenario is categorized by a set of assumptions on the development narrative, the average annual growth in GDP per capita for the next 30 years (2023-2050) and the fiscal capacity to adapt (Table 1.1). The "Status Quo" scenario represents a "modest-to-moderate-growth" future for Yemen with a continuation of the status and some adaptation measure, while the "Peace and Prosperity" scenario represents an aspirational "high-growth" future and the "Escalation and Intensification" scenario a "growth-decline" future in which the situation worsens as political tensions escalate, leading to full-scale hostilities and violence, with the potential for further fragmentation.

The scenario based approach provides the basis for a risk informed framework for building resilience to climate change. Each scenario allows for a certain level of preparedness/readiness to face climate change. The level of intervention reflects the geographic scope within which climate actions might be realized (Figure 1.9). All of these build on the foundations provided by basic humanitarian support aimed at building resilience among households and local communities to exogenous shocks. For example, a peace and prosperity scenario would allow for uniform country interventions, along with local interventions at the community level, while an intensification of the conflict would limit the entry points to those community level interventions aimed are increasing resilience at the local level to a range of exogenous shocks. While not representing political predictions or development forecasts, the scenario-based approach provides a useful framework for exploring different policy options that allow flexibility to respond to the deep uncertainty around the country's future governance arrangements and to inform thinking about how to design them accordingly.

Figure 1.9. The Scenario Based Approach to Building Resilience.



Source: Based on World Bank (2024).[13]

13 World Bank (2024) Charting the Course - A Water Security Diagnostic for Yemen. Washington, DC. World Bank. [link]

Table 1.1. Description of Potential Future Scenarios Used in the CCDR.

Peace and Prosperity	Status Quo	Escalation and Intensification
A settlement is achieved between the warring factions and de facto and/or de jure authority are consolidated around a single set of central state institutions.	A continuation of the current situation where the conflict persists along the trajectory it has followed since 2015, with no political settlement.	A deterioration of the current situation with increasing political animosity and escalation of the conflict to full-scale internal hostilities and violence.
Characterized by a political settlement that would either enshrine de jure decentralization or lead to de facto decentralization, resulting in a number of semi-autonomous regions with divided territorial control and overlapping formal and informal institutional frameworks.	Characterized by occasional low-to-medium intensity conflicts and violence; the Houthi continue to exercise control over two-thirds of the population and one-third of the country's territory; the IRG continue to rely on external financial support with IRG areas remaining fragmented, administratively, and politically, with persistent instability and rivalries.	Characterized by further restrictions and operational difficulties in both Houthi and IRG areas, each being increasingly focused on exercising dominion over land and control of civilian and economic interventions, with a lack of concern for environmental and sustainable management of natural resources and renewed prospects of interventions from regional and international actors that would eventually lead to the formalization of fragmentation into several entities
Governance improves, notwithstanding the above, allowing for national, regional and local level activities to be implemented and a renewed focus on addressing the economic, social and environmental needs of all Yemenis.	Governance continues to be fragmented, limiting the ability for national interventions with a continued focus on regional and local interventions implemented through third parties and a limited ability to address the economic, social and environmental needs of all Yemenis.	Governance deteriorates with increasing fragmentation, limiting the ability for national and regional interventions and a limited focus on local interventions implemented through third parties aimed at sustaining only the most essential of basic services.
International support would likely increase, increasing the potential to shift from humanitarian assistance to longer term development supported by increased potential access to climate financing	International support would continue to focus on the humanitarian response and contribute to the provision of basic services but likely decline due to fatigue and competing global priorities, undermining the country's potential to mobilize development assistance or access to climate financing	International support would continue to focus on the humanitarian response and contribute to the provision of basic services but likely decline due to fatigue and competing global priorities, undermining the country's potential to mobilize development assistance or access to climate financing.
Public and private sector investment would increase, driven by national and international companies, with increasing Foreign Direct Investment and the removal of financial controls	Public and private sector investment would continue to stagnate and be limited to small and medium sized local companies with little Foreign Direct Investment with continued uncertainty around financial controls	Public and private sector investment would decrease and be limited to micro- and small-enterprises, focusing mainly on provision of essential services (water, energy, food etc.) with little, if any, FDI and increasing financial restrictions.

Peace and Prosperity	Status Quo	Escalation and Intensification
GDP growth would increase over current levels to average 5 percent annually and the economy would strengthen under a unified currency and increased stability	GDP growth would stagnate at around 2 percent and the economy would continue to be fragile, fragmented and unstable	GDP growth would decline rapidly to around 4 percent per year and the economy would weaken further, with increasing fragmentation and instability.
Poverty rates would fall to levels approaching those seen pre-conflict.	Poverty would continue to rise due to the continued instability and violence leading to an increase in internal displacement and migration with corresponding increases in unemployment and poverty rates.	Poverty would increase rapidly with a rise in mortality and infrastructure destruction, resulting in a decline in basic services, and increasing hunger, disease, displacement, and large-scale migration.

Source: Original for this publication.

Yemen © Davor Lovincic / iStock

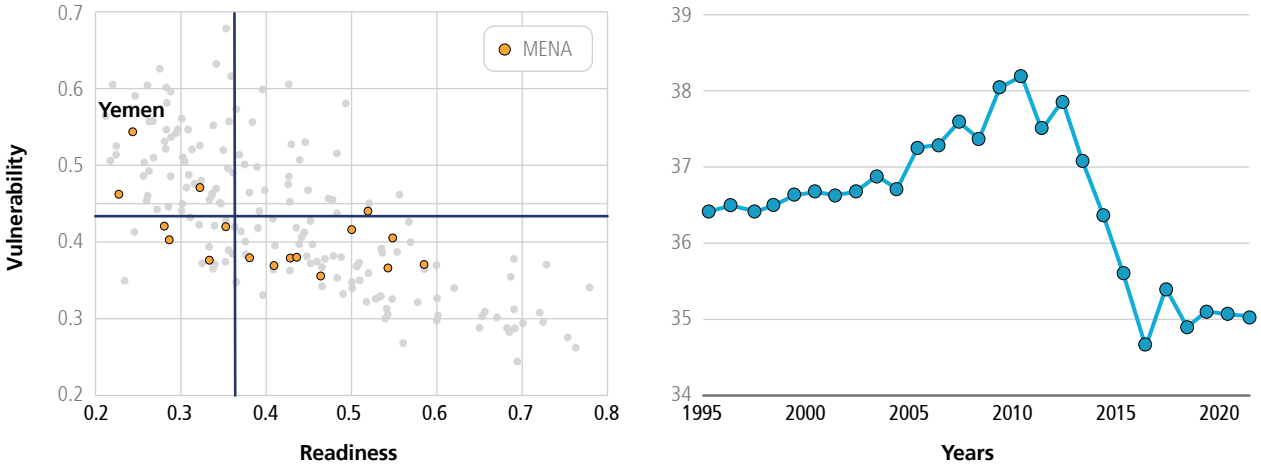
2. Climate Commitments, Policies and Engagement

2.1. Yemen's Readiness and Resilience to Climate Change

Yemen is the most vulnerable and least ready country in MENA to deal with the challenges of climate change. The country's readiness to respond to climate challenges has declined significantly over the last decade (see Figure 2.1), mainly due to the conflict, and in 2022 Yemen ranked the 27th most vulnerable country globally and topmost in MENA.[14] Vulnerability in Yemen is characterized by limitations on water and food security, increasing health issues like cholera, lack of ecosystem services preventing biodiversity loss, and weakness in habitats and infrastructure. Several of these systems in the country have high exposure to climate change, independent of the socioeconomic context, and are simultaneously aggregated in areas with high a concentration of population. These sectors also have very low sustainable adaptive capacity and thus easily succumb to shocks in climate and social situations, exacerbating the impact of both.

Building a society that is prepared for the impacts of climate change and that can respond effectively to the challenges it presents requires a comprehensive approach. Such approaches to build readiness and resilience are often challenged by institutional fragility, poor service delivery, and limited technical and financial resources. Moreover, climate change can strain government capacity, damage critical infrastructure, consume public resources, and undermine development prospects. FCV-related challenges can weaken the ability of governments and communities to respond to climate change, while also fostering fear and mistrust, making it difficult for governments and communities to work together to address shared social and environmental challenges. A lack of social cohesion, low trust in government, and poor community ties further limit opportunities for equitable climate action. Ensuring the appropriate institutions are in place, supported by adequate infrastructure and the data and information required to make risk informed decisions are critical for creating a robust framework to manage the effects of climate change in countries facing fragility and conflict, where the risks are often compounded by weak governance, lack of resources, and social tensions.

Figure 2.1. Yemen's (a) Vulnerability and Readiness to Climate Change and (b) ND-GAIN Score Over Time



Source: Original for this publication based on Notre Dame Global Adaptation Initiative (ND-GAIN) Country Index and World Bank FCV country data.

14 2021 Notre Dame Global Adaptation Initiative (ND-GAIN) Country Index [link]

2.2. Climate Change Governance and Adaptive Capacity

Addressing the governance arrangements at the intersection of development, conflict and climate change is crucial for ensuring that climate action is effective and equitable. Failing to acknowledge and integrate FCV related issues can stall progress on climate action, lead to maladaptation and increase the risks associated with fragility, conflict, and violence. This can render climate actions ineffective and unintentionally serve to reinforce, redistribute, or create new sources of vulnerability, worsening local grievances, creating negative externalities, and further marginalizing vulnerable regions and social groups. A 2023 survey of rural communities on climate change coping strategies, revealed that roughly 70 percent of more than 2,000 respondents indicated that they would sell land, switch from agriculture, or consider migrating, and 28 percent indicating that they would deepen wells to secure more water.[15] Addressing these challenges will require establishing comprehensive policies that address climate change mitigation and adaptation, developing institutions at the national, regional, and local levels that are specifically tasked with implementing climate change policies and coordinating between different sectors and stakeholders, and securing funding and financing for climate change initiatives while also enhancing the data, information, skills and knowledge to effectively respond to climate change.

Despite the challenges, Yemen has shown a strong commitment to climate action and outlined an ambitious agenda that places development needs at the center of Climate Action Pathways. Yemen has been a party to the UNFCCC since 1996 and adopted several policies, plans, and communications. The Initial National Communication submitted in 2001 provided the foundations, followed by preparation of a National Adaptation Programme of Action (NAPA 2009) and submission of the second national communication in 2013, it's Intended Nationally Determined Contribution (INDC) to the UNFCCC in 2015, the first biennial update report in 2017, and Third National Communication (TNC) in 2018. The INDC established a target for reducing greenhouse gas emissions 14 percent by 2030, in addition to sector-specific adaptation measure. The TNC updated the greenhouse gas mitigation scenario and identified strategies for a 26 percent reduction of 2010 emissions by 2040, focusing primarily on energy production and the transportation sector. The latest communication also expands the three critical adaptation sectors (water resources, agriculture, coastal zones) identified by the 2009 NAPA to include public health and biodiversity. A new Nationally Determined Contribution is being prepared and the Climate Change Unit is drafting an action plan for an updated national adaptation program, both of which are expected in 2025.[16]

This ambitious agenda provides guidance to the institutions, infrastructure and information needed to build resilience to climate change and support adaptation efforts within a range of potential future scenarios. These can be seen as part of a broader strategy to build resilience by integrating natural and engineered solutions and position Yemen towards development of climate resilience, as outlined in the National Dialogue Conference (2013-2014), upholding democracy, freedom, rule of law, human rights and good governance.[17] There are opportunities to help to lay the foundation for a more sustainable and resilient future that can respond to uncertainty, build on the strength and legitimacy of Yemen's traditional practices and institutions, while informing the evolution of new hybrid governance arrangements. Committed international support for investments in Yemen's future development will be essential, with opportunities to focus on green resilient recovery, while also addressing the ongoing conflict and humanitarian crisis. By focusing on the institutions, information and infrastructure need to build resilience across different levels, Yemen can better adapt to the current and future impacts of climate change, reduce the risk of disasters, and support sustainable economic development.

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15 World Bank (2024) Charting the Course - A Water Security Diagnostic for Yemen. Washington, DC. World Bank. [link]

16 Al-Sarari, L. (2023). Yemen's Climate: From Tree Day to the Race of the Tortoise and the Hare. Assafir Al-Arabi. [link]

17 United Nations (2014) Yemen National Dialogue Conference. Office of the Special Envoy of the Secretary General for Yemen. [link]

Effective institutions are critical for creating and enforcing policies that promote resilience and adaptation. The Ministry of Water and Environment (MWE) is responsible for planning and implementing strategies to manage climate risks, mobilizing resources, and coordinating actions across different sectors and levels of society, through coordination by the Climate Change Unit (CCU) at the Environment Protection Authority (EPA). There are a number of ministries, technical agencies, local authorities, academic and research institutions, civil society and private sector stakeholders involved in climate related activities, particularly those active in sectors like water, agriculture, and energy. Local institutions, municipalities and organizations play a key role in implementing adaptation and mitigation strategies at the community level and building resilience, with local, national, and international non-governmental organizations supporting climate change related projects, awareness campaigns, and community mobilization. There are also a wide range of international organizations, including the United Nations, the World Bank, and a number of other bilateral partners that provide essential funding and technical assistance.

The cross sectoral nature of adaptation and mitigation measures requires institutions that can foster collaboration among various stakeholders to ensure a cohesive response to climate change. The National Climate Change Committee (NCCC) was officially launched in 2009 and updated in 2023, with responsibility to oversee the Climate Change Coordination Mechanism (CCCM), which consists of three levels: (i) The high level Climate Change Committee (referred to as the Council or Board) chaired by the Minister of Planning and International Cooperation or by the Minister of Water and Environment; (ii) The Technical Committee chaired by the EPA Chairman; and, (iii) the Sub-technical Committees, one of which is specialized on Climate Change Adaptation and DRR and DRM. Other Sub-technical Committees support low GHG emission development. The Sub-technical Committees are working groups consisting of technical professionals from different Governmental and Non-Governmental Organizations and entities. The Sub-technical Committees is intended to guide the Technical Committee and the Climate Change Unit on technical climate change adaptation and mitigation items and issues. The Climate Change Unit serves as the Executive Secretariat to the CCCM and is the UNFCCC Focal Point. While the structure of the CCCM has been endorsed by the Government, only the CCU has been established.

The capacity of Yemen's institutions to respond to the impacts of climate change has been eroded by the protracted conflict. The conflict has resulted in fragmentation of central level institutions across political divides and created parallel reporting lines for decentralized institutions, with local institutions and communities providing the foundations for building resilience and adapting to the impacts of climate change. Many institutions suffer from notable capacity constraints after years of conflict, with human and financial resources diverted to address immediate humanitarian needs and security concerns, leaving fewer resources available for long-term issues like climate change. Stakeholders across the board cite resource and capacity constraints for even the most basic of services, let alone climate related interventions that are often perceived as longer-term endeavors. Public institutions are underfunded and unable to maintain the human resources required to perform their functions, with a phone survey indicating that while 17 percent of respondents had a public-sector job before the conflict, this had since declined to around eight percent in 2023.[18] Not only has public-sector employment declined, but public-sector wages are paid irregularly, if at all, especially in Houthi-controlled areas. Focus group discussions with local policy makers carried out for the CCDR highlight the impact of the lack of fiscal transfers and budgets on the development and implementation of climate resilience plans, and that while climate interventions by international partners are welcome, they are typically not anchored within systematic efforts towards planning for climate resilience at the local level.

18 Gansey, R.J., and Aghajanian, A.J. (2023). Monitoring Food Insecurity and Vulnera¬bility in Yemen: Results from the Yemen Mobile Phone Monitoring Survey - Round II. Washington, D.C.: World Bank Group. [link]

While Yemen has the institutional architecture in place to effectively manage climate related risks, the capacity of these institutions and their coordination have been limited. There are a number of ministries and authorities that play important roles in Yemen's Disaster Risk Management (DRM) in Yemen, including the Civil Aviation and Meteorology Authority (CAMA), Civil Defense Authority (CDA), Ministry of Public Works and Roads, and Ministry of Water and Environment, and National Water Resources Authority, among others. In particular, CAMA engages in climate monitoring and weather forecasts and provides weekly weather and climate bulletins to all relevant parties in Houthi and IRG controlled areas in Yemen. However, the coverage of interventions to strengthen and update CAMA's climate monitoring and weather forecast information systems have been inconsistent at best: for example, WMO's forecaster and technical training programs have benefitted mostly CAMA Aden and the Center for Weather Forecasting and Early Warning in Hadramawt, while CAMA Sana'a has limited access to WMO resources. Coordination and collaboration of DRM operations among authorities are weak, whereby CAMA's information provision does not always reach all stakeholders and beneficiaries in time and authorities rely on social media to inform decisions on response operations, if any resources are available to mobilize.

The data and information essential for understanding climate risks and vulnerabilities and responding effectively to climate-related hazards in Yemen are limited. This includes data on weather patterns, water resources, climate projections, and the impact of climate change on different sectors, all of which are critical to making informed, robust decisions that can ensure appropriate adaptations within the dynamic context of Yemen's future development trajectories in order to respond effectively to climate-related hazards. Such data and information also support the development of early warning systems, risk assessments, and educational programs to raise awareness about climate change. However, there are a number of challenges, particularly around fragmentation, as exemplified by the national agrometeorological network which is now managed by the Ministry of Agriculture, Fisheries, and Irrigation (MoAFI) in the south and the Ministry of Agriculture and Irrigation (MoAI) in the Houthi controlled areas. The National Water Resources Authority (NWRA) had 354 stations in 2010 which undertook meteorological and wadi flow measurements, among others. However, the hydrometeorological network has been greatly impacted by the conflict with 70 percent of its stations either not operational, destroyed or stolen.[19] Given the prevailing context, coordination and collaboration among authorities are weak, whereby information does not always reach all stakeholders and beneficiaries in time and many authorities rely on social media to inform decisions on response operations, if any resources are available to mobilize.

Yemen's poor data and communications network infrastructure and high cost of service severely limit its ability to respond to and manage the effects of climate change. Yemen faces increasingly limited telephone and internet access, penetration of fixed and mobile telecom services is extremely low and continues to decline, prices are extremely high, while access is suppressed by extremely low availability and affordability. Yemen had the highest cost of mobile data in 2020 compared to other countries in the Middle East and North Africa, while the penetration rate of mobile broadband services was the regions lowest (Figure 2.2).[20] The telecom sector has been severely impacted by the situation on the ground, with the provision of telecommunications services affected by sector fragmentation, the suboptimal legal and regulatory framework, uncertainty about spectrum allocation, and limited connectivity to global infrastructure, relying on expensive satellite connectivity for international communications. The limited or lack of internet connectivity undermines efforts and options to improve resilience through a number of pathways, including hindering the ability to interconnect between banks in Yemen and abroad, as well as their ability to provide mobile money services to customers, impair satellite and remote sensing technologies that are essential

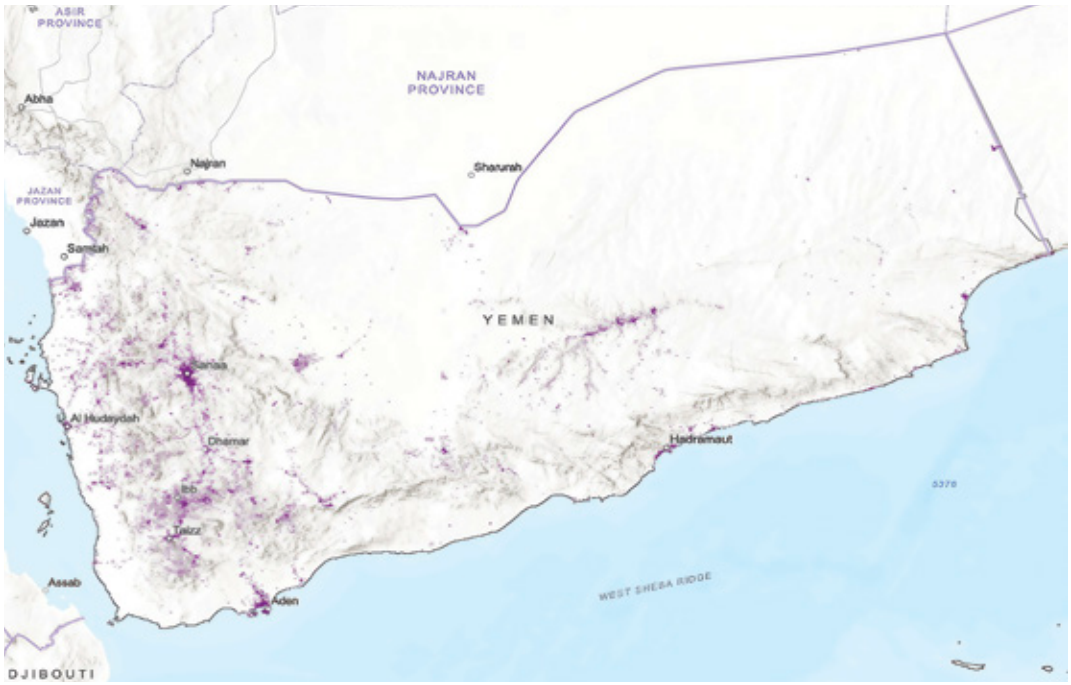
19 FAO (2017). Assessment of Hydrometeorological Stations in Yemen. Rome. [link]

20 ITU data and Macmillan Keck estimates / cable.co.uk, 2020 & Sana'a Center for Strategic Studies, Jan 2021

for monitoring environmental changes and implementing early warning systems, and prevent the adoption of smart technologies, such as smart grids and precision agriculture, can significantly enhance resilience to climate change.

The complex country context presents challenges for an effective governance in response to the challenges posed by climate change. The extended timeframe over which climate change unfolds requires a capability to sustain a credible commitment to climate policies, with the conflicting making it difficult to sustain the institutional environment required for effective climate governance (Figure 2.3). Effective institutions and governance help in achieving climate goals, with the actions required to address climate change needing coordination among many government and nongovernment actors. Coordination bodies can facilitate the complex task of aligning climate action across state and non-state actors. In the absence of such mechanisms, and a unified set of governance functions it is difficult to address the challenge of ensuring a credible commitment by establishing legally binding targets and translate climate policy into climate action. Despite the challenges, the Climate Change Unit has been able to advance on several key fronts, with support from a wide range of partners, advancing Yemen's obligations under international conventions and putting in place the necessary foundations for advancing the planning, budgeting, public investment, procurement, and intergovernmental fiscal systems that can help align public resources with climate policies.

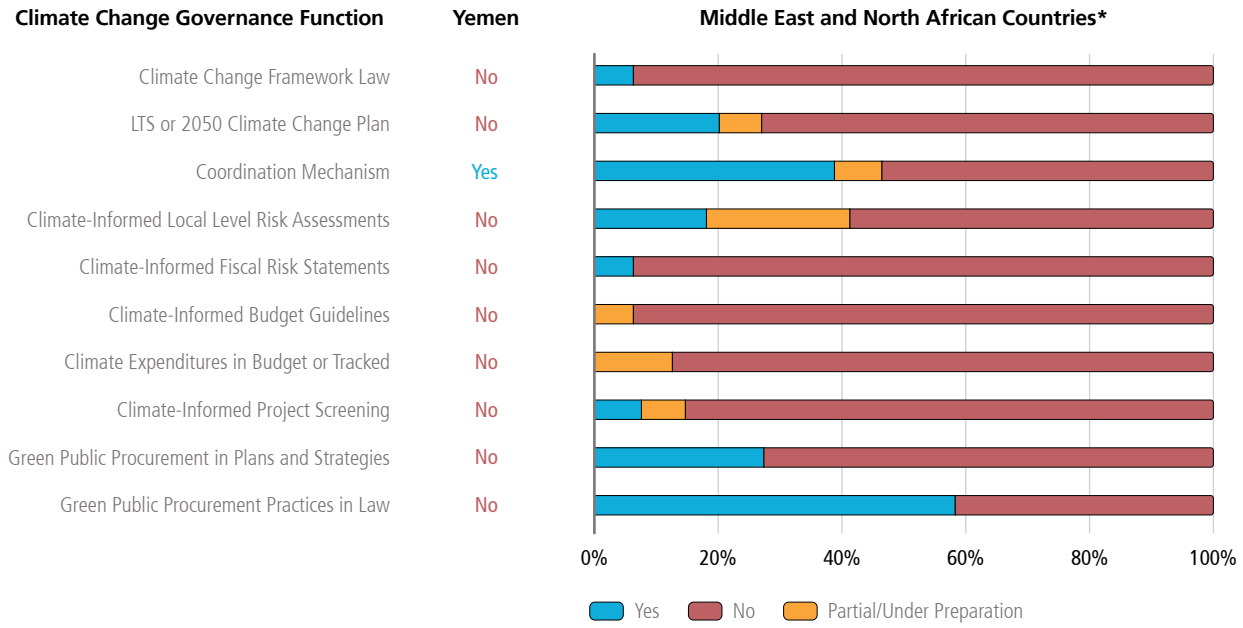
Figure 2.2. Broadband Speed Test Clusters in Yemen



Note: Map includes data from speedtest clusters (fixed and mobile) in Yemen with download speed ranging from >90 Mbps (dark) to <1 Mbps (light).

Source: Original for this publication based on Ookla data.

Figure 2.3. Climate Change Governance Indicators in 2022.



Source: Original for this publication based on Climate Change Governance Indicators, 2022.

2.3. Financing Climate Resilience in Yemen

The opportunities to finance climate resilience in Yemen are limited by structural issues compounded by the impacts of the conflict. Public sector resources were limited prior to the conflict, which has only worsened the situation and subsequently led to the collapse of public services, suspension of most public services and the majority of public salaries. The economic conflict between the Houthis and the IRG has split Yemen into two monetary and economic zones,[21] each with its own regulation and governance arrangements. In addition, there is little communication and coordination between the Central Bank (CBY) administration in Aden and the administration in Sana'a, leading to competing and incoherent fiscal and monetary policies that further weaken Yemen's economy. For instance, two different banknotes are used in the country. The Houthis in Sana'a and neighboring governorates have banned the use of the new currency issued by Aden, leading to two exchange rates for foreign currencies between old banknotes printed prior to 2024 and new banknotes printed after 2017, increased inflation rates, as well as an increase in transfer fees for businesses and households.[22]

The private sector in Yemen has been pivotal in sustaining the country's economy, especially in the face of conflict, emerging as the main source of employment, income, and livelihoods. Prior to the conflict, it was responsible for over 60 percent of healthcare services and a significant share of the agricultural GDP, producing 20-25 percent of agri-food products. However, structural vulnerabilities, such as the prevalence of family businesses and the fragility of MSMEs, have rendered the private sector less resilient to recurrent crises. Other issues, such as economic fragility, underdeveloped institutions, inconsistent parties, corruption, and crony capitalism, have made legal protections and decision enforcement costly

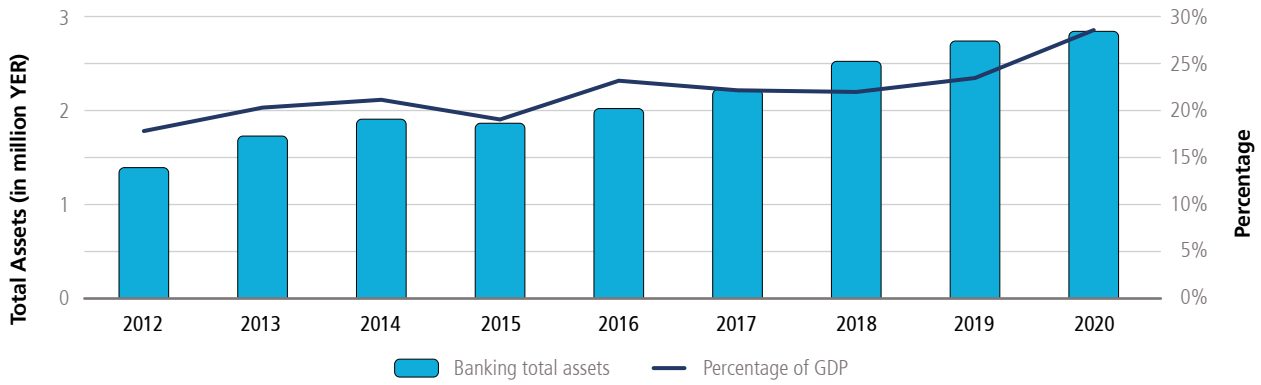
21 The internationally recognized government relocated the central bank headquarters to Aden in September 2016 while the Houthi movement rejected the move and continued central bank operations in Sanaa. [link]

22 Al-Akhali, R., Saab, M., and Sacchetto, C. (2021). Options for an economic track of the Yemen peace process. State Fragility Initiative Working Paper. [link]

and ineffective, further eroding the capacity and confidence of the private sector. The workforce is largely under-skilled, with a majority having only primary education, leading to a skills mismatch, While the absence of a strong financial market, limited innovation, and minimal ICT usage further hinder progress. The entrepreneurial environment suffers from ineffective social capital and a lack of shared vision, trust, and collaboration, which are vital for inclusive growth, with entrepreneurs depending on personal networks with those in power, which favors family-owned businesses but does not benefit the broader community. The conflict has only served to exacerbate these issues, leading to fragmentation and discoordination within government institutions, macroeconomic instability, market distortions, damaged infrastructure, and limited law enforcement.[23] The duality in governance systems has also resulted in many private investors facing a risk of double taxation due to the disparity of customs and tax controls.[22, 24] Economically, the conflict has been catastrophic, with the private sector losing US$27 billion in the three years,[25] leading to business closures, downsizing, or relocation, with survivors facing numerous operational challenges, including political instability and trade restrictions.

The financial sector in Yemen has been significantly impacted by the conflict, leading to severe economic challenges, disruptions in fiscal management, and difficulties in the banking sector. The main financial players operating in Yemen are banks and money exchangers. Insurance companies, pension funds, and other traditional intermediaries play only a marginal role in a cash-dominated economy.[26] The sector is composed of at least 24 financial institutions, including six state-owned banks, ten Islamic banks, four commercial banks, three microfinance institutions, and four foreign bank branches.[26] Bank assets have increased as a share of GDP (Figure 2.4). However, net loans as a share of total assets have declined from 12 percent in 2012 to only 6 percent in 2020.[26] Regulatory fragmentation and an increasingly high-risk economic climate are driving many banks toward liquidation, especially state-owned and non-Islamic private banks. These have experienced a decrease in loans and a corresponding increase in government securities as a share of total assets.[26] With two central banks in operation, the status of these government securities holdings is ambiguous. No interest has been paid on them, nor has any provisioning been made. The Anti-Usury Law introduced by the Houthis further complicates the status of these securities. Should they be deemed illegitimate, significant write-offs would be necessary, exacerbating the financial sector's instability.

Figure 2.4. Total Banking Sector Assets in Yemen.



Source: Original for this publication based on World Bank data.

23 YPSC. (2020) Policy Framework to Mitigate the Impact of the Conflict on Yemen's Private Sector. Yemen Private Sector Cluster [link]
24 World Bank (2023). Yemen Country Economic Memorandum: Glimmers of Hope in Dark Times. Washington, D.C: World Bank. [link]
25 CSO (2020). Promoting Partnership with the Private Sector, Central Statistical Organization Socio-Economic Update, Issue (53) October, 2020. [link]
26 World Bank (2024). Yemen Financial Sector Diagnostics. Washington, DC: World Bank. [link]

Fragmentation and conflict have eroded public trust in banks, precipitating a crisis within the domestic financial sector and reducing the capacity of the banks to meet client demands. This has resulted in massive capital outflows, weak investment by the private sector, and the imposition of severe restrictions by fiscal and monetary authorities. For instance, credit provided by the banking sector to the private sector dwindled from 5.6 percent of GDP in 2014 to 1.4 percent by the end of 2022.[27] Foreign grants and loans from multilateral development partners are frozen, and banks have stopped purchasing public debt. It is estimated that up to 3.5 trillion rials (over US$4 billion), around 49 percent of the total money supply, are circulated outside the formal banking sector.[28] This situation has triggered currency speculations, the evasion of financial monitoring and auditing apparatuses in both regions, and the freezing of many hard-earned household and business deposits.[29] Furthermore, the cancellation of bank licenses by the CBY-Aden in 2024 for banks that have not relocated operations to Aden has resulted in uncertainty and concerns regarding their financial stability.

The withdrawal of commercial banks from private lending has created a massive unmet demand for credit. Estimates in 2024 show that the demand for credit to the economy outstripped supply 5 to 8 times over.[27] Furthermore, financial inclusion remains significantly low. The population is almost entirely unbanked, including about 90 percent of men and 99 percent of women. Just 0.4 percent of adults borrow from formal financial institutions, while 1 percent have savings accounts and only 6.3 percent of adults have access to financial service points.[30] Due to an eroding confidence in the banking sector, deposits in commercial banks dropped from 24.0 percent of GDP in 2014 to 15.6 percent by the end of 2022.[31] When peace is restored, these institutions can play a critical role in shaping a livable future for Yemen by financing and investing in climate responsive projects. However, banks in Yemen lack an understanding of how the climate-conflict nexus negatively affects their strategies and operations, and how to take advantage of innovative instruments, such as green sukuks and disaster risk financing, to mitigate their exposure to climate risks while contributing to increasing the resilience of the Yemenis. For instance, climate change is negatively affecting their physical assets, clients, staff and customers. Yet banks do not fully understand how these negative impacts translate into financial losses and lost investment opportunities. Under the status quo the financial sector is unlikely to significantly contribute to the achievement of Yemen's climate change goals.

The insurance market in Yemen remains underdeveloped, facing significant barriers to growth. These include a lack of knowledge and awareness among the population and businesses, as well as outdated regulatory frameworks. The local insurance law and the international insurance (branch) law have not been amended since 2010 and the market is notably deficient in insurance products tailored to climate risks, such as floods and droughts, with existing offerings primarily focused on natural disaster insurance for earthquakes and cyclones.[32] These products span various sectors, including transport, industry, and manufacturing, yet they are less developed in the agricultural sector. Until 2022, Yemen had 15 insurance companies (all private but one public) based in Sana'a. However, the emergence of five new insurers headquartered in Aden indicates a growing interest in developing the insurance market. The Ministry of Industry and Trade is tasked with issuing licenses and supervising these companies, which are required to consult with the Ministry before operating or developing new insurance products. The Central Bank of

27 World Bank (2023). Yemen Country Economic Memorandum: Glimmers of Hope in Dark Times. Washington, D.C: World Bank. [link]
28 Sana'a Center Economic Unit 2022
29 Al-Akhali, R., Saab, M., and Sacchetto, C. (2021). Options for an economic track of the Yemen peace process. State Fragility Initiative Working Paper. [link]
30 World Bank (2024). Yemen Financial Sector Diagnostics. Washington D.C. World Bank [link]
31 World Bank (2023). Yemen Country Economic Memorandum: Glimmers of Hope in Dark Times. Washington, D.C: World Bank. [link]
32 Eight types of insurance are offered by insurance companies, including against health, Islamic, fire, natural disasters, accidents, transportation and capital but nothing related to climate risks.

Yemen also plays a role in supervising the financial position and investments of insurance companies, as well as in anti-money laundering and counter-terrorism financing. Following extreme weather events that cause damage to assets and properties, the Yemeni government provides limited support to affected households, leaving the primary financial burden of repairs on the uninsured. This government aid is not consistently available, and while development partners may occasionally provide support, the involvement of international financial institutions could significantly boost customer awareness and contribute to the development of the market.[33]

While climate finance provides increasing opportunities, Yemen faces a number of challenges and receives 80 to 90 percent less than the average for countries with the lowest vulnerability. Although climate finance reached a record high of US$1.3 trillion in 2021/2022, access is influenced by conflict and fragility. Fragile and extremely fragile states together averaged just US$8.8 per person from the vertical climate funds, of which extremely fragile states, such as Yemen, averaged only US$2.1 per person; compared to US$10.8 per person in fragile states and up to US$161.7 per person for non-fragile states (including the SIDS).[34] Commitments in countries gripped by high intensity conflict were around half of that committed to those facing social and institutional fragility or medium-intensity conflict, with non-FCS IDA-eligible countries receiving more than two and a half times that of conflict-affected countries.[35] Only 19 projects in Iraq, Syria, and Yemen had been approved for funding as of January 2022, with the total funds disbursed amounting to a modest US$20.6 million, representing less than 0.5 percent of the global disbursement for climate-related projects.[36] This is significantly less than the estimated financing requirements for Yemen's adaptation efforts, with the GCF Country Program for Yemen indicating an initial budget for adaptation investment needs at roughly US$330 million for 2025 to 2030 alone. This represents more than 50 times the current amount funding received by Yemen from the GCF Readiness Program, which is estimated at only US$2 million.[37]

Yemen faces several technical and political economy barriers to accessing climate finance that are deeply intertwined with the country's institutional, socioeconomic, and FCV context. These include, but are not necessarily limited to, low absorptive capacity, weak appetite among financing institutions due to high perceived and real risks, high rate of institutional instability and fragmentation, lack of fiduciary standards, shortage of technical skills and data to support project design and implementation, limited knowledge about climate finance opportunities, as well as the lack of effective coordination mechanisms at the national and sub-national levels. These factors, individually and collectively, deter climate investments, despite Yemen's disproportionate vulnerability to the impacts of climate change and have a number of cascading effects. This is reflected in the positive relationship between access to climate finance and the financial absorptive capacity of recipient countries in MENA between 2015-2020 (Figure 2.5).[38] Among these, the lack of climate financing and weak fiduciary capacities and policies of national institutions has led to an increased reliance on projects funded by development partners working through humanitarian agencies to support key national local level institutions in providing the most basic of services.

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33 Ministry of Industry and Trade

34 UNDP (2021). Climate Finance for Sustaining Peace : Making climate finance work for conflict-aected and fragile contexts. United Nationas Development Programme, New York. [link]

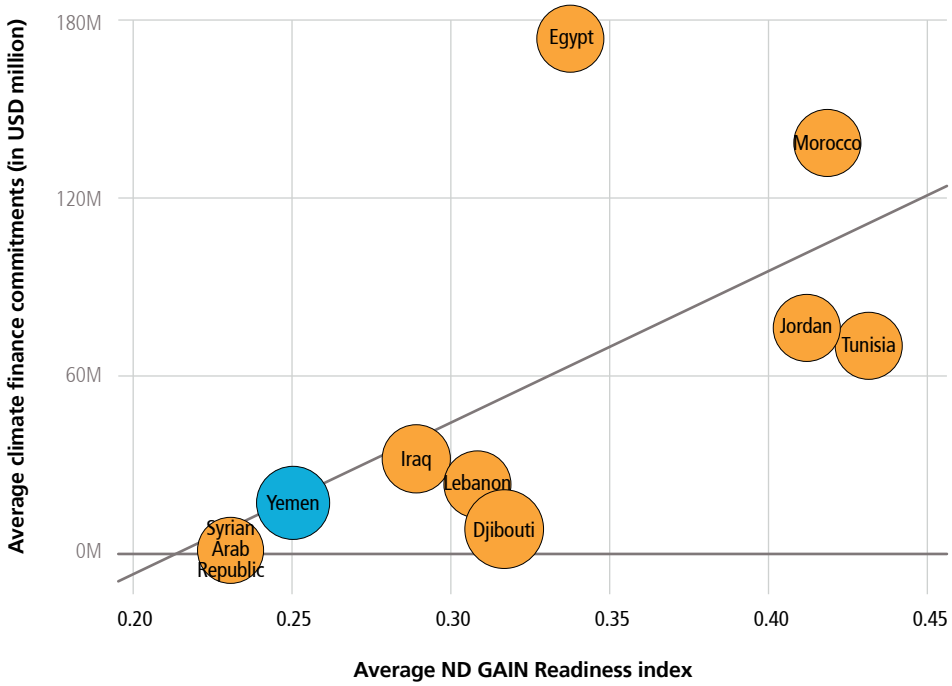
35 Jones, L., Banga, J., Notkin, B., & Brochen, A. (2024). Closing the gap: Trends in adaptation finance for fragile and conflict-affected settings. World Bank Group. Washington, DC, USA. [link]

36 Based on the Climate Funds Update database aggregates data from 27 multilateral climate funds. [link]

37 Ministry of Water and Environment (2024). Yemen 2025 - 2030 Climate Finance Country Programme. [link]

38 Relationship between the ND-GAIN readiness index and the average global commitments for adaptation and mitigation projects in selected MENA countries based on 529 single country projects worth US$3.26 billion extracted from the Aid Atlas database.

Figure 2.5. Climate Finance Positively Correlates with Country's Readiness to Absorb Funding.



Source: Original for this publication.

2.4. Yemen's Climate Priorities and the Imperative of Adopting a Whole-of-Society Approach

Yemen's climate priorities have expanded from an initial focus on water and agriculture to recognize six priority sectors and the need for supply and demand side institutional capacity development. The initial national communication submitted in 2001 identified improved irrigation practices and traditional technologies, along with shifts in cropping patterns and improved crop performance among the key priorities. The INDC presented adaptation measures for water, agriculture, resource use, disaster risk management, coastal and marine resource management, and institutional capacity, but did not include any measurable targets. The 2009 NAPA iterated these priorities, while emphasizing the importance of including an active civil society and open, transparent, and accountable policy and decision making processes, combining government-led approaches with bottom-up approaches rooted in regional and local knowledge, and conducting vulnerability assessments to understand and address poverty exacerbated by climatic events.[39] These priority sectors and domains are reflected in Yemen's first country program for the Green Climate Fund which highlights a number of urgent investments for which climate finance is urgently needed, specifically (i) water, (ii) agriculture, (iii) coastal zones and fisheries, (iv) renewable energies, (v) climate services, (vi) DRR and DRM structures, and (vii) institutional capacity development needs, including that of national and local government entities, academia and nongovernment organizations. An initial pipeline includes eight proposals to be submitted to the GCF, estimated in excess of US$230 million for GCF-2 (2024-2027).

39 Environment Protection Authority (2009). Republic of Yemen National Adaptation Programme of Action. [link]

These priorities have been re-affirmed through extensive multi-stage consultations and workshops throughout the process of developing the CCDR. These included representatives from key ministries, agencies and institutions, local experts and policy makers, as well as those from the private sector, civil society and different social groups, including women and youth, along with development partners. Community consultations in Ataq, Shabwa and Mukallah, Hadramawt highlighted issues with desertification and reduced rainfall, which have led to unemployment, migration and changes in community demographics and dynamics. Local communities also attested to the strain on local infrastructure due to migration, the disruption of traditional agricultural livelihoods due to drought, as well as the destruction of properties and spread of water borne diseases due to flooding. While most groups demonstrated a level of awareness of climate change, there is scope to improve the knowledge and capacity to adapt to its impact, with NGOs and academia highlighting the need for a more expansive and inclusive approach to awareness raising on climate change in Yemen, particularly as it pertains to individual behaviors and practices, community-based efforts and national initiatives to support climate change adaptation.

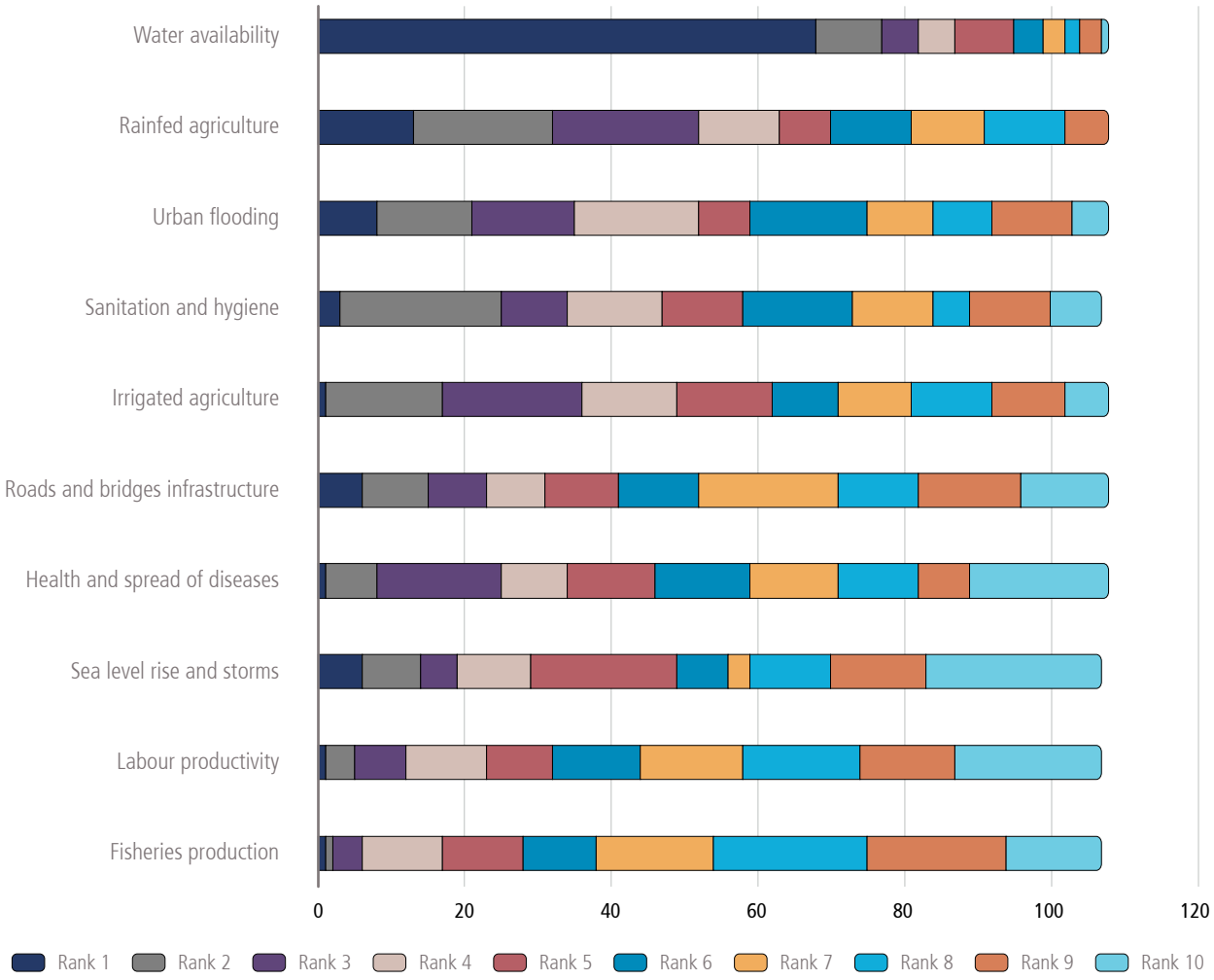
Despite demonstrated a level of awareness of climate change among Yemen's citizenry, there is scope to improve their knowledge and capacity to adapt to its impacts. Surveys conducted from February to October in 2023 revealed that close to 70 percent of respondents acknowledged that climate change impacts their family and community lives significantly or moderately, while more than 80 percent reported some degree of concern about it.[40] Notably, over 50 percent indicated that they have experienced or heard of tensions or conflicts in their district in relation to environmental issues, and one in four respondents reported adverse impacts due to such conflicts escalating into violence, with natural resource scarcity, access, and distribution widely recognized as drivers of conflict: close to 70 percent of respondents reported tensions and disputes over water resources within their communities, followed by energy resources such as oil and gas. At the same time, less educated and illiterate respondents disclosed the lowest levels of understanding of concepts relating to climate change, compared to more highly educated respondents, particularly those employed in the health, finance, manufacturing, and construction sectors.

In order to determine the priority pathways through which climate might impact Yemen, a survey was carried out as part of the CCDR. The survey was conducted with 108 national experts, academics, and NGOs, development and humanitarian specialists, along with World Bank sector specialists.[41] The survey involved ranking the importance of priority areas that are likely to be most impacted by climate change. Among this ranking, there is strong agreement between all groups that water availability and closely related sectors, like rainfed and irrigated agriculture, and sanitation and hygiene are of high importance. Nearly 70 percent of respondents ranked water availability as the priority, compared to rainfed agriculture which ranked second with only 13 percent identifying this as the priority. Issues related to disasters and emergencies like urban flooding, as well as increasing resilience of roads and bridges following closely (Figure 2.7).

40 Ferré Garcia, T., Geres, L., Al-Salahi, S., al-Omeisy, H., and Martinez, A. (2024). Weathering Risk: Environmental Pathways for Reconciliation in Yemen - Consultation Report. The European Institute of Peace. [link]

41 Out of this group 72 percent of the respondents were from ministries, NGOs, and academic institutions based in Yemen, 15 percent belonged to development and humanitarian organizations working on issues in Yemen, and 13 percent were from World Bank Global Practices involved in Yemen.

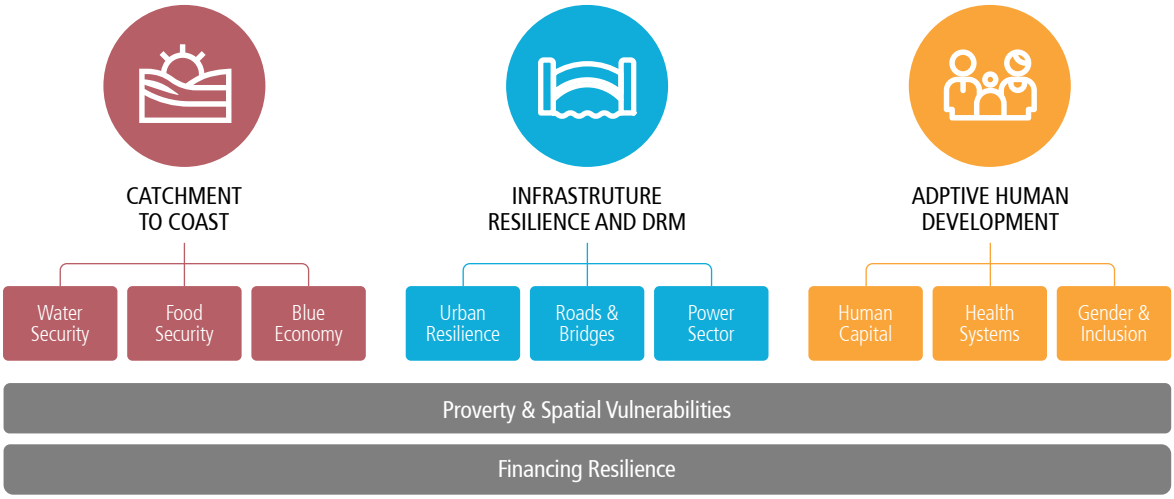
Figure 2.6. Stakeholder Rankings of Climate Priorities in Yemen.



Source: Original for this publication.

The CCDR focuses on three pillars and six priority areas that are informed by national priorities and a consultative stakeholder process. These are respond to the unique socio-economic characteristics and geo-political circumstances of Yemen and include a strong spatial orientation (Figure 2.7). Pillar 1 is oriented around the linkages between water resource management, agriculture and food security, as well as fisheries and the coastal zone through a landscape management approach from the catchment to coast. Pillar 2 is focused on strengthening disaster risk management and building resilient communities, ensuring resilient infrastructure and logistics, with a focus on the urban, transport and energy sectors. Pillar 3 is focused on safeguarding human development with a focus on human capital, health systems and considerations around gender and inclusion. Linking all of these key issues is poverty, which has a strong spatial dimension, and constraints on the financing required to build resilience. These combine to advocate for a targeted spatial approach that can maximize the impact and equity of investments in building green, climate resilient recovery and reconstruction in Yemen.

Figure 2.7. Priority Pillars and Sectors for Country Climate and Development Report Cased on Climate Related Documents and Stakeholder Inputs.



Source: Original for this publication.

Yemen © Ali Sunidar

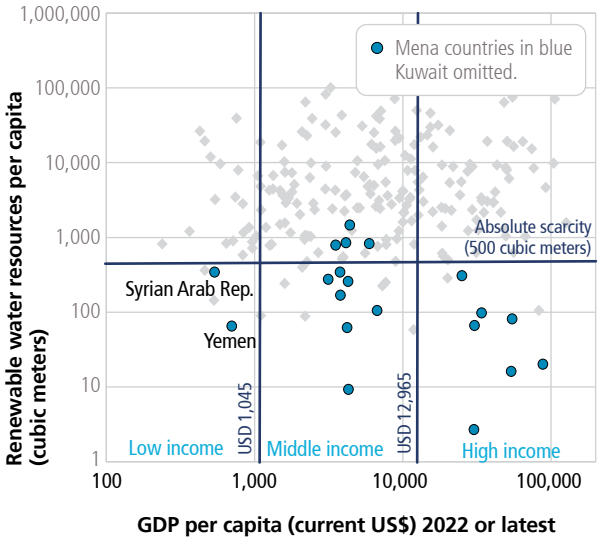
3. Pillars of a Climate Resilient Development

3.1. From Catchment to Coast – An Area Based Approach

3.1.1. Building Climate Resilience in the Water Sector

Yemen is the most water scarce, low-income country in the world with per capita water availability well below the threshold for absolute scarcity (Figure 3.1). Total run-off is estimated to be 2.5 billion cubic meters (BCM), with 1.0 BCM available for spate diversion and an estimated 1.5 BCM in groundwater storage, with an annual average recharge estimated around 316 MCM. This limited natural endowment is being eroded by one of the world's highest population growth rates, with per capita water availability having decreased by roughly 60 percent since 1990, with the estimated 65 cubic meters per person in 2020 projected to decrease to less than 54 cubic meters per capita by 2050.[42] More than 90 percent of the population is concentrated within eight water management areas in the western and southern parts of the country; three of these account for more than 70 percent of GDP, with Sana'a alone accounting for roughly half (Figure 3.2). Increasing pollution threatens to further exacerbate water scarcity, with groundwater particularly susceptible to salinization, notably in the northern coastal areas of Tihama and the Abyan and Lahi. The physical scarcity of water in many areas is accentuated by economic scarcity, with historical gaps in infrastructure compounded by internal displacement of people overwhelming existing infrastructure, much of which has been damaged by the conflict.

Figure 3.1. Renewable Water Resource and GDP per Capita for MENA Countries.



Source: Original for this publication based on World Bank data.

Figure 3.2. Water Management Areas Used in the WEAP Modelling for the CCDR.

Source: Original for this publication.

42 Absolute water scarcity is defined as less than 500 cubic meters per person per year.

Yemen's physical water scarcity combines with economic scarcity to create a low-level equilibrium where it is difficult for communities to break out of poverty. The limited access to water in Yemen imposes significant constraints on agricultural production and food security, health, and productivity, undermining the potential to achieve higher levels of development. Scarcity can also lead to increased competition for water resources, potentially leading to conflict and social instability. These challenges are exacerbated by the prolonged conflict, which has cascading effects that further erode the resilience of the population and increase their vulnerability to water scarcity. Forced displacement of millions of people has overwhelmed water supply and sanitation infrastructure, accentuating social conflicts, and fragmenting water management structures. The governorates of Al Mahra, Aden, Aldali, Ibb, Dhamar, Al-Mahwait and Hajjah all show an increase in population above national average growth, while Sana'a has the highest increase in the absolute number of IDPs, with over 1.1 million people, and Marib the highest percentage increase, with a 267 percent change in population.[43] While Sana'a has the highest increase in the absolute number of IDPs, with over 1.1 million people, the highest percentage increase has been observed in Marib, with a 267 percent change in population. These changes take place faster than the ability of infrastructure to keep up and increase the vulnerability of local communities, with many IDPs forced to live in flood-prone areas or dangerous locations, characterized by widespread food insecurity and a lack of water, healthcare and sanitation services that further erodes adaptative capacity. This increases the risk of water borne disease, forces consumers to seek costly alternative sources of supply, often with questionable quality, and compounds the challenges of food insecurity.

Yemen experiences significant shortages of water with 50 percent of demand across all sectors projected to be unmet by 2050 in the absence of climate change considerations. Demand for water outweighs the available supply, leading to overexploitation and depletion of non-renewable groundwater resources with an estimated deficit of 2.6 BCM in 2020 projected to increase by 2050.[44] Model estimates show unmet demands are concentrated in the northwestern and eastern-central basins (e.g. western Rub Al Khali, central Red Sea, eastern Arab Sea), with unmet demand estimated to reach as high as 90 percent in certain basins due to high irrigation demands overall coupled with limited water resources in these areas. Irrigation accounted for 83 percent of water demand in 2020, and while absolute demands are projected to increase to 3.9 BCM by 2050, the relative share of irrigation is projected to decrease to 76 percent due to increasing municipal requirements. More than 40 percent of irrigation demands are not met under current conditions, with these projected to increase to nearly 50 percent by 2050 under the no climate change reference scenario. The challenges associated with high water demand in the agriculture sector are exacerbated by low irrigation efficiencies (e.g., as low as 35 percent)[45] and rapidly increasing demands due to expanding cultivation of qat. This mild stimulant consumes roughly 40 percent of the country's renewable water resources and is responsible for over 30 percent of groundwater withdrawal,[46] with the area under cultivation having expanded by more than 40 percent in selected regions from 2016 to 2021.[47] Unmet municipal water supplies, which require a higher level of assurance than water for agriculture, are projected to increase from 12 percent to nearly 20 percent nationally by 2050, with many areas, including Sana'a, already experience acute shortages of water.

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43 World Bank (2024) Charting the Course - A Water Security Diagnostic for Yemen. Washington, DC. World Bank. [link]

44 A Water Evaluation And Planning (WEAP) water systems model was used to evaluate supply and demand scenarios for key sectors (including irrigated agriculture, municipal users, industry, and environmental flows) across the 12 water management areas, taking into account climate change effects, and available storage infrastructure, with allocation of water across sectors in the WEAP model adhering to the following order: Municipal → Irrigation → Industrial → Livestock → Environment, with available surface water used before drawing from groundwater resources.

45 UNDP and Netherlands Enterprise Agency (2021), Water Availability in Yemen, [link]

46 McCracken, M. (2012). The Impact of the Water Footprint of Qat on Yemen's Water Re¬sources. MSC. Thesis on Water Security and International Development, Tufts, University, USA. [link]; ICRC (2022). The Water Situation in Yemen. International Committee of the Red Cross. [link]

47 World Bank (2023). Yemen Country Economic Memorandum: Glimmers of Hope in Dark Times. Washington, D.C: World Bank. [link]

Table 3.1. Aggregated National Unmet Water Demand for Each Sector by Decade and Climate Scenario.

Sector	Decade	Estimated Unmet Demands		
		No Climate Change Reference	Dry/Hot Mean	Wet/Warm Mean
Municipal	2020s	12.40%	8.30%	9.50%
	2030s	16.00%	14.30%	12.60%
	2040s	19.60%	16.30%	13.60%
Irrigation	2020s	43.20%	35.40%	37.70%
	2030s	46.10%	42.80%	40.40%
	2040s	47.90%	44.60%	38.80%
Industrial	2020s	28.70%	22.10%	21.00%
	2030s	38.20%	30.40%	30.60%
	2040s	44.40%	36.90%	26.80%
Livestock	2020s	25.70%	20.20%	21.50%
	2030s	26.80%	25.40%	20.70%
	2040s	27.80%	25.60%	20.40%

Source: Original for this publication.

The projected increase in precipitation can alleviate unmet demands but will not be able to bridge the gap between demand and supply. Model projections show a high degree of consensus around increased precipitation compared to historical means, with runoff expected to increase under both mean climate scenarios. The more optimistic climate scenario is projected to result in increases throughout the year, with more pronounced peaks in March and August, while the more pessimistic scenario is projected to result in small increases throughout much of the year, but with the potential for a small reduction in runoff relative to the no climate change reference in the month of March. While projecting the potential impacts on groundwater is more complicated, unmet demands are expected to decline across all sectors under both mean climate scenarios by mid-century relative to future conditions without climate impacts, most notably under the more optimistic Wet/Warm mean scenario and in the north-western parts of the country. Unmet demands in the irrigation sector are projected to decline from 48 percent to about 45 and 39 percent under the pessimistic and optimistic scenarios, respectively (Figure 3.3). This exhibits strong spatial differences, with some water management areas projected to reduce average annual unmet irrigation demands by more than half. Similarly, unmet national demands in the municipal sector are projected to reduce from around 20 percent to 14 to 16 percent by mid-century, depending on the climate scenario. Unmet demands in the industry sector show sharper declines from 44 percent to 37 and 27 percent under the pessimistic and optimistic scenarios, respectively.

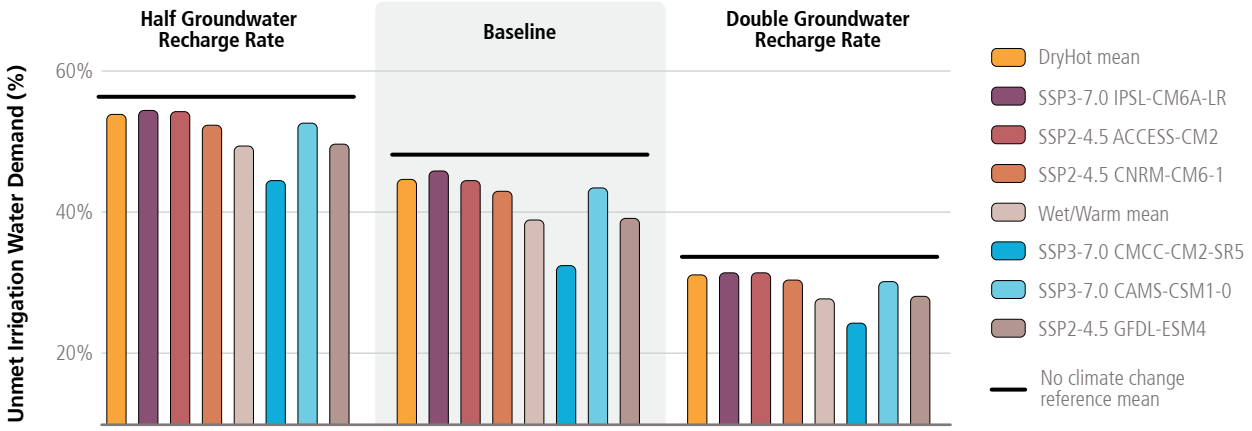
However, the impact of changes in temperature and precipitation on Yemen's water resources and long term water security depend on a complex set of assumptions and the sustainable management of groundwater resources. This is particularly true for groundwater resources, which provide the majority of water resources in Yemen and are very poorly characterized. The lack of a comprehensive monitoring network undermines the data and information needed to inform sustainable management and regulation. This results in the resources being abstracted at a rate faster than they are being replenished, leading to overexploitation and persistent groundwater depletion. Groundwater tables have dropped by two–four meters each year with current pumping depths in excess of 1,000 meters,[48] with more than 100,000 unlicensed and unmonitored

48 UNDP (2022). A Holistic Approach to Addressing Water Resources Challenges in Yemen. United Nations Development Program. [link]

private wells. Long term projections are therefore susceptible to assumptions around recharge rates.[49] These are influenced by a complex array of factors, with increased temperatures changing vegetation patterns, land use practices and influencing evapotranspiration, increasing consumption from agriculture, and reducing the amount of water that percolates into the ground and recharges aquifers. Similarly, shifts in patterns of precipitation and changes in rainfall-runoff relationships, including amounts, frequency, and intensity, can increase or decrease groundwater recharge. Meanwhile, climate driven sea-level rise can accelerate saltwater intrusion into coastal aquifers.

Assumptions around groundwater recharge rates increase or decrease unmet irrigation demands by as much as 30 to 40 percent. A sensitivity analysis was carried out to model unmet demands under scenarios assuming groundwater recharge rates that are halved or doubled relative to the baseline (Figure 3.3). The reduction of groundwater recharge rates represents a worsening of the current situation, whereby more intense precipitation events coupled with land degradation results in a lower fraction of rainfall being available to recharge groundwater. In contrast, doubling the recharge rate is an indicative adaptation scenario where artificial recharge interventions, such as terracing, percolation ponds, groundwater dams, and injection wells, are implemented to increase the fraction of precipitation that recharges groundwater. The results of this sensitivity analysis show unmet irrigation demand decreases by more than 10 percent across both the no climate change reference and the climate futures considered when doubling the recharge rates. Overall, unmet irrigation demand decreases from about 48 percent to approximately 33 percent by the 2040s without climate effects, and from approximately 45 and 39 percent under the pessimistic and optimistic scenarios, respectively, to 31 and 27 percent, respectively. Conversely, halving the recharge rate sees unmet irrigation demand increase to more than 55 percent under the no climate change reference, with the impacts of climate change again projected to drive reductions in unmet demand.

Figure 3.3. Average Annual Unmet Irrigation Water Demand for 2041-2050 under Different Assumptions of Groundwater Recharge.



Source: Original for this publication.

There are a range of climate resilient interventions that can mitigate the risks of intensifying precipitation and increase water availability. Landscape approaches to catchment management provide a useful framework for integrated water resources planning and management of measures that can harvest precipitation and increase both natural and built storage Afforestation and reforestation, coupled with artificial recharge interventions such as traditional terracing practices, percolation ponds, and sand dams can help increase infiltration, thereby increasing groundwater recharge. Such measures can be

49 For the purposes of this analysis these are based on national accepted recharge estimates computed using a regression 4 percent of annual precipitation goes to groundwater recharge for all but the Sana'a and Marib basins for which basin specific recharge rates were available [link]

implemented through labor intensive practices that can have co-benefits for local communities, particularly under the status quo and escalation scenarios. When conditions allow, managed aquifer recharge can help accelerate recharge through injection wells. For those areas where municipal demands require augmentation, investments in improving the performance of local corporations, such as reducing non-revenue water, improving energy efficiency, and improving billing and collections, will provide some relief but require an appropriate enabling environment. Long term resilience and assurance of municipal supplies may require development of desalination, although this will require significant improvements in the enabling environment and strong commitments to mitigate associated risks and safeguard poor and vulnerable users. All such measures need to be accompanied by institutional and policy measures that increase awareness and incentivize sustainable water management practices. Under the status quo scenario this could involve no regret measures in improving monitoring, including the use of remote sensing, an area-based approach to prioritized investments and pricing mechanisms coupled with transitional, smart subsidies that can facilitate the transition from humanitarian assistance to longer term, resilient development.

3.1.2. Climate Smart Agriculture and Restoring Value Chains

Yemen's agri-food sector has been severely impacted by the protracted conflict, leading to widespread food insecurity and famine-like conditions. The sector accounted for 13.7 percent of GDP and around 13 percent of employment in 2014. However, the conflict has compounded long standing underlying structural problems, such as water scarcity, low productivity, lack of infrastructure, and inadequate marketing systems. As a result, the value and volume of production fell about 16 percent between 2014 and 2018,[50] with the area harvested and quantity produced falling 5 percent and 7 percent, respectively.[51] As a result, over 24 million people (or 83 percent of the total estimated population) are considered food insecure, including 16.2 million people in Integrated Food Security Phase Classification (IPC) Phase 3+ requiring emergency assistance.[51] This food insecurity is driven in part by constrained production, supply and distribution of food, along with the diminishing purchasing power of individual households and imposes significant constraints on human development. Despite these challenges, agriculture remains one of the main sources of income, with 26 percent of rural households interviewed reporting their main income earner was working in the agriculture sector.[52]

Yemen's agricultural production and food security have always been subject to constraints imposed by limited land and water scarcity. Only 2 to 3 percent of the country's landmass is considered arable, leaving it highly vulnerable to desertification and water stress. The principal agricultural systems are in the rainfed highlands characterized by terraced agriculture for coffee, fruits, grains and qat, and extensive livestock production. Horticulture and field crops predominate in the plains, using groundwater for irrigation. However, an estimated 97 percent of agricultural land is threatened by increased desertification, which affects about 90 percent of farming areas,[53] with roughly 50 percent of terrace soil partially or fully destroyed by desertification and water-intensive qat production,[54] while there has been an estimated 63 percent decline in land potentially suitable for coffee production over the last 20 years.[55] As a result, agriculture supplies around 15 to 20 percent of Yemen's food needs, with self-sufficiency in some cereals (sorghum, millet, and barley), but up to 85 percent of food consumed is imported, including most staples, such as wheat (90 percent of which is imported), rice, oil, sugar and milk.

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50 FAO (2022) FAOSTAT: Crops and livestock products. Food and Agriculture Organization. Rome. Cited on 03 July 2024. [link]

51 The Integrated Food Security Phase Classification (IPC) provides a common scale for classifying the severity and magnitude of food insecurity and acute malnutrition. [link]

52 World Bank (2024) Charting the Course - A Water Security Diagnostic for Yemen. Washington, DC. World Bank. [link]

53 Carnegie Endowment for International Peace. (2023). Agriculture and Yemen's Economy. [link]

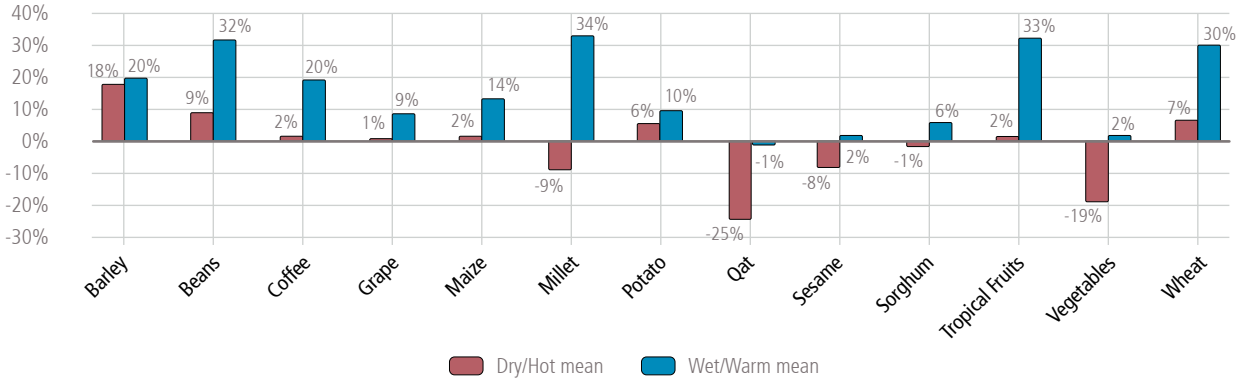
54 Pietsch, D., and Mabit, L. (2012). Terrace soils in the Yemen Highlands: Using physical, chemical and radiometric data to assess their suitability for agriculture and their vulnerability to degradation. Geoderma 185, 48–60. [link]

55 Qima Foundation. (2022). Climate Smart Coffee Production. [link]

Increased precipitation presents a number of opportunities for a country that has long struggled with droughts and depleting groundwater. Satellite data and machine learning suggests that cropland expanded by 10-40 percent between 2018 and 2022,[56] with the increase in cropland extent tightly linked to corresponding local rainfall, rather than with changes in the conflict or internal displacement. In addition to changes in rainfall volume, variation in rainfall has also nearly doubled over baseline levels, particularly in the summer. However, managing unpredictable rainfall and averting severe soil erosion and flood damage presents a number of significant challenges and there is a need to better understand which areas are becoming increasingly vulnerable to flood events. In a country like Yemen, where roughly half of agriculture is rainfed and an additional 10 percent of land is directly dependent on rainfall through flood irrigation, with the remaining 40 percent irrigated from groundwater (~67 percent) and surface water (~33 percent), crop yields are vulnerable to changes in rainfall patterns and water availability, increasing evaporative demands, and extreme heat as temperatures rise. In order to assess the potential impacts of climate change, rainfed and irrigated crop production were evaluated under the climate scenarios, as well as for different adaptation scenarios.[57]

Rainfed crops show potential increases in production, although high revenue crops, like qat and vegetables exhibit vulnerabilities to climate impacts. By mid-century, climate change is anticipated to have varied production impacts across the rainfed crops considered in the analysis (Figure 3.4). High revenue crops such as vegetables and qat are expected to be most vulnerable to climate change and may experience sizable production declines under a more pessimistic future, with impacts estimated at -19 and -25 percent, respectively. However, other high revenue crops such as tropical fruits may experience production gains under both climate scenarios, with impacts potentially reaching upwards of 30 percent. The remaining crops (e.g., beans, millet, wheat) are generally expected to experience production gains under the optimistic mean, with smaller production gains also possible under the pessimistic mean. This can lead to important nutrition and food security effects.

Figure 3.4. Rainfed Crop Production Shock under Baseline Scenario, 2041-2050.



Source: Original for this publication

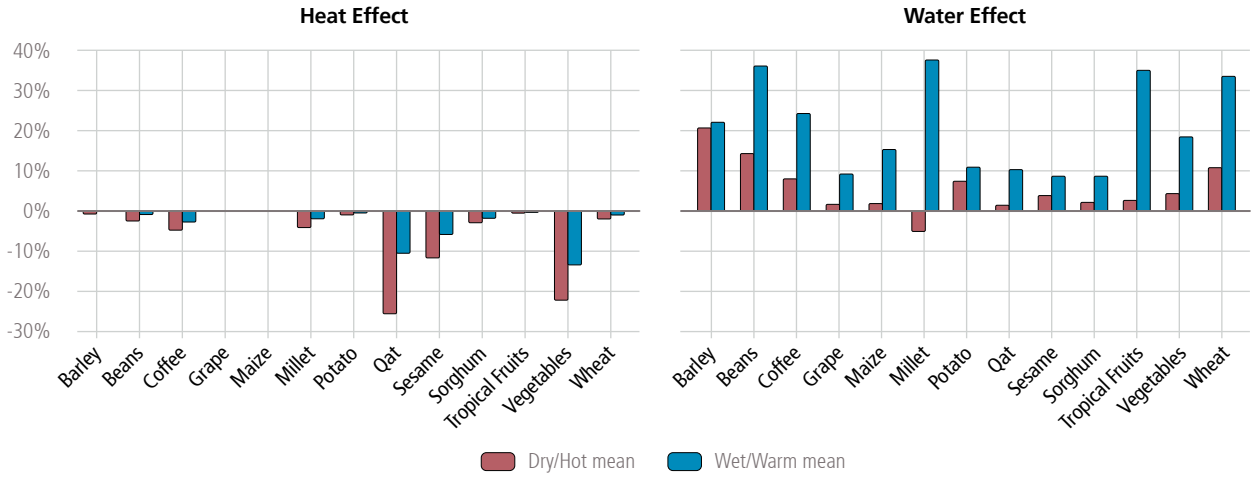
Rainfed crop production typically shows negative impacts due to heat effects, while overall positive impacts due to precipitation. The heat effect due to increasing temperatures results in negative impacts to all crops considered, with heat related impacts particularly high for qat and vegetables. In contrast, the precipitation effect is generally positive for all crops, as a result of both the optimistic and pessimistic scenarios experiencing increases in precipitation relative to the historical baseline. When the heat and precipitation effects are aggregated (Figure 3.5), the significant heat effect on qat and vegetables helps

56 DrivenData/World Bank, (2023). Yemen: Key spatial-temporal trends in agricultural production. Unpublished technical report.

57 Assumes that no changes in harvested area, crop yields, or total production take place other than due to the modeled climate effects that occur over the course of 2021-2050. Initial crop production is based on the Annual Agricultural Statistics Book for 2020 (2016-2020 average) from the Republic of Yemen's Ministry of Agriculture and Irrigation.

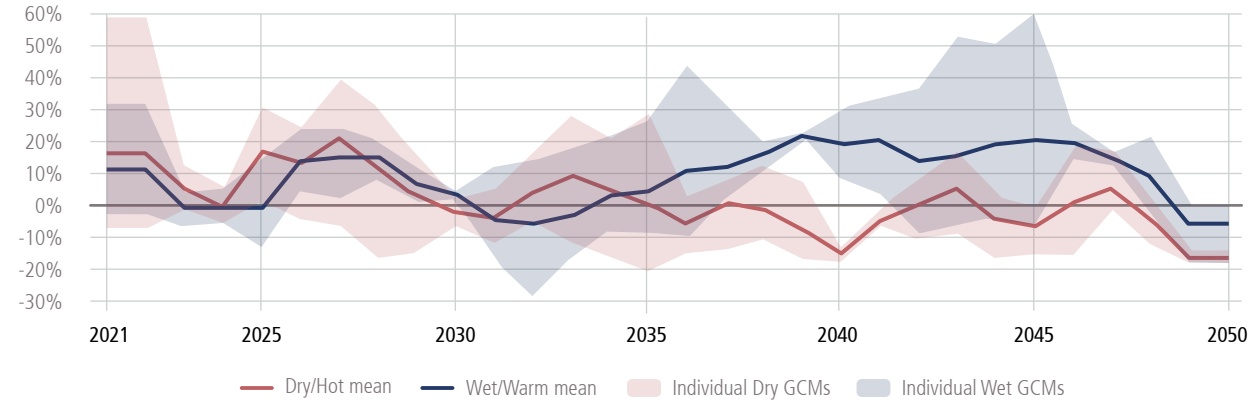
explain the negative production impacts projected for these crops under the pessimistic climate scenario. Under the optimistic mean scenario, the large positive production impacts estimated for most crops are explained by the positive precipitation effect experienced by the majority of crops. Aggregating the projected production shocks across all the rainfed crops evaluated, Figure 3.6 shows the overall impact of climate change on rainfed crop production under the baseline scenario with no planned adaptation. While there is significant year-to-year variability, as mid-century approaches, the pessimistic mean climate scenario is generally associated with negative production shocks, while the Wet/Warm mean scenario sees production gains as a result of climate change. By the 2040s, the average rainfed production shocks are estimated at +11.9 and -4.5 percent under the optimistic and pessimistic mean climate scenarios, respectively.

Figure 3.5. Rainfed Crop Production Shock Under the Baseline Scenario with No Planned Adaptation Broken down into Heat and Precipitation Effect, 2041-2050.



Source: Original for this publication.

Figure 3.6. Rainfed Crop Production Shock, under Baseline Scenario, 3-year Moving Average.

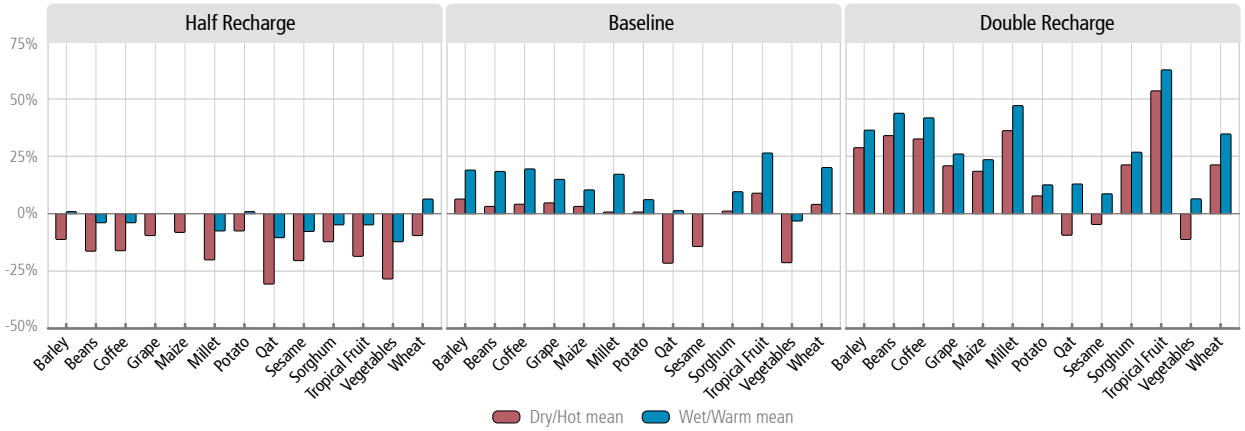


Source: Original for this publication.

Irrigation can increase resilience to water related shocks and crop production by more than 40 percent for a number of crops. This depends on the ability to increase the capture of precipitation and storage that allows to bridge the extended duration dry periods predicted under future climate conditions. The baseline shows potential increase in crop production, even under more pessimistic scenario, except for Qat, sesame and vegetables (Figure 3.7). However, the results are sensitivity to assumptions around groundwater recharge. Doubling groundwater recharge increases overall crop production and minimize the climate impacts on

sensitive crops such as qat and vegetables. This can be achieved through climate resilient investments that increase infiltration, such as terracing, percolation ponds, groundwater dams, injection wells, recharge trenches, among others. If groundwater recharge rates are halved, then this has significant impacts on irrigated crop production, with all crop types showing a significant reduction under both climate scenarios.

Figure 3.7. Irrigated Crop Production Shocks from 2041 to 2050 under Different Adaptation Scenarios Reflected in Groundwater Recharge Rates.



Source: Original for this publication.

Climate related impacts on crop production are likely to exhibit strong spatial variation, requiring a targeted area-based approach. Increased exposure to extreme heat and drought poses challenges for agricultural adaptation in a country in which water is already scarce and groundwater reserves are being rapidly depleted. While an average of 5 percent of the land at risk of increased exposure to extreme heat by 2050 is classified as cropland, this can reach up to 45 percent in some districts (Figure 3.8).[58] However, in non-coastal areas cropland is significantly more exposed to climate hazards, especially in the governorates of Al Mahwit (45 percent), Raymah (35 percent), Dhamar (30 percent) and Al Hudaydah (17 percent). These governorates in the Western and Central Wadi and Western Coastal Plain have historically supported livelihoods through the production of sorghum, millet, vegetables, fruits, and livestock.[59]

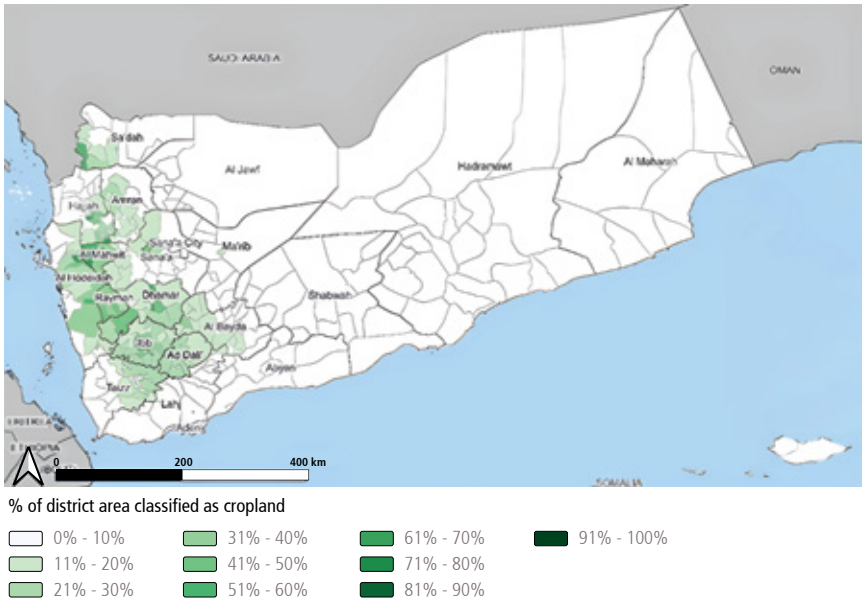
Climate-related impacts can also unlock important opportunities for improving nutritional outcomes at the local and national level. Potential increases in local production can address pervasive problems of malnutrition. Prior to the 2015 escalation of conflict, levels of malnutrition were among the highest in the world, with the potential to adversely impact long term human capital outcomes. In 2021, over 2.25 million cases of acute malnutrition threaten children under the age of five in Yemen,[60] 395,000 of which are expected to suffer from severe acute malnutrition and could die without treatment. The projected figures in the IPC nutrition analysis[61] mark a 16 percent increase in acute malnutrition and a 22 percent increase in severe acute malnutrition among children under five compared to previous estimates. Acute severe malnutrition[62] has immediate effects, including greater susceptibility to diseases like cholera, wasting and a whole range of other poor physical and mental health outcomes. Malnutrition impacts on children is particularly severe, as it results in long term declines in cognitive development. Given the agriculture sector's importance in producing food for consumption and commercialization, and generating incomes, it will continue playing

58 DrivenData/World Bank, (2023). Yemen: Key spatial-temporal trends in agricultural production. Unpublished technical report.
59 FEWSNET (2011). Livelihoods Zoning "plus" activity in Yemen: a special report by the Famine Early Warning System Network. [link]
60 Cases of malnutrition are counted here as some children will have repeat episodes.
61 Yemen: High levels of food insecurity persist | IPC Global Platform (ipcinfo.org)
62 Severe acute malnutrition is defined by a very low weight for height (below -3z scores of the median WHO growth standards), by visible severe wasting, or by the presence of nutritional oedema (WHO).

an important role in households' coping strategies and is expected to play a leading role in post-conflict recovery and reconstruction and improved local production can improve nutritional outcomes.

Climate targeted investments can mitigate the impacts of climate change and harness the potential opportunities afforded by increased precipitation. Investments that increase infiltration, soil moisture and groundwater recharge can significantly mitigate the potential impacts of climate change and increase production. Many of these, such as improved percolation ponds, groundwater dams, and recharge trenches can be deployed through local interventions, while others like terracing can build on traditional practices to safeguard indigenous knowledge systems. Where possible, heat-tolerant crops should be promoted and adopted to build resilience, improve water efficiency and increase economic benefits from higher yields, lower costs, and greater returns. Focusing on climate resilient crops and other climate smart investments on farm can have multiple benefits. For example, reduced tillage associated with heat-tolerant crops can help preserve soil structure, reduce erosion, and increase water infiltration and retention, leading to a build-up of organic matter in the soil that can enhance soil fertility and improve resilience.

Figure 3.8. Percentage of District Area Classified as Cropland.



Source: Based on data from Dynamic World, MCD12Q1 v061.

Improving the resilience of agriculture to climate shocks, amid on-going conflict, is closely related to the improvement of livelihoods of many women in Yemen. With close to 88 percent of women engaging in agriculture, investments in climate smart agriculture can provide important employment opportunities for women, minimizing income volatility due to climatic shocks. However, limited access to land ownership, finance, markets, livelihood activities, and information, aside from legal and cultural restrictions on economic independence, limit women's formal employment opportunities. Women are the main custodians of knowledge related to crop varieties and hence play a critical role in local, community-led natural resources management strategies. Women are also vital to food value chains, maintaining food security and providing sufficient food for their families. As such, women are important catalysts of nutrition. Nutritious crops are mostly tendered by women who are actively involved in small income-generating projects, such as kitchen gardens, honey bee production, animal husbandry, dairy production, and greenhouse cultivation, among others. However, women have less access to agricultural assets and higher food insecurity, and rarely have land ownership rights, with only 13 percent of women agricultural landholders in Yemen. Recognizing the role of women in the rural economy, and capitalizing on their economic empowerment as well as traditional knowledge, can be critical for improving the resilience of the agri-food sector.

Box 3.1. Climate Resilient Coffee Value Chains Provide Potentially Significant Adaptation Opportunities

Yemen is a recognized origin of the coffee plant and is among the driest coffee-growing countries in the world.[63] As such, coffee plays a critical role in maintaining the biological diversity of this high value crop and coffee has been a longtime key export that provides an important source of income for rural households. Coffee is grown in 15 governorates across the Houthi and IRG controlled areas of Yemen, where it is cultivated on agricultural terraces on mountains and valleys. Over 104,000 farming families are involved in coffee production,[64] with approximately one million people working in the field along the value chain.[65] As of 2019, coffee was planted in 2.4 percent of cultivatable land in Yemen. Exports totaled US$28m in 2021,[66] representing about a quarter of production,65 with the most important importers being Saudi Arabia (60 percent), the U.S. (11 percent), and Japan (9 percent). Plots of land tend to be small and tended by hand, given the challenging mountainous topography, and coffee farmers have historically been among the poorest farming households in Yemen.

Coffee could provide market opportunities and an important tool for adaptation, if risks to production and market access are properly addressed. Globally, the size of areas highly suitable and marginally suitable for coffee are projected to fall by 54 and 31 percent, respectively, between 2000 and 2050.[67] Within that global picture, growth in higher altitude area is estimated to be less affected and may expand in suitability, relative to tropical lowlands with traditionally heavy rainfall. Such changes provide potential opportunities for Yemen to benefit from higher prices and greater market share.[68] The varieties of coffee grown in Yemen are already suited for a challenging arid climate, and increased precipitation may be supportive; official data shows coffee production nearly doubling in 2021 compared to 2020,[69] in the context of several years of unusually strong rainfall.[70] Coffee rarely relies on groundwater pumping, increases water retention, and bolsters resistance to drought,[65] and as such is far less stressful on the water supply that qat, a common substitute as a cash crop, which takes up 15 percent of agricultural land and consumes almost 40 percent of resources available for irrigation.

Climate specific investments and targeting the sector more broadly could better position the coffee sector. Infrastructure, farmer practices, and market institutions would all benefit from greater investment. Farmers need to be better educated and trained on managing climate shocks and investments need to be made into rainwater conservation and drainage to manage the soil erosion and damage to trees from floods, and mitigate the risks associated with rainfall that is heavier and more volatile. Additionally, while Yemen's coffee breeds have proven resilient, the creation of a Yemeni coffee atlas and investigation into the possible use of other coffee varieties under various temperature and precipitation scenarios would reduce climate risk.[65] The extension of financing for the installation of new irrigation infrastructure and testing/processing facilities would bolster production and support higher quality and value sales. Greater investment into warehouses, transport, logistics, and other infrastructure could reduce operating costs and pave the way for the

63 Qima Foundation. (2022). Climate Smart Coffee Production: Embracing Shade; [link]
64 UNDP. (2022). Qat and Coffee: Value Chain Analysis in Yemen. United Nations Development Program. [link]
65 Sweet Maria's Coffee Library. (2020). An Interview with Mrs. Fatoum Muslot, Yemen Coffee Exporter. [link]
66 The Growth Lab at Harvard University. The Atlas of Economic Complexity. [link].
67 Grüter, R., Trachsel. T., Laube. P., and Jaisli, I. (2022). Expected global suitability of coffee, cashew and avocado due to climate change. PloS one 17.1 : e0261976. [link]
68 Pham, Y., Reardon-Smith, K., Mushtaq. S. and Cockfield, G. (2019). The impact of climate change and variability on coffee production: a systematic review. Climatic Change 156: 609-630. [link]
69 FAO. 2022. FAOSTAT: Crops and livestock products. In: FAO. Rome. Cited on 03 July 2024. [link]
70 DrivenData/World Bank, (2023). Yemen: Key spatial-temporal trends in agricultural production. Unpublished technical report.

expansion of warehouse financing[71] Technical assistance would be valuable to support the farmer workforce and revitalize coffee cooperatives and bodies for certification and market promotion, such as the National Center for the Development of Coffee Production established at the Ministry of Agriculture, Irrigation and Fisheries in 2023, while revolving guarantee programs supporting coffee cooperatives in the acquisition of wet mills and meeting working capital needs through support to local bank balance sheets could improve quality and open market opportunities through off-take agreements with international buyers.

3.1.3. Safeguarding Yemen's Fisheries and Coastal Livelihoods

Yemen's blue economy is essential for building resilience, providing livelihoods, ensuring food and nutrition security, and sustaining economic development. Yemen's geographical location, with 2,200 km of coastline along the Gulf of Aden, the Arabian Sea and the Red Sea, presents significant opportunities for economic growth and job creation, with the blue economy encompassing various economic activities related to the ocean and coastal areas, including fisheries, aquaculture, tourism, shipping, and renewable energy. However, the full potential of the blue economy in Yemen has not been realized due to a number of systemic challenges, coupled with the ongoing conflict. Climate change has the potential to accentuate these challenges through multiple pathways, including sea level rise, more frequent and extreme weather events, the loss of coastal habitats and infrastructure, higher ocean acidity and changes in sea temperature, potentially leading to fish migration to cooler waters, among others.

Yemen's coastline is one of the most biodiverse marine ecosystems in the world, supporting productive fisheries. Prior to the conflict, the fisheries sector contributed 15 percent of the country's GDP,[72] and was a major source of employment, income and food security. In 2013, fish catch was estimated at 229,000 metric tons,[73] the majority of which originated from the country's artisanal fishing fleet. This has been estimated at around 70,000 fishers and accounted for 98 percent of the total fisheries production.[72, 74] These primarily rely on small vessels, estimated at approximately 20.000 boats, and limited equipment as compared to the industrial fishing fleet. Overall, pelagic species, like anchovy, mackerel, mullet, and tuna, represent the majority of catch, at 60 to 70 percent.[73] Yellowfin tuna and kingfish dominate in terms of production value, while sardines and Indian mackerels are most prevalent in quantity. Despite its potential, aquaculture production is negligibly low. By 2020, capture fisheries production had reduced to 131,000 mt. The majority of the harvest is exported, with only 25 percent consumed domestically due to consumer preferences, high prices, and significant supply chain losses, given the limited cold chain capacity.[75]

Yemen's fisheries sector provides significant economic opportunities, with exports a crucial component of the economy. In 2022, fish exports were valued at US$154 million, contributing 9 percent of total exports. Fish exports decreased 25 percent from 2021 exports of US$204 million and well below the 2010 peak of US$323 million.[76] Fish contributed a large share of agrifood exports constituting 47 percent in 2019, with main destinations including North Africa, West Asia, Europe, and Southeast Asia, Oman, and Saudi Arabia. Saudi

71 Yemen Reform Series: Warehouse Finance for Food Security. Dobromir Christow, Senior Economist, WB UNDP-WB-Private Sector Discussions. Amman, Jordan, February 21/2024

72 USAID (2019). The Fisheries Sector in Yemen: Status and Opportunities. [link]

73 See Yemen IRG report citation xlv

74 World Bank (2022). Program on Sustainable Fishery Development in Red Sea and Gulf of Aden (SFISH) Project Appraisal Document. Washington, D.C. World Bank Group. [link]

75 FAO and IFC (2022). Fisheries Value Chain in Yemen: Export potential and investment opportunities. Food and Agriculture Organization of the United Nations and the International Finance Corporation. [link]

76 Observatory Of Economic Complexity (2024). Processed fish in Yemen. [link]

Arabia was the top destination, accounting for 32 percent of all fish exports, although exports to Southeast Asia have grown the most in the past years, with exports to Thailand and Malaysia increasing significantly by 620 percent and 975 percent, respectively, between 2014 and 2022.[77] YYemen still has unrealized potential in the markets it already serves, especially when it comes to fresh or frozen products, and less in processed products. Yemen's gap in actual fish exports and its export potential is around US$128 million with fresh whole fish being the biggest opportunity with a gap of more than US$54 million. Most notably, unmet supply potential in whole fish is around US$26 million per year in Saudi Arabia, US$15 million in the UAE, US$10 million in Thailand, and US$14 million in the Republic of Korea.[77]

The fisheries sector provides important livelihood opportunities and is a crucial source of jobs, particularly for women. Small-scale enterprises dominate, providing livelihoods for approximately 115,000 small-scale fishers and around a million household members. Fisheries provide jobs for another 500,000 people along the value chain, supporting 18 percent of the coastal population (total population of 9.4 million). Fishers make up the majority of the workforce (79.5 percent), while non-governmental and private sector actors constitute 2.8 and 17.7 percent, respectively. Most jobs are concentrated upstream in the value chain due to limited local value addition.[76] While the overall economic participation of women in the fisheries sector is as low as 6 percent, with their involvement mainly confined to fish processing, small-scale fish drying and salting, selling in some markets, net making and mending,[78] there are significant prospects to create more inclusive opportunities. There are a number of initiatives to promote women's entrepreneurship and business development, with some fisheries cooperatives targeting income generation and skills development for women.

Despite the opportunities, Yemen's fisheries sector faces a number of challenges that affect its development, resilience and sustainability. Limited access to finance, exacerbated by dwindling government support amidst conflict and economic crisis, has stakeholders depending on loans from family and local financiers, as traditional financial institutions like the Cooperative and Agricultural Credit Bank curtail operations. The Agriculture and Fisheries Production and Promotion Fund has also ceased due to conflict. A regulatory vacuum has led to uncontrolled fishing, depletion of fish stocks, and habitat damage. Uncontrolled fishing has depleted fish stocks and damaged marine habitats, despite halting the issuance of new licenses since 2004 and the introduction of a regulations restricting industrial fishing within 5 miles of the coast in 2006 and it's extension to within 22 miles in 2022. Small-scale fishing communities are poorly prepared to manage, restore, and conserve aquatic resources and state institutions have not been able to empower and support fishing communities to engage in participatory management, with inadequate adoption of technologies and a lack of qualified workforce, resulting in low productivity. Furthermore, dilapidated and damaged landing sites, transportation infrastructure and limited market access amplify these challenges, with damaged roads, ports, and landing sites increasing costs and reducing the quality and competitiveness. The destruction of fishing infrastructure and post-harvest facilities, like ice plants and boat factories, has led to significant post-harvest losses due to poor handling, storage, and transportation, while exporters struggle to penetrate new markets and enhance exports.

Climate change poses significant threats to Yemen's fishing sector, which is among the world's most vulnerable. This vulnerability is driven by high exposure to the physical effects of climate change, the dependency on social and economic returns along with the limited adaptive capacity that constrains the extent to which these potential impacts can be offset.[79] The maximum catch potential is projected to decrease by around -16.6 percent under RCP 2.6 to an estimated-23.1 percent under RCP 8.5 between 2041 and

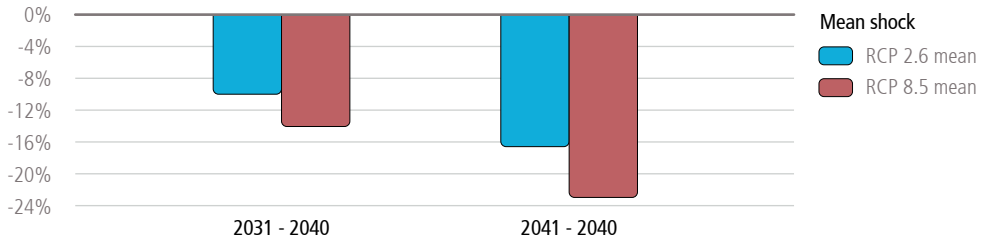
77 ITC Export Potential Map. 2024.

78 World Bank (2022). Program on Sustainable Fishery Development in Red Sea and Gulf of Aden (SFISH) Project Appraisal Document. Washington, D.C. World Bank Group. [link]

79 Allison, E.H., Perry, A.L., Badjeck, M-C., Adger, W.N., Brown, K., Conway, D., Halls, A.S., Pilling, G.M., Reynolds, J.D., Andrew, N.L., Dulvy, N.K.. (2009) Vulnerability of national economies to the impacts of climate change on fisheries. Fish and Fisheries, 10: 173-196. [link]

2050 (Figure 3.9).[80] Assuming that current fishing rates continue to 2050, the revenue in response to changing sea surface temperatures relative to 2020 are projected to have roughly a one percent impact on real GDP. Climate impacts on the sector are projected to grow incrementally towards mid-century and vary depending on the climate scenario considered.[81]

Figure 3.9. Shock to Fisheries Output, Relative to 2020 Baseline[82]



Source: Original for this publication.

The magnitude of impacts is highly uncertain, with the physical effects of climate change on fish stocks and fisheries manifest through a complex array of potential pathways. Rising sea temperatures can alter the distribution of fish species as they migrate to cooler waters, alterations in major ocean currents can impact nutrient distribution and migration patterns, while increased CO_2 levels lead to ocean acidification and warmer waters leading to reduced levels of dissolved oxygen. More frequent and severe storms can damage critical infrastructure, such as ports and vessels, reduce opportunities for fishers to leave the coast for fishing activities, and disrupt fishing and fish processing. Fishing trips by artisanal subsistence-oriented fishers are usually short and close to shore, averaging a distance of about eight nautical miles and not exceeding ten days, but typically last half a day or overnight with the duration depending on seasonality, varying by climate conditions (monsoon) and the migratory patterns of some fish stocks.[83] Rising sea levels are also leading to the loss of coastal habitats such as mangroves and estuaries, which are critical nursery grounds for many fish species.

Yemen's mangrove and seagrass habitats are important parts of adaptation strategies to combat climate change and it's impacts. They serve as crucial nursery grounds, which are vital for maintaining healthy fish stocks, support a wide range of biodiversity, provide important livelihood opportunities and help to reduce the vulnerability of coastal areas to sea-level rise. They serve as invaluable natural defenses, shielding coastlines from the erosive forces of waves and storms, while also playing a significant role in mitigating climate change by acting as carbon sinks, absorbing and sequestering atmospheric carbon dioxide. Additionally, algae and seaweeds contribute to the purification of the marine environment and play a crucial role in metabolizing nitrogen compounds, reducing nutrient pollution and preventing harmful algal blooms. By regulating pH levels, seaweed meadows help maintain a stable and balanced marine environment and contributes to biodiversity. The extent of the Red Sea and Gulf of Aden mangrove ecosystem was estimated to be 189.2 km^2 in 2020

80 Based on results from the World Bank's Climate Change and Marine Fisheries in Africa (2019) and Food and Agriculture Organization's Fisheries and Aquaculture Technical Paper 627 (2018), which assess the ecological impact of climate change on fish populations to project future changes in fish catch potential. These studies rely on different models that simulate ecological processes among fish populations, namely the Dynamic Bioclimate Envelope Model, the Multi-Species Size-based Ecological Model, and the Dynamic Size-Based Food Web Model. Neither direct impacts to fisheries nor ecological risk scores are available for Yemen in the studies. Thus, we rely on modeled fisheries impacts from nearby countries to serve as a proxy for fisheries impacts for Yemen. Specifically, the shocks to Yemen's fisheries output are based on a weighted average of impacts to fisheries in Somalia (50 percent), Oman (45 percent) and Djibouti (5 percent). Weights are estimated using Yemen's catch areas in 2018, reported by Sea Around Us (University of British Columbia 2019).

81 Relies on modelling analyses that were previously completed as part of a World Bank study (2019), and as such consider RCP2.6 and RCP8.5 from the CMIP5 suite of model outputs.

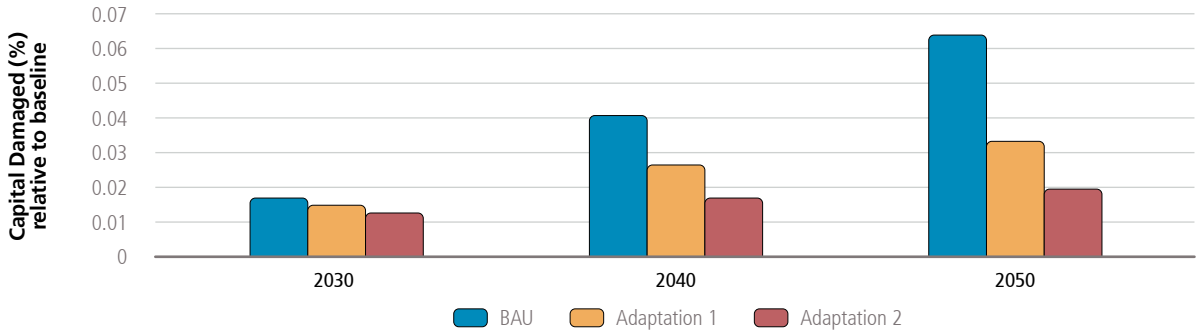
82 The fisheries channel relies on modelling analyses that were previously completed as part of a World Bank study (2019), and as such consider RCP2.6 and RCP8.5 from the CMIP5 suite of model outputs.

83 FAO and IFC (2022). Fisheries Value Chain in Yemen: Export potential and investment opportunities. Food and Agriculture Organization of the United Nations and the International Finance Corporation. [link]

and considered endangered, having decreased by 21.7 percent since 1996.[84] Moreover, 1.7 percent of the mangrove ecosystem is undergoing degradation, with the potential to increase to 5.2% within a 50-year period, based on a vegetation index decay analysis in 2024.[84] Under a high sea-level rise climate scenario (RCP8.5) it is thought that around 67.1 percent of the Red Sea and Gulf of Aden mangroves would be submerged by 2060.

Integrated coastal zone management is critical to protecting mangrove habitats and building resilience to the impacts of sea level rise. Climate change is expected to increase the severity of the impact sea level rise and storm surges will have on coastal infrastructure, with coastal flooding impacts expected to increase in severity, especially later in the century. The sea level is anticipated to rise between 0.3 to 0.54 meters by 2100, damaging coastal infrastructure and leading to saltwater intrusion and reduction of available ground-water supply. Under historical conditions, coastal flooding is expected to damage approximately US$658 million worth of coastal infrastructure, or 0.12 percent of Yemen's national capital. Under the SSP3-7.0 climate scenario ensemble mean, the expected damages are projected to increase by around 50 percent by 2050, reaching 0.18 percent of the national capital. Capital losses could be reduced by 25 percent by 2050, as compared to the historical baselines, through soft measures, such as regulatory requirements for new coastal development projects to be located outside the historical 20-year floodplain. Further, hard measures such as floodproofing of existing structures would reduce the capital damages from over 0.06 percent in the historical baseline to less than 0.02 percent by 2050 (Figure 3.10).

Figure 3.10. Expected Annual Damage due to Sea Level Rise and Coastal Flooding under the SSP3-7.0 Ensemble Mean by Adaptation Scenario



Source: Original for this publication.

Climate-specific investments can maximize the long-term sustainable contribution of the blue economy to climate resilient development in Yemen. A path to peace and prosperity would unlock significant opportunities, including support for aquaculture production, incentives for sustainable fishing quotas, and insurance schemes tailored to fishers and fish species. Insurance schemes tailored to small-scale fishers reduce risks of coastal hazards to fishers, with the goal of replacing critical losses to essential equipment such as boats or motors and avoiding a spiral into poverty or more destructive fishing practices. Additionally, future capture fish stock insurance mechanisms could also be developed to help fish and fishers recover by transferring and reducing risks associated with the collapse of fisheries. These mechanisms could increase adaptive capacity by providing income to fishers when fishing efforts should be reduced to allow fish stocks to recover.[85] Investment support is also needed for small- to medium-scale biorefineries for fish processing byproducts (e.g., oil, collagen, amino acid, mineral production) in jurisdictions with enforced sustainable fishing quotas. Similarly, investment in sustainable land-based aquaculture production of high-value niche products, such as crustaceans, sea urchins, ornamental corals, and fish is critical. In the interim, no regret

84 Ghoraba, S.M.M., Almahasheer, H., Siddig, A.A.H., Nagi, H.M., and Suárez, E.L. (2024). *IUCN Red List of Ecosystems, Mangroves of the Red Sea and Gulf of Aden.* EcoEvoRxiv [link]

85 Heck, N., Beck, M. W., Agostini, V., Reguero, B., Pfliegner, K., Mucke, P., Kirch, L., Ricker M. (2020): Fisheries at Risk - Vulnerability of Fisheries to Climate Change. Summary Report. The Nature Conservancy, Berlin. [link]

measures to improve the resilience of fishers to climate related hazards, such as strengthening early warning systems, can improve safety and reduce vulnerabilities to extreme events.

These challenges highlight the need for strategic investments and policy reforms to ensure the long-term sustainability and growth of Yemen's fishing sector. There is a need to build the business capacity of private agents, and especially fisher alliances to reduce transaction costs through more aggregation and use of joint processing facilities, as well as strengthening the capacity of the Marine Biology Center, the Marine Pollution Centre and the Marine Science Authority. Innovative business solutions could also minimize operational costs, like multi-purpose use of vehicles and the use of technology-enabled solutions to bypass intermediaries. More generally, investments should focus on infrastructure and agri-logistics, such as seaports, key roads, landing sites, packaging sites, and cold chain storage facilities, with special emphasis on areas of high presence of fisher alliances.[86] Investment support should focus on developing climate ready fisheries with actions targeted at conservation of natural marine resources, emerging fisheries, reference points development, future planning, integrated monitoring and management, and increasing adaptive capacity across all levels.[87]

3.2. Resilient Infrastructure and Disaster Risk Management

3.2.1. Strengthening Disaster Risk Management and Building Resilient Communities

The increasing frequency and intensity of climate hazards, particularly flash floods, is increasing the vulnerability of the population and economy, disproportionately affecting urban areas. While the population has historically been predominantly rural, at 62 percent, Yemen's urban population is growing at around 3.9 percent per annum,[88] and is projected to almost double from a pre-conflict urban population of 8.4 million in 2013 to 16.2 million people by 2030. This transition has been accelerated by the ongoing conflict, which perpetuates a cycle of displacement affecting approximately 4.3 million individuals. This includes movement of the population from rural to urban areas and intra-urban migration, compounding the impacts on already limited basic services and critical infrastructure. Some urban areas, such as Marib, have seen a three-fold increase in population (from around 300,000 people in 2010 to over one million in 2021), while more than 1.1 million more people have moved to Sana'a. Out of the country's 21 governorates, roughly 40 percent of the population now live in Sana'a, Aden, Hadramawt, Al Hudaydah, and Ta'iz, with those in the eastern desert areas almost depopulated.[89] These five governorates account for nearly 70 percent of GDP, with 20 districts (out of 333) and 15 percent of the total population accounting for 50 percent of estimated GDP. Sana'a and Aden alone account for an estimated 40 percent of GDP and 15 percent of the population.

The resilience of urban areas in Yemen has been eroded by years of protracted conflict, increasing vulnerability to flooding. Damages in 16 major cities between March 2015 and January 2020 have been estimated between US$6.9 and US$8.5 billion, with more than 80 percent of damages concentrated in the cities of Sanaa, Taiz, Aden, and Hodeida.[89] The prolonged conflict has also diverted resources away from operation and maintenance, as well as investments in rehabilitation of infrastructure, eroding the quality of infrastructure and provision of critical services, including solid waste management, mobility, electricity, water and sanitation, healthcare, and digital connectivity, among others. The deterioration of infrastructure and in critical services poses serious risks to the population and are exacerbated by the erosion of human capital with much of the trained workforce leaving, without the ability or prospect to replenish with younger professionals. Such dire conditions leave these services vulnerable to disaster events, during and after which the demand for these services would become essential.

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86 FAO and IFC (2022). Fisheries Value Chain in Yemen: Export potential and investment opportunities. Food and Agriculture Organization of the United Nations and the International Finance Corporation. [link]

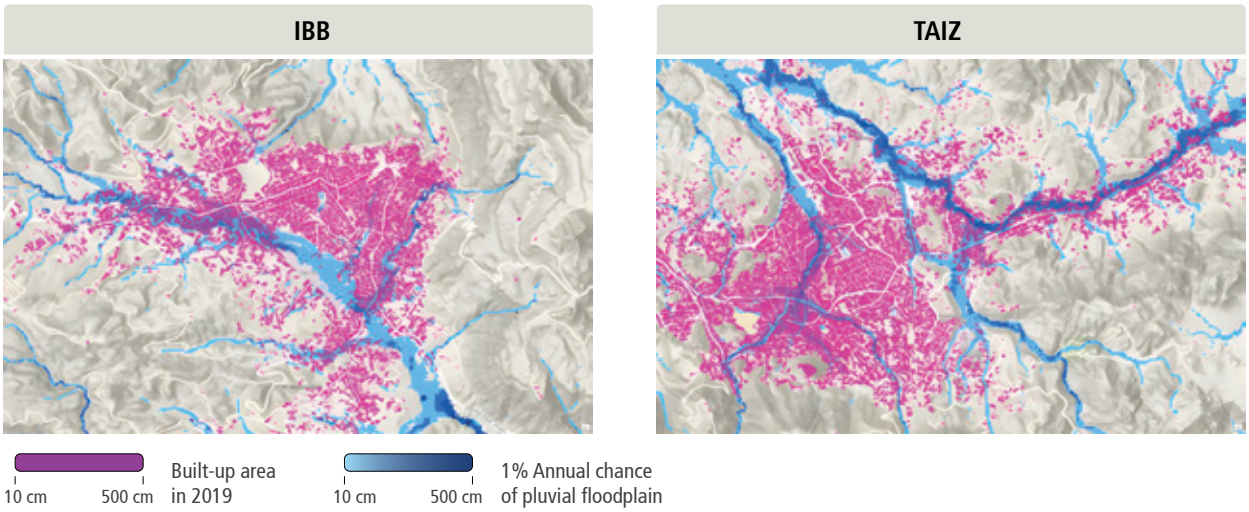
87 Bell, R.J., Odell, J., Kirchner, G., and Lomonico, S. (2020). Actions to Promote and Achieve Climate-Ready Fisheries: Summary of Current Practice. [link]

88 World Bank (2020). Yemen Dynamic Needs Assessment: Phase 3 (2020 Update). [link]

89 Such as Al-Maharah, Marib and Raymah comprise respectively 0.5%, 1% and 2% of Yemen total population

The coalescence of multiple factors has already manifest in increasing flood damages. Satellite-derived built-up area data shows a significant portion of urban zones are located in flood-prone areas.[90] This is supported by flood depth estimates from the FATHOM flood-hazard model, which are based on a 1-in-100-year flood event using 2020 as the baseline (Figure 3.11). An assessment of flood risks indicates that these are significant in Dhamar, Abyan, Hadramawt, and Al Maharah governorates, where urbanization and the growing informal settlements, along with poor storm water management, spatial planning, and limited forecasting availability, have increased the vulnerability of local communities. As a result of these driving forces the economic costs can be significant. Unprecedented rains during the monsoon season in 2022 resulted in severe flooding across 182 districts in 18 governorates, affecting more than 73,000 households. The majority of those affected residing in areas with higher concentrations of displaced population, with the total direct economic damages between June and November 2022 estimated at US$570 million, representing roughly 2.7 percent of 2021 GDP.[91] The projected increase in rainfall intensity and associated flooding is expected to increase vulnerability, especially in urban areas, particularly coastal cities, due to exposure to storm surge, flash floods, and epidemiological hazards enhanced by flash floods, the depletion of water resources for household consumption, and sea level rise.

Figure 3.11. Urbanization and flood-prone areas.



Source: Original for this publication based on World Bank analysis.

The vulnerability of many communities is exacerbated by limited institutional capacity for disaster preparation, response, and recovery. The country lacks an integrated national development strategy for disaster risk management, leading to a reactive response and a significant financial gap between needs and resources. The limited awareness of the socio-economic impacts of climate shocks, results in uncoordinated and fragmented responses, an outdated Early Warning System (EWS), and inadequate preparedness. These challenges are compounded by rapid population growth, resulting in cities that are ill-equipped to address these issues, facing multiple hurdles that are further exacerbated by climate change. The absence of integrated systems has caused inefficient responses and confusion over mandates, complicating efforts and contributing to system vulnerabilities. This disconnect hinders international support, as stakeholders struggle to identify the appropriate bodies in charge. The lack of an integrated approach and national capacity has negatively impacted communities and Civil Society Organizations (CSOs), leading to health crises, security risks from unexploded ordnance, increased conflict, damaged WASH systems, and exclusion of vulnerable populations, including IDPs.

90 World Settlement Footprint - WSF2019
91 The needs assessment was based on the Global RApid post-disaster Damage Estimation (GRADE) approach.

Box 3.2. Lesson learned from Cyclone Tej

Tropical Cyclone Tej struck south-eastern Yemen and Oman on October 23, 2023, resulting in severe flooding that displaced thousands of people. The destruction was particularly acute in Al Mahrah Governorate, impacting districts such as Haswayn and Al Ghaydah, where the airport recorded 406 mm of rain in a few hours.

A coordinated disaster response was executed through clusters involving various agencies, including line ministries, security authorities, and local community committees, supported by regional and international organizations. During the cyclone, the Ministry of Public Health and Population, supported by WHO and local partners, assisted hospitals and public centers, and managed road and clearing of debris. CAMA, along with YMS, collected and analyzed meteorological data to provide forecasts that played a central role in the Early Warning System (EWS), with CAMA producing weather bulletins and issuing alerts using a color-coded system, and its capacity was strengthened in 2018 through an FAO-EU initiative. The National Centre of Meteorology responded to inquiries, communicated with forecasters in Socotra, Al-Mahra, and Hadramout, and disseminated bulletins via various channels. Warning notices were sent via SMS to authorities and the public in affected areas. The Governor of Al-Mahra called on people to take precautions against Tej's dangers, especially warning those in valleys, farmers, and fishermen via radio and TV.

Despite these efforts, many agencies continue to face challenges associated with a lack of financial and human resources, outdated equipment, absence of frameworks to integrate meteorology into national strategies, and limited awareness of the value of EWS. There is also a lack of mechanisms to facilitate collaboration with the private sector, a shortage of technical expertise and standardized equipment. Practical challenges include reduced visibility due to the end of national weather bulletins, difficulty connecting with interested parties, and struggles in assuming a leadership role due to fragmented EWS systems.

The increased amounts and intensity of precipitation is projected to increase damages to urban infrastructure assets. An evaluation of ten cities suggests that historically, a 100-year pluvial flooding event (flooding from heavy rainfalls) would result in damages of around US$7.1 billion or 1.3 percent of capital (Table 3.2) and US$452 million or 0.08 percent of capital for a 100-year fluvial flooding event (flooding from rivers and streams overflowing their banks) (Table 3.3).[92] With climate change, and without any adaptation measures, the impact of these climate related disasters is projected to increase compared to the historical baseline. Under the more pessimistic climate scenario (SSP3-7.0), the percent increases relative to the historical baseline of 20-year, 50-year, and 100-year pluvial floods are projected to be in the order of 18, 20, and five percent, respectively, while those for fluvial floods are projected to increase by 52, 36, and 28 percent, respectively. Annual expected damages[93] for the historic baseline period are estimated at 0.045 percent of capital from pluvial flooding, with these expected annual damages increasing to 0.054 percent under the SSP3-7.0 ensemble mean by 2050 (Figure 3.12). The expected damages from fluvial flooding (Figure 3.13) for the historic baseline of 0.003 percent of capital increasing to 0.0047 percent under the SSP3-7.0 ensemble mean. While expected damages are a commonly used metric, the small increases in expected damages due to climate change obscures the significant increases in the damages associated with individual flood events of a particular return period.

92 Cities included in the analysis included Aden, Al Ghaydah, Al-Hodeidah, Al Mukalla, Dhamar, Ibb, Lahij, Marib, Sana'a, and Taizz.

93 Annual expected damage is the sum of all magnitudes of flood events times their annual probability of occurring (i.e., a 10-year flood times 1/10, plus the 11-year event times 1/11, plus the 12-year event times 1/12, and so on). While these impacts are seemingly very small, this is due to the impact of multiplying the damages by their probability of occurring in a given year.

Table 3.2. Percent of National Capital Damaged by Urban Flooding due to Pluvial Flooding

Event	Historical Capital Damages		% Increase Relative to Historical Capital Damages as a Result of Climate Change		
	Percent Damaged	Monetary Damages (US$ m)	SSP1-2.6	SSP2-4.5	SSP3-7.0
20 year	0.3%	1,766	15%	9%	18%
50 year	0.7%	3,971	18%	12%	20%
100 year	1.3%	7,059	4%	3%	5%
Expected Damages	**0.04%**	**238**	**1.2%**	**0.7%**	**1.3%**

Table 3.3. Percent of National Capital Damaged by Urban Flooding due to Fluvial Flooding.

Event	Historical Capital Damages		% Increase Relative to Historical Capital Damages as a Result of Climate Change		
	Percent Damaged	Monetary Damages (US$ m)	SSP1-2.6	SSP2-4.5	SSP3-7.0
20 year	0.02%	142	44%	32%	52%
50 year	0.06%	303	30%	21%	36%
100 year	0.08%	452	24%	16%	28%
Expected Damages	**0.003%**	**18**	**3.0%**	**2.2%**	**3.6%**

Source: Original for this publication.

Figure 3.12. Expected Annual Damages from Pluvial Flooding under the Baseline Scenario with No Planned Adaptation.

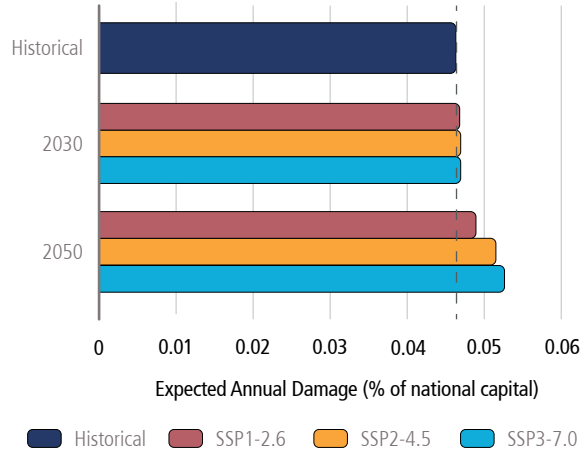
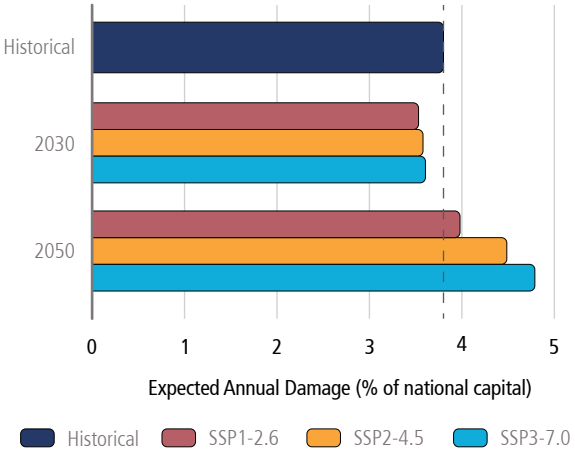


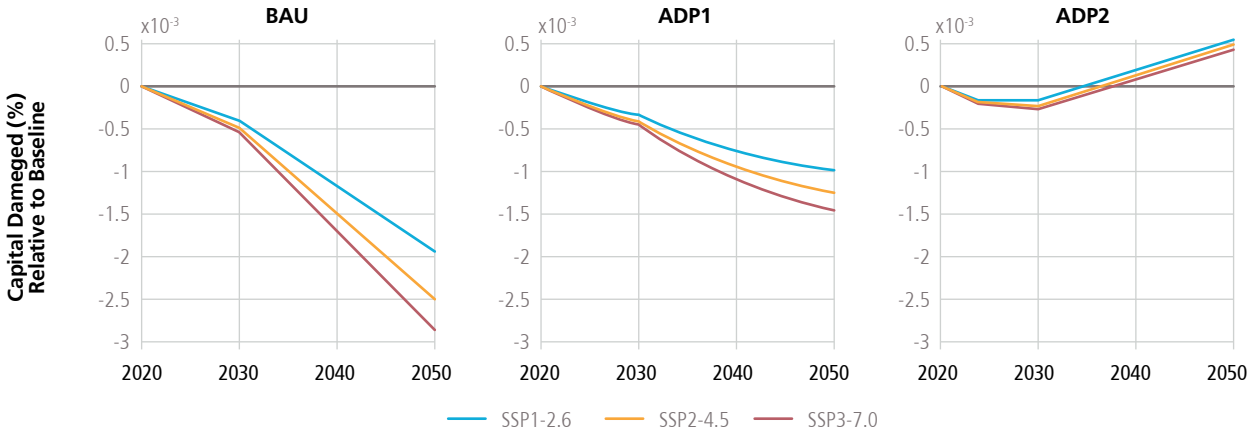
Figure 3.13. Expected Annual Damages from Fluvial Flooding under the Baseline Scenario with No Planned Adaptation.



Source: Original for this publication.

Capital damages from urban flooding in 10 major cities may increase to about -0.003 percent of the national capital by 2050 under the baseline scenario with no planned adaptation. The expected annual damage from urban flooding by adaptation scenario under the SSP3-7.0 ensemble mean (Figure 3.14). However, a no cost adaptation intervention aimed at building new infrastructure outside of the historical 20-year floodplain (i.e., ADP1) would be expected to provide a high level of resilience by 2050 reducing capital losses by about 50 percent under SSP3-7.0. A more aggressive adaptation scenario (i.e., ADP2) that pairs interventions under ADP1 with floodproofing of vulnerable buildings is anticipated to provide the highest level of resilience by mid-century and may result in positive infrastructure benefits. For example, instituting regulatory requirements for new construction to be outside the historical 20-year floodplain would provide a higher level of resilience, reducing capital losses by about 50 percent by 2050. In addition to these interventions, more aggressive measures to floodproof existing vulnerable buildings would provide the highest level of resilience by mid-century while benefitting the owners and the municipalities through higher asset values. The costs of such interventions would be borne by the asset owners and have been estimated to be in the order of US$186 million through 2050 in the 10 cities.

Figure 3.14. Expected Annual Damage from Urban Flooding by Adaptation Scenario.



Source: Original for this publication.

Building resilience and adapting to the increased risk of flooding in urban areas will require investments in infrastructure, institutions, and information. There are a number of no regret measures that can reduce exposure to risks through prevention measures even under an intensification and escalation scenario, such as updating hazard maps to improve public awareness, and discourage new settlements in high-risk areas, and protection measures, including community level Nature-Based Solutions, which not only provide cost effective measures to help mitigate flood risks but have additional benefits such as protecting and/or restoring biodiversity, enhancing climate regulation and ecosystem services, as well as supporting local livelihoods. Additionally, implementing capacity-building programs for community committees and providing flood-resilient infrastructure in vulnerable cities like Dhamar, Abyan, Hadramawt, and Al Maharah are crucial. Developing Early Warning Systems using global data sources will further enhance preparedness. In the status quo scenario, it is essential to prepare for the next phase of climate-resilient development by implementing regional flood-resilient infrastructure programs, building an institutional foundation with accessible Early Warning Systems, updating the Civil Defense Law for effective disaster risk management, and enhancing the capacity of CAMA, NWRA and other agencies, such as those under the Ministry of Agriculture and Fisheries, through improved hydro-meteorological forecasting tools and climate alert systems. Capacity building activities should also benefit Non-Governmental Organizations and civil society with a focus on preparatory measures that can be taken to minimize the loss of life and mitigate damages to assets as well as to enable timely recovery.

The Peace and Prosperity scenario provides for more ambitious interventions and financing mechanisms that will be essential for building resilience against future climate-related challenges. Adopting an integrated, catchment based approach that addresses floods and droughts, such as the EPIC Response Framework,[94] can encourage coordination across government agencies, to support efforts in reducing the social, economic, and environmental impacts associated with extreme hydro-climatic events. Integrating climate-responsive principles into national territorial planning, such as land use controls in flood-prone areas and strengthening building codes, will help ensure that development and service delivery are adaptive and resilient to climate change. Modernizing hydrometeorological and Early Warning Systems by installing additional automatic climate stations will enhance hydro-meteorological coverage, particularly in high-risk and flood-prone areas, while strengthening institutional capacity will be crucial for ensuring nationally coordinated systems. Once a stable financial market can be established, insurance programs to protect the assets households and businesses own may become possible under a peace and prosperity scenario. However, Yemen's insurance market is nascent and primarily focused on conflict-related risks, and the industry lacks products for specific natural disaster events, with no government contingency financing mechanisms to provide immediate funds in the aftermath of disasters. The prospects of peace would allow for the establishment of a national disaster risk management, reconstruction, and recovery fund that could provide vital financial resources for reducing risks through investments in structural and non-structural measures, and for responding to and recovering from climate-related disasters, with proper valuation and cost-recovery mechanisms.

3.2.2. Strengthening Climate-Resilient Transport and Logistics

Yemen's transport networks are crucial for protecting people, promoting social and economic opportunities, and will be essential for the transition to reconstruction and development. Given its strategic location connecting the Middle East with the Horn of Africa, Yemen's transport networks, including ports, roads, and airports, are vital for regional trade along with the movement of people and goods. The road network, on which logistics and freight transport relies, is rather undeveloped, with the 50,000 km road network (72 percent) largely unpaved dirt or earth roads that are highly susceptible to heavy rainfalls and floods. The road assets are in poor condition due to decades of inadequate maintenance and damages from natural disasters and unregulated traffic, such as overweight trucks, with the mountainous terrain exposing the road network to landslide risks. The conflict has also caused significant damage, with approximately 33 percent of paved roads damaged by military operations targeting critical infrastructure facilities. For example, blockades on key highways, seaports, and airports have disrupted trade, logistics, and mobility of people, significantly increasing the costs of economic activities with detrimental impact especially on the poor. Farmers cannot deliver their products to market in time, roads are unsafe for children and sick people to travel to reach healthcare or schools. Such challenges, coupled with high transport costs, have made it difficult for communities to access economic opportunities and essential services, such as health and education.

The impact of climate change on logistics and transport infrastructure is multifold. Increased temperatures, precipitation, and flooding cause roads to deteriorate faster, causing delays and disruptions to traffic while increasing repair and maintenance costs. Extreme precipitation events cause floods and landslides, resulting in traffic disruptions in the short run, and asset damages with traffic disruptions as well as further increases in recovery costs. Some villages experience extensive disruptions of the access roads due to floods and inundation. A sample of 12 roads shows that disruptions occur 27.5 days per year on average,[95] with a severe impact on the access to humanitarian aid, essential services, and economic opportunities. For example, the Al Muares – Al Bajeelah road in Al-Hodeidah, which connects villages and farms in Al Sharqi and Al Zahra

94 Browder, G., Nunez Sanchez, A., Jongman, B., Engle, B., van Beek, E., Castera Errea, M., and Hodgson, S. (2021). An EPIC Response: Innovative Governance for Flood and Drought Risk Management. Washington D.C.: World Bank [link]

95 UNOPS, The World Bank, and Rural Access Program (2023). Baseline Data Study of Yemen Emergency Lifeline Connectivity Project (unpublished project report).

districts with public service areas, nearby markets and commercial city centers, has experienced disruptions extending over 51 days per year due to torrential rains. As a result, people use an alternative bumpy dirt road, increasing travel times to the market by more than three hours. The CCDRs model projections suggest the road assets exposed to 100-year pluvial and fluvial flood risks are expected to reach 40,000 km by 2040. Bridges are also affected, in terms of increased moisture, washaways, and overtopping from riverine flooding events, as well as the increasing frequency and intensity of precipitation events adding to the annual repair and maintenance costs. Increases in sea level rise (SLR) and coastal flooding are also likely to damage coastal infrastructure, including seaports, with Yemen having been identified as one of the five most vulnerable low-income countries and Aden the world's sixth most vulnerable city to SLR and storm surge.[96]

A transport network analysis identified key corridors that are critical for the nation-wide logistics chain along with access roads that are important for vulnerable populations. Given that Yemen imports nearly 90 percent of food needs through Al-Hodeidah, Ade, Salif, and Mukalla ports, along with humanitarian aid and fuel, the analysis focused on crops by assessing the exposure of the logistics and freight activities to climate risks. Road links with high criticality that play important roles in the freight network, including the N1, N2, N3, N4, and M55, constitute roughly 13.7 percent of the network (Figure 3.15) and are likely to cause broader disruptions to imported crop traffic due to the increased likelihood of climate events. Some of the coastal roads, such as from Aden to Mukalla and Al Ghayzah, are particularly susceptible to sea level rise. Rehabilitation of these links would cost in aggregate US$160 million. There are also several road links that may not be major arterials, but which would have serious implications for the communities they serve if disrupted due to the lack of alternative routes. The analysis estimates that more than one million people in Lahij and 2 million in Hadramawt, Ta'iz, and Sana'a would face severe connectivity disruptions in a 200-year flood event by 2050 (Figure 3.16). Road links with high criticality, once disrupted, would have serious implications for the communities they serve and should therefore be prioritized for rehabilitation to mitigate the risks.

Figure 3.15. Road Network and Critical Traffic Flow for Yemen (Crop-Weighted Criticality), 2050 by Quantile (RCP7.0)

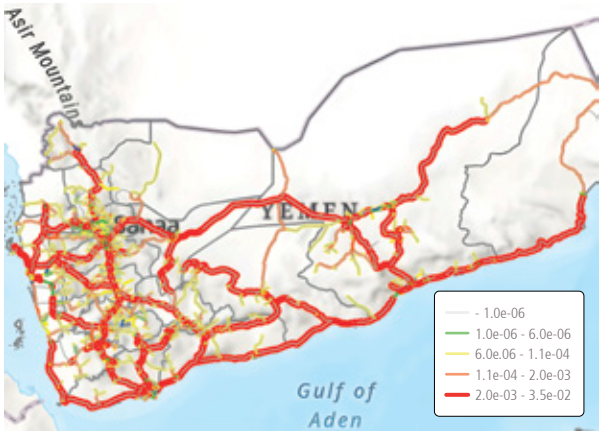
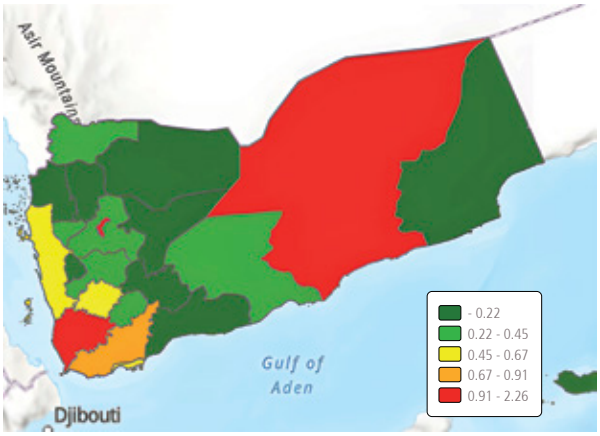


Figure 3.16. Millions of People with Flood-Inducted Connectivity Disruptions by 200-year Floods in 2050 by Governorate (RCP7.0)



Source: Original for this publication.

The impacts associated with climate change are projected to increase damages to roads by as much as 45 percent. The annual incremental road costs and delays due to climate change are expected to worsen from 2041 to 2050 under both climate scenarios with respect to the historical baseline in the absence of adaptation measures. Annual costs in the 2040s increase by approximately US$90 million and US$85 million

96 Yemen Family Care Association (2023). Climate Change Impacts on Yemen and Adaptation Strategies. [link]

relative to the historical baseline under the SSP2-4.5 and SSP3-7.0, respectively. These damages are driven predominantly by flooding impacts (accounting for more than 72 and 67 percent of total damages under the SSP 2-4.5 and SSP3-7.0 ensemble means, respectively), followed by precipitation and temperature related damages. Similarly, annual costs due to increased road repair and maintenance between 2041 and 2050 are projected to total between US$100 and US$98 million under the SSP2-4.5 and SSP3-7.0, respectively. These impacts are expected to be more prominent in eastern governorates such as Al Mahrah, as well as Sana'a and Dhamar governorates and other western-center areas of the country.

Bridges will also be subject to increases in maintenance and repair costs as washaways, overtopping, and increased moisture due to riverine flooding events. The future impacts associated with shocks due to inland flooding on bridges are projected to increase, with damages reaching nearly US$200 million under the SSP3-7.0 ensemble mean in the period from 2041-2050. In contrast to single flood impacts, the expected annual damages from inland flooding on bridge infrastructure is anticipated to result in incremental damages of nearly US$9 million by 2050 under SSP3-7.0. Under the historical baseline, severe storms (100-year events) are projected to damage bridge assets on average by US$237 million per annum. Climate change is expected to increase the annual damage by 11.8 percent to US$265 million. The analysis found that the damages of more moderate storms (25-year events) will increase significantly from the historical baseline to 2050, from US$13 million per annum by 13-fold to US$172.9 million, by 2050.

The climate induced impacts on roads and bridges will result in delays and disruptions affecting labor productivity, estimated to reach 1.4 percent of GDP loss. This is expected given the country's high proportion of tertiary gravel roads which are most vulnerable to the impacts of flooding and precipitation. During the period from 2041-2050, road delays are anticipated to increase by 21 and 22 million hours under the SSP2-4.5 and SSP3-7.0 climate means (Figure 3.17). Under the baseline scenario with no planned adaptation, total annual delays are estimated at around 30 million hours for the SSP2-4.5 and SSP3-7.0 means. This corresponds to a labor supply shock of approximately -0.2 percent due to traffic delays. The expected annual change in labor supply due to bridge infrastructure damage for the Baseline scenario across selected climate scenarios is expected to reach -0.10 percent by 2050 under SSP3-7.0 (Figure 3.18).

Figure 3.17. Projected Annual Road Costs by Adaptation Scenario, 2041-2050

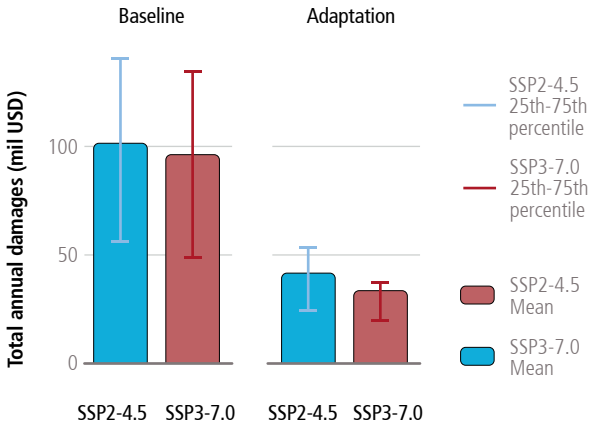
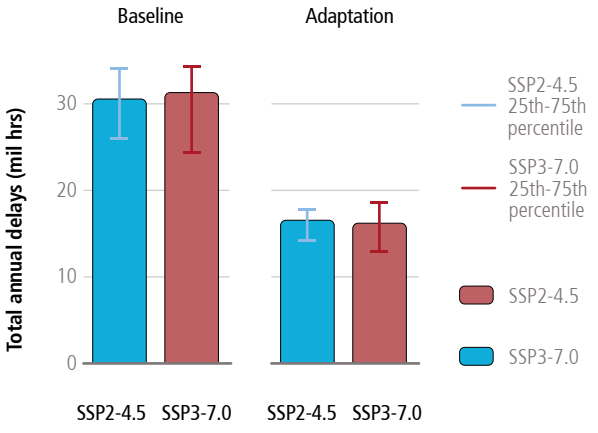


Figure 3.18. Projected Annual Delays by Adaptation Scenario, 2041-2050



Source: Original for this publication.

Investments in more resilient road infrastructure and bridges could reduce total damages by more than half under both climate scenarios. Yemen has traditional techniques such as stone pavement of village access roads that are low-cost and resilient to climate hazards. Identification of interventions

should leverage locally available knowledge and techniques, using local insights on flood and landslide risks to complement analytics based on higher level and external data and projections, considering nature-based solutions where beneficial. Investing an estimated US$620 million in increasing the resilience of road assets to the significant impacts of flooding expected in the future under climate change, by US$1.28 billion cumulatively 2021-2050, while the labor supply shock would decrease by 10 percent to -0.2 percent. Such investments could reduce the cost to around US$8,676 annually per km compared to a projected increase in annual damages to roads by around US$21,019 per kilometer under the SSP2-4.5 ensemble mean without adaptation. Annual transportation delays are projected to be reduced from between 6,311 and 6,489 hours per km to between 3,343 and 3,422 hours per km as a result of the implementation of adaptation measures. The development of new climate-resilient roads would reduce commuting delays to around 15 million hours under both scenarios. This translates to reductions in labor supply shocks, reaching -0.07 and -0.06 percent on average by 2041-2050 under the SSP2-4.5 and SSP3-7.0 ensemble means, respectively. Improving bridge design standards and investing in adaptation measures, estimated cumulatively at US$169 million (2021-2050), is projected to have positive effects. For example, the annualized damage to bridges is projected to be reduced, by 9 percent to US$252.9 million per annum for 50-year flood events. The adaptation measures would also reduce the labor supply shock to -0.07 percent as compared to -0.1 percent, by 2050.

Investing in climate-resilient logistics and transport infrastructure and logistics also generates a range of co-benefits supporting broader social and economic objectives, contributing to green, inclusive development and the well-being of communities. Logistics and transport infrastructure serve as the foundation for enabling economic activities and can significantly contribute to the sustainability and accessibility of essential services. Resilient infrastructure is often safer, reducing the risk of accidents and injuries, which is particularly important for vulnerable populations who rely on safe transport for access to essential health and education services. By minimizing weather-related delays and damage, resilient transport infrastructure can lower the costs associated with logistics and maintenance, improving economic efficiency and savings for service providers and users, potentially making services more cost effective and affordable. Such measures also promote greater social inclusion and contribute to safeguarding human capital by facilitating access for all segments of society to transport services under all weather conditions, ensuring access to education, healthcare and other essential services that are critical for productivity and economic growth. By focusing on climate resilience, transport infrastructure and logistics not only provide immediate employment opportunities but also contribute to the long-term sustainability of job markets by protecting against climate-related disruptions, enhancing supply chains, and stimulating economic growth by enhancing access to markets and reducing transportation costs. Resilient transport investment should also be complemented with a systematic public transport development to promote greater social inclusion, by ensuring transport systems are accessible for all segments of the population to reliably access essential services and contribute to safeguarding human capital.

The domain of possible interventions to manage climate and disaster risks in Yemen depends on the broader enabling context. Under the status quo, continued political instability limits the implementation of the full set of adaptation measures. This is due to a number of contributing factors, including security concerns, competing humanitarian demands, limited access to financing and limited human capacity. In this context, preserving the foundations for future development can take the form of strategically selected rehabilitation works of infrastructure assets with the immediate policy objectives notably food security and protecting people from emergent climate hazards. Under a more optimistic scenario of peace and prosperity, rehabilitating existing infrastructure including roads, bridges, and strategic infrastructure facilities, such as seaports and airports, would be an essential for adapting Yemen's economy to the projected impacts of climate change. Airports are increasingly vulnerable to climate events such as heatwaves, heavy rainfall, and sandstorms, posing serious safety risks to the traffic. Measures such as improved drainage systems, heat-resistant materials, and advanced weather monitoring and forecasting systems would build climate-resilient connectivity to the rest of the world. Yemen has no public transport, and road-based passenger mobility in

Yemen is entirely by the private sector that are not regulated or planned. The poor quality of the fleet and operation, operational safety risks due to dangerous driving behaviors, as well as unregulated price and affordability challenges limit mobility, especially of the most vulnerable, for trips both outside cities and within and in-between cities. Development of a multimodal urban transport strategy and master plans will facilitate collaboration of stakeholders to improve the sector and unlock development financing. In the interim, the rehabilitation of roads and bridges should incorporate proactive climate resilience measures to improve the ability of these assets to withstand higher levels of temperature, precipitation, and flooding events. For those bridges that have reached their design life, replacement should account for the exposed flood risks and designed adequately e.g., a bridge designed for the 25-year flow to be upgraded to the 50-year design event where appropriate. Approaching programmatically, rehabilitation of assets should be prioritized based on network criticality among other policy priorities.

If a pessimistic scenario prevails, the emphasis should be on preserving the existing critical infrastructure assets in priority geographical areas. Determining the minimum investments in transport and logistics infrastructure needed to safeguard the resilience of local communities to climate change involves a complex array of considerations that take into account various factors. These include the current state of infrastructure, climate risk assessments, economic considerations, and the specific needs of the community. The actual investments will vary greatly depending on the geographic location, the economic value of the infrastructure, the severity of the anticipated climate impacts, as well as the resilience goals of the community. Given this, and the limited financial resources available, an area-based approach tailored to the local context is needed to maximize impact through incremental approaches. Low cost and labor-intense road maintenance works involving simple manual labor (e.g., gutter clearing, masonry repairs, pothole patches) can maintain road assets in a condition that can improve the likelihood of withstanding extreme weather events. These works can be engaged as community-based contracting to strengthen the ownership of locales for the assets that provide their lifeline connectivity while laying the foundation for the private sector to emerge in the local economy.

Informing and empowering local institutions, as well as geographic areas with weak institutions and/or limited endowments, will be critical to building resilience. Initiatives to raise awareness and build capacity will be essential for people and local institutions to access and benefit from such resources. Capacity-building support to develop and maintain technical expertise at local levels, in such areas as meteorology and essential equipment, can target vulnerable areas with weak institutions while having national benefits. International support for preserving critical infrastructure should focus on alleviating bottlenecks to support the localized effort to rehabilitate and maintain infrastructure assets. For instance, the Road Maintenance Fund (RMF) under the Ministry of Public Works and Highways would benefit from strengthening the capacity for revenue collection from fuel sales as well as maintenance works programming. Building capacity around sustainable contracting modalities to package the design, construction, and maintenance of road segments through private contractors for fixed payments would improve predictability and sustainability in providing strategic infrastructure as a service to people and businesses. The development community can also support rehabilitation and maintenance of critical infrastructure assets, targeting areas that are particularly vulnerable and/or with weak institutions. In the event of climate and disaster risks in specific areas, the continued of the international community will be required to provide humanitarian support and protect the most vulnerable, along with recovery efforts in complementary forms, such as cash for work and community-based contracting.

3.2.3. Addressing Yemen's Energy Needs as a Means for Building Resilience

Yemen's energy system is characterized by its limited infrastructure, which has been severely impacted by ongoing conflict and political instability. The country has one of the lowest rates of electricity access in the Middle East with only 66 percent of the population having had access to power before the

conflict in 2014. Electricity supply and demand were out of balance, with installed capacity 20 percent short of peak demand and direct and indirect subsidies costing the country over 10 percent of GDP annually.[97] Weak public electricity utilities, inconsistent fuel supplies and pricing, resulted in operational inefficiencies and poor quality of service, with only 12 percent relying on public electricity. This dropped to 10 percent due to extensive damage to the national grid,[98] with a significant portion of the population lacking reliable power and the critical power infrastructure that remains intact often sitting idle due to fuel shortages.

Yemen possesses substantial hydrocarbon resources, and the energy sector has been heavily reliant on fossil fuels. With the exception of the gas-fired Marib power plant, which came online in 2009, all electricity has historically been generated by old and inefficient HFO/diesel fired plants owned by the Public Electricity Corporation and small diesel units contracted through short-term rentals with the private suppliers. HFO and diesel fired-power plants accounted for about 70 percent of grid-connected generation in 2010, with millions more small diesel units owned by industry, commercial establishments and households to combat the frequent blackouts of the lack of access to the grid-connected electricity. However, the sector suffers from chronic underinvestment and lack of maintenance, with a substantial need for investment in existing power facilities and the development of new, more resilient energy infrastructure, Furthermore, Yemen's oil production has significantly declined, with forecasts indicating exhaustion of privately-operated oil fields by 2030-2033 and state resources by 2033, without further investment in exploration, while natural gas production peaked in 2013 and has plummeted due to the conflict.

Yemen has an abundance of naturally renewable resources and some of the highest levels of solar irradiation globally. The practical potential of solar energy, onshore wind, and geothermal is estimated at over 55 GW.[99, 100] While many Yemenis lack access to the basic infrastructure and resources to harness such potential, generation through small solar-powered systems has experienced remarkable growth due to collapse of the state system and the need to meet the increasing demand. In 2020, 74 percent of the population had regained access to electricity (93 percent urban; 62 percent rural) with 75 percent using solar PV, and 12 percent each using private and national grids. Consequently, distributed solar energy has become a vital resource for millions of households and businesses. Other renewable energies, such as networked geothermal or stand-alone ground source heat pump installations, could help to mitigate the required load for critical facilities and reduce the demand on the local grid, but remain untested.

The deployment of distributed renewable energy is essential for climate adaptation and building resilience for millions of Yemenis. Restoring power and ensuring a stable supply is crucial to supporting services and livelihoods that are critical for mitigating climate impacts, like healthcare and water supply, and responding to climate-related challenges, such as waterborne diseases and food security. A stable electricity supply is necessary to maintain cold storage supply chains for vaccines and important medicines, as well as perishable foods, while also supporting water and sanitation facilities, along with other services that are key to building resilience against climate-related impacts, particularly in rural and peri-urban areas where the poorest populations live. Distributed renewable energy also provides opportunities to build the private sector, with the commercial operation of the solar market in Yemen having had cascading impacts on the supply chain, from trading houses that import panels, charge controllers, and batteries, to small-scale retailers, who have expanded their business to solar panels.

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97 Huenteler, J.T. (2017). Restoring and Expanding Energy Access: Power Sector Reengagement Note. Washington, D.C. World Bank Group. [link]

98 Al-Akwaa, G.K.I. (2019). Measuring electricity access amidst active conflict: Lessons from Yemen. World Bank Blog [link]

99 UNDP (2024). A Summary of the Yemen Mixed-Renewable Energy Investment Plan. United Nations Development Programme, May 2024. [link]

100 The strategic location along one of the most active plate boundaries, and at the junction of the Gulf of Aden, Red Sea and African Rift system, gives rise to an estimated 29,000 MW of gross technical and 2,900 MW of gross practicable (which accounts for the accessibility of electrical grid) geothermal potential, the majority of which is concentrated in the western governorates close to the Red Sea.

A scenario-based analysis was carried out to assess development of the electricity sector and identify investments that can contribute to decarbonization. This was done using The World Bank's Electricity Planning Model (EPM), which is a long-term, multiyear, multizone capacity expansion model with economic dispatch, over the period from 2024 to 2040. The objective function of the model is to minimize the sum of discounted fixed and variable generation costs for all zones and years, given certain specific constraints while avoiding long-run costs and risks. This included: (i) an in-depth assessment of the feasibility and implications of various scenarios of Yemen energy transformation by year 2040, (ii) determining the requirements for power sector investments and deployment of suitable technologies, and (iii) identifying regulatory or policy barriers and means to address these. To inform a clean energy transition and enhance climate change resiliency through the climate transformation of the power sector, the CCDR's three scenarios have been used to explore development of Yemen's electricity sector, including modeling of the "Status Quo" and "Peace and Prosperity" scenarios (see Table 3.4 for detailed assumptions). Gas-fired electricity supply depends on Yemen's future gas availability, which is uncertain across scenarios and relies on substantial investments in refurbishing existing facilities, new exploration, or LNG imports, which are not accounted for in this model.

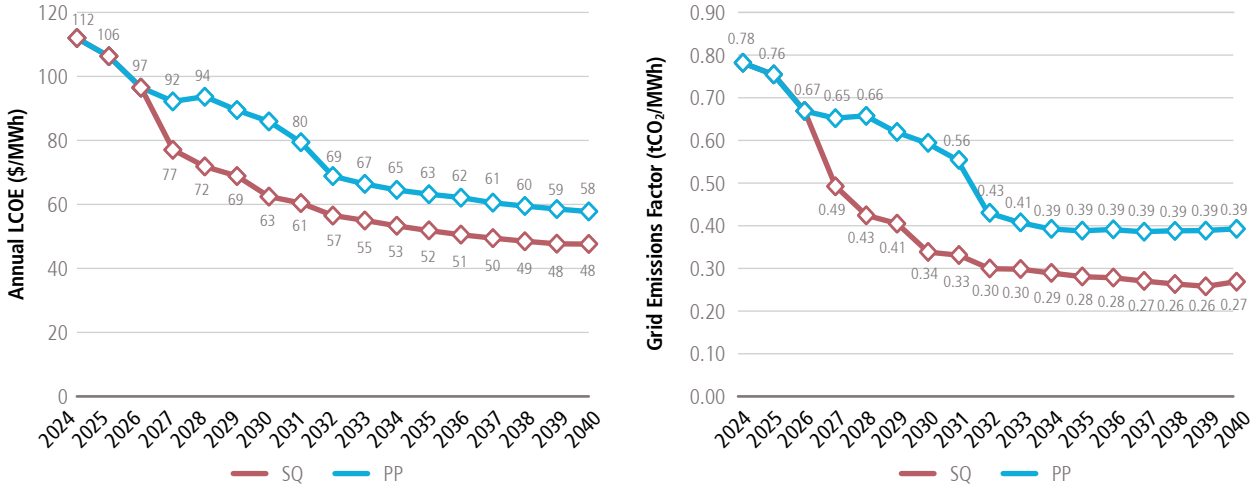
Table 3.4. Power Sector Modelling Scenarios.

Scenario Name	Description	Electricity Demand	Electricity Supply
Escalation (ES) (Not modelled)	• Conflict heightens causing Yemen's GDP to contract by 2% per year.	• -1.6% reduction in electricity demand over 2024-2040 period.	• Off-Grid Solar technologies continue to play a key and increasing role in electricity access.
Status-Quo (SQ)	• Severity of conflict in Yemen is contained to current levels, enabling a moderate 2% GDP growth rate out to 2040	• Linear-Regression GDP based modelling resulting in a 1.2% electricity demand growth rate from 2026-2040.	• 1.5 GW Marib CCGT plant develops over 2029-2032. • 1 GW of Solar PV and 0.9 GW of Wind plants develop by 2040. • Off-Grid Solar technologies continue to play a key role in electricity access.
Peace & Prosperity (PP)	• Conflict in Yemen is resolved and the Country's power system is set on a clean development pathway (5.6% GDP growth).	• Linear-Regression GDP based modelling resulting in a 3.5% average annual electricity demand growth rate from 2026-2040.	• 2.3 GW of CCGT plants develop by 2030, 2.7 GW by 2040. • 2.6 GW of Solar PV and 2.1 GW of Wind plants are deployed by 2040.

In the Escalation Scenario, renewable energy-powered distributed power generation provides a lifeline to critical facilities and resilience to local communities. Solar energy presents a bottom-up resilient solution, reducing dependency on imported fuel. Despite challenges such as the affordability of solar products for vulnerable populations, distributed solar power remains the fastest and most resilient option to address Yemen's severe electricity shortages in the Escalation Scenario. The private sector-driven solar market, with its established supply chain, provides a lifeline for households and critical services, ensuring continued access to electricity even in the most volatile conditions.

The 'Peace and Prosperity' scenario delivers lower cost electricity and lower emissions, while meeting higher levels of demand, compared to the "Status Quo". The Status Quo scenario experiences a temporary rise in emissions over 2028-2031 where a combination of new CCGT and liquid fuels are used to close the supply-demand gap. In the Peace and Prosperity scenario, the early and rapid development of new renewables results in the lowest total emissions, despite having the highest growth of demand. This trend can be seen in the grid emissions factors, where by 2040 the Status Quo results in 0.39 tCO2/MWh, compared to the 0.27 tCO2/MWh in the Peace and Prosperity scenario.

Figure 3.19. Cross-Scenario Power Sector Annual System LCOE, 2024-2050Scenario (Left) / Grid Emission Factor (Right)

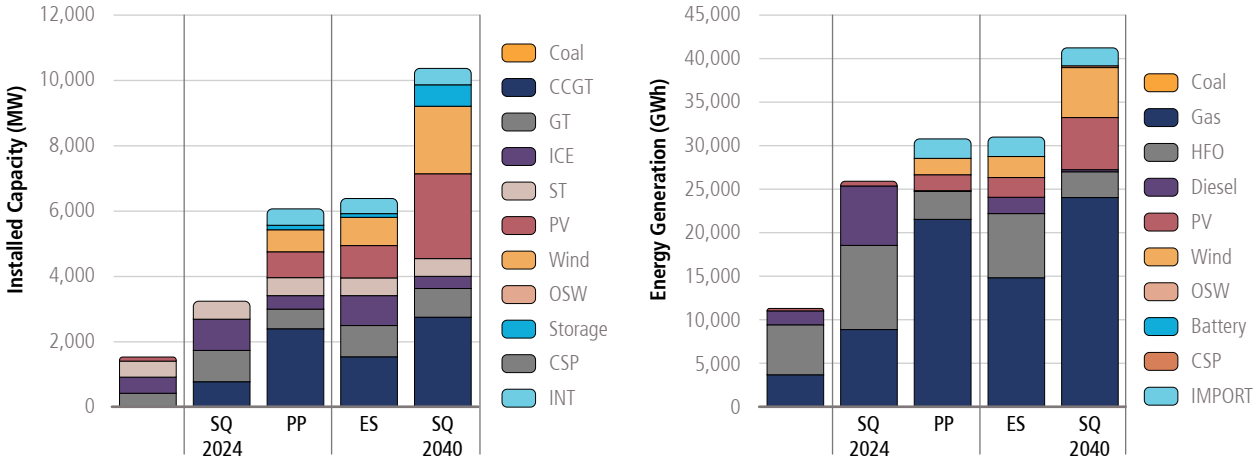


Source: Original for this publication.

Investment requirements in Yemen's power system will vary significantly under each development pathway, requiring an estimated US$4.3 billion in the Status Quo scenario by 2040. The Status-Quo scenario requires up to US$4.3 billion in cumulative investments for new CCGT and renewable energy generators. In turn, there is a significant drop in system costs on a levelized basis, averaging US$78/MWh over the period. To achieve the Peace and Prosperity outlook, up to US$7.1 billion in cumulative investments will be required for additional renewable energy generators in Yemen, up 195 percent from the Escalation scenario, and achieving an average LCOE of US$66/MWh over the period.

There are a number of potential investment options that could help with decarbonization of the power sector and unlock innovative sources of financing. Capturing flared gas associated with Yemen's oil production has significant potential to contribute to decarbonizing the power sector but remains untapped. With an appropriate enabling environment, projects to reduce flaring could generate about 600 megawatts of power and would likely generate carbon credits if the petroleum industry worked with operators and international institutions to reduce, and eventually eliminate, emissions along the value chain. Similarly, the efficiency of the networked geothermal or stand-alone ground source heat pump systems and the ability to deploy them locally, make them a potentially effective way to address the climate hazard challenges in parts of Yemen, particularly for critical facilities such as hospitals, schools, or municipal buildings. Not only do shallow geothermal systems have no inherent emissions, but they are also inherently resilient to the hazards presented by climate change and able to operate regardless of storms, flooding, or heat waves. Additional energy supply sources, such as an interconnection with Saudi Arabia, particularly under the PP scenario, could be both feasible and advantageous, contributing to enhanced energy security and supporting decarbonization efforts.

Figure 3.20. Installed Power System Capacity in Yemen by Scenario (left) / Annual Energy Generation by Scenario (right)



Source: Original for this publication.

Investing in the resilience of Yemen's power sector assets is critical, but will be determined by the enabling environment. Yemen's electricity infrastructure is highly vulnerable to climate and natural disasters, such as floods, storms, extreme temperatures, and coastal surges, which is exacerbated by the damages inflicted by the conflict. Building resilience to exogenous shocks requires locally distributed, off-grid systems such as solar. Other local sources of energy, such as geothermal networks, can reduce reliance on imports or deliveries, and could be particularly important for insulating critical facilities from the risk of a gas line being shut off or an oil delivery not arriving. The lack of maintenance and investment in infrastructure, especially in coastal cities, leaves the national grid at risk of widespread outages due to climate events. Regulatory bodies and emergency management systems are under-resourced and ill-equipped to respond to these challenges, further increasing the vulnerability of the power sector. To mitigate these risks, Yemen needs to invest in maintaining and refurbishing damaged infrastructure, strengthen regulatory frameworks to incorporate climate risk planning, and enhance institutional capacity for disaster risk reduction and climate resilience.

3.3. Adaptive Human Development

Hurdles in human development in Yemen are multidimensional as access to basic services, education, and health have faced significant deprivations in the last decade. Life expectancy at birth fell from 68 years in 2013 to 64 years in 2021, far below the MENA regional average of 73 years. Malnutrition has remained the top risk factor for total disability-adjusted life years (DALYs) since 2009. This figure is the second highest in the MENA region, nearly equivalent to Afghanistan. Over 50 percent of the population has insufficient access to water, energy, garbage collection, or food, and about a quarter of the population has insufficient access to all.[101] Food insecurity is heightened in the governorates of Saadah, Hajjah, Amran, Marib, Hodeidah, Raimah, Dhamar, Al Dhale'e and Abyan, some of which also experience high numbers of conflict incidence.[102]

Multiple intersecting deprivations will cause short-term deficiencies and long-term intergeneration barriers to human development even in the absence on climate change. Practically every Yemeni is exposed to harmful air pollution levels, while 7.2 million are exposed to extreme heat, 6.7 million to drought, and

101 Favari, E., Krishnaswamy, S., Tandon, S.A., Aghajanian, A., and Almoayad, S. (2023). Surviving in the Time of War : How and Why Well-Being Is Evolving in the Conflict in Yemen. Washington D.C.: World Bank. [link]

102 As per the Armed Conflict Location and Event Data (ACLED) [link]

7.4 million to flooding. There is geographical overlap in areas where people are exposed to extreme heat and drought. This implies that the average probability of a compound shock involving extreme weather events is likely to be much higher in some areas, such as the coastline. When also considering exposure to conflict related events, the vulnerabilities levels are even higher, while around 10 million people could be exposed to extreme heat when considering projections to 2050, many of them living in governorates with a high prevalence of asset wealth-based poverty.[103] Reduced food access coupled with poor asset based wealth, lack of medical care and access to clean drinking water could exacerbate the malnutrition and development challenges Yemenis already face. Combining climate related hazards to these pre-existing issues can push the population further into extreme poverty. Implementing shock-responsive social protection systems will be critical to address these heightened and overlapping vulnerabilities.

More than 4.5 million people are displaced by the conflict in Yemen, with 234,000 new displacements in 2022 alone[104], which limits resources both for the host communities and the displaced people. In addition to this, Yemen hosts around 99,877 refugees and asylum seekers, 70 percent of whom are Somali and 20 percent Ethiopian - making Yemen the world's fourth largest host of Somali refugees. Most of the internally displaced population and refugees live in overcrowded and impoverished neighborhood of the bigger cities in unsuitable accommodations without access to water and energy services. This has also put pressures on the infrastructure of cities like Taiz, that has seen an influx of 750,000 people since the outbreak of the conflict and is unable to provide the required WASH services for the growing population. The shrinking economy and dwindling employment opportunities in the urban areas also forces people to migrate to their villages or places of origin to take up less productive tasks in areas with fewer potential for health and education services, especially for women and girls. In the absence of climate adaption of the major population centers of Yemen, the most vulnerable people in the urban centers will face the direst impact. At least 26 percent of displaced households are female-headed, 20 percent of whom are under the age of 18[105] and 75 percent of the IDPs are composed of women and girls.[106] In the recent past, the poorest within the host communities have expressed displeasure by humanitarian resources being directed to the IDPs which has fueled tensions and conflicts within these communities.[107] If the population continues to get displaced due to the conflict or climate related shocks, these tensions are likely to rise.

3.3.1. Safeguarding Human Capital

Fluctuations in climate conditions create insufficiencies for food and nutritional security as they impact agricultural production, storage, processing, distribution, and consumption. Yemen ranks 126th out of 127 countries on the Global Hunger Index (GHI 2024) and has the 3rd highest number of people suffering from hunger across the globe (WFP 2023). Roughly half the population—17 million people in Yemen—remain food insecure.[108] Food insecurity in Yemen is also induced by conflict associated disruptions in food systems, transitioning to water-intensive cash crops like qat, and dependence on food imports which are subject to international trade, currency fluctuations, and conflict risks. A number of contributing factors have been identified as drivers of the country's falling agricultural productivity, increasing food prices and reliance on staple imports. Among others, these include limited arable land

103 CSO and UNICEF. (2023). "Yemen Multiple Indicator Cluster Survey 2022-2023, Survey Findings Report." Yemen: Central Statistical Organization and United Nations Children's Fund

104 UNHCR (2024) Yemen Humanitarian Crisis. [link]

105 UNHCR (2024) Yemen Crisis Explained. [link]

106 World Bank. (Forthcoming) Climate and Health Vulnerability Assessment. Washington D.C.: World Bank.

107 Kim, J., Elsamahi, M., Humphrey, A., Kadasi, A., & Maxwell, D. (2022). Sharing to Survive: Investigating the Role of Social Networks During Yemen's Humanitarian Crisis. Washington, DC: Resilience Evaluation, Analysis and Learning (REAL) Associate Award. [link]

108 World Bank. (Forthcoming). An Economic Assessment of the Health Impacts of Climate Change in Developing Countries. Washington D.C.: World Bank.

and water resources, exacerbated by poor water management, damage from extreme hydrological events, and transitions from traditional to unsustainable agricultural practices.[109] Severe poverty, especially in rural areas, magnifies all these challenges.[110, 111, 112]

In Yemen, 40.7 percent of children are moderately or severely underweight, 48.6 percent are stunted, and 16.9 percent are wasted.[113] Children under five who are stunted face chronic malnutrition and thus limits on height, and children facing wasting are too thin or face increased risk of death due to rapid weight loss. Across all governorates, the prevalence of stunting is highest in Raymah at 69 percent. Children with mothers who have formal education see fewer instances of stunting.[113] These results indicate that inadequate nutrition and repeated bouts of diseases are actively limiting the potential of young people. These factors also go on to create negative impacts on income generating capacity into adulthood for these children.[114] More than 90 percent of all children aged six to 24 months were not receiving the minimum acceptable diet in 2022. Stunting cases are projected to see an additional 89,000 cases in 2050 (14.7 percent of total) will be attributable to climate change by midcentury. This translates to more than US$90 million additional climate change-attributable costs associated with stunting in 2050.[121]

Young people in Yemen are missing out on critical education which could help catapult them out of poverty and aid post-conflict recovery. Over two-thirds of the children live in hard-to-reach areas which limits their educational opportunities. Displaced children face educational deficits due to disruptions. Young people remain among the most impacted by the on-going conflict as 2,426 schools were reportedly non-functional due to damages or use as shelter or other purposes. In 2023, 4.5 million children did not attend school, and 1.3 million must deal with overcrowded classroom and overburdened teachers. Teachers are often front-line workers in developing environmental sensibilities in the youth, but degradation in working conditions for teachers has deterred young people from choosing the profession. Poor infrastructure, road closures, and lack of transportation also make it especially difficult for women to access higher education. Policies that support primary and secondary educational infrastructure that combine traditional and modern knowledge will create human capital that is productive and sensitive towards climate adaptation.[115]

Health and productive capacity of outdoor workers and IDPs are at increased risk because of incidences of severe heatwaves in major coastal cities, especially Al Hodeidah, Aden, and Mukalla. Due to limited electricity access (74.9 percent as of 2021), the population is not well-equipped to adapt to extreme heat driven by climate change. The health risks related to extreme temperature will also depend on humidity levels, which can increase the feels-like temperature and limit the capacity of the body to cool down. Illnesses related to extreme heat, like lower respiratory infections, ischemic heart disease, chronic kidney disease, hypertension, etc., per 100,000 people, are projected to increase from 141 cases in 2020 to nearly 1,400 by 2050, with 350 cases directly attributable to climate change. This translates to more than US$73 million in excess health costs attributable to extreme heat in 2050.[129] Considering a wet-bulb temperature, which measure how well one can cool themselves by sweating, in a 100-year return period, there are over five million Yemenis exposed to temperature over 35 degrees Celsius. Most of these people are concentrated in Al Hodeidah governorate (2.5 million people), followed by approximately 700,000 people in Aden and 500,000 people in Hadramawt

109 Researchers and The Republic of Yemen government publications

110 EPA (2009). National Adaptation Programme of Action. Environmental Protection Authority, Sana'a.

111 Noaman, A. A. (2018). Third National Communication to the Conference of the Parties of United Nations Framework Convention on Climate Change. E. P. Authority. Sana'a

112 YFCA (2023). Climate Change Impacts on The Republic of Yemen and Adaptation Strategies. Sana'a, The Republic of Yemen Family Care Association

113 CSO and UNICEF (2023). The Republic of Yemen Multiple Indicator Clustery Survey 2022-2023 Survey Findings Report Multiple Indicator Cluster Survey 2022-2023. The Republic of Yemen, Central Statistical Organization United Nations Children's Fund.

114 Galasso, E, Wagstaff, A., Naudeau, S., and Shekar, M. (2016). The Economic Costs of Stunting and How to Reduce Them. World Bank Policy Research Notes. Washington D.C.: World Bank. [link]

115 Wamsler, C., Brink, E., and Rentala, O. (2012). Climate Change, Adaptation, and Formal Education: The Role of Schooling for Increasing Societies' Adaptive Capacities in El Salvador and Brazil. Ecology and Society, vol. 17, no. 2, 2012. [link]

(). There are approximately 400,000 children under five years of age exposed to wet-bulb temperatures of 35 degree Celsius. The combination of increased hot days and tropical nights disproportionately effect the elderly, pregnant women, children and newborns, people with chronic illnesses and disabilities, as well as outdoor workers, low-wage earners, and people living in areas with poorly equipped and ill-prepared health services.

Precipitation anomalies, floods, and degraded water infrastructure due to the conflict have led to substandard water quality which is the root cause of water-borne disease threats. This degradation has led households to indicate that about 50 percent of all health problems during the conflict are due to inadequate access of sanitation and clean drinking water.[116] Children under five years of age are at increased risk for diarrheal diseases, especially when compounded by coinciding nutritional deficiencies, and the last decade has experienced outbreaks of hepatitis A, typhoid, and leishmaniasis in addition to its major cholera epidemic, as recently as 2024. As a direct result of the conflict, the population without access to clean water rose from 28 percent in 2015 to 69 percent in 2017. According to United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), by 2018, 95 percent of the country was relying on private or unregulated wells or basins, and more than 15 million Yemenis (about half the population) were experiencing trouble accessing water.[117] Nationally, 18.9 percent of households use unimproved water sources. This rate is higher for rural and impoverished households (26.0 and 54.2 percent, respectively). Additionally, 37.4 percent of households have no access to improved sanitation facilities, with rural and impoverished households reporting rates of 51.6 percent and 75.9 percent, respectively. With changes in projected precipitation, associated health challenges of water-borne diseases could be exacerbated. This translates to more than 200 additional deaths and more than US$120 million in excess health costs attributable to diarrhea in 2050.

Weather and climate variability are critical drivers of spatio-temporal vector-borne disease distribution and transmission, which persists in Yemen despite improvements seen in regional peers. Droughts and precipitation variability and anomalies under climate change are likely to be major drivers behind vector-borne diseases.[118] The priority vector-borne diseases of concern in Yemen are malaria and dengue, primarily carried by *Anopheles arabiensis* (optimum survival at 32 degrees Celsius) and *Aedes aegypti* (optimum survival between 25 and 30 degrees Celsius) mosquitoes, respectively. Dengue-attributed DALYs in Yemen have grown rapidly at an annual average of almost 5.5 percent in the period 1990-2019, which made dengue the fastest-growing single cause of death and disability in the country during this period (second only to conflict and terror). Malaria is responsible for 2.3 percent of all DALYs in The Republic of Yemen, compared to just 0.3 percent for the MENA region.[119] More than 1.2 million excess cases of malaria by 2050 is estimated to be attributable to climate change, including more than 8,800 excess deaths. This translates to more than US$5 billion in excess health costs, cost of treatment and loss of income, attributable to dengue and malaria.[120]

3.3.2. Increasing the Resilience of Health Systems

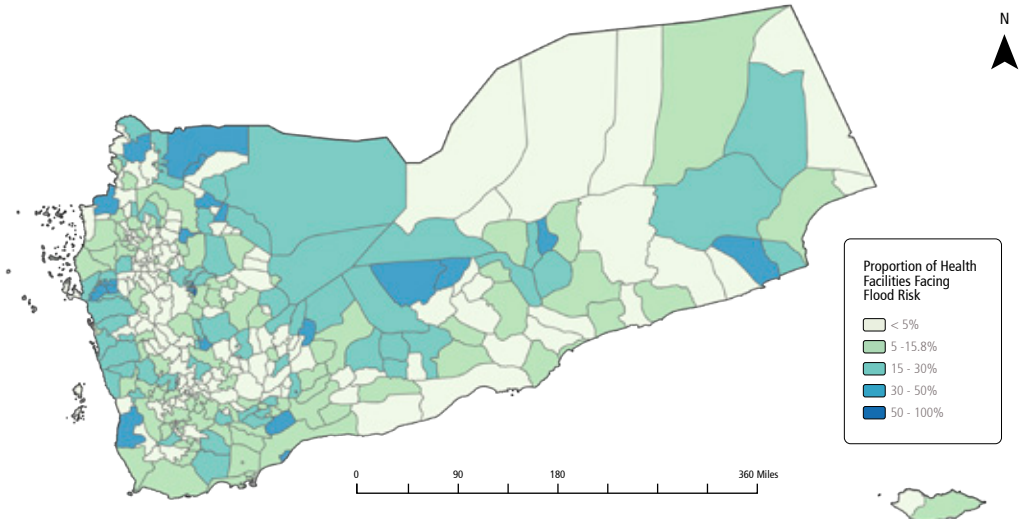
The conflict has rendered the health infrastructure in a state of disfunction and emergency support is the main driver of health infrastructure in the country. Healthcare facilities, staff, and resources were already inequitably distributed before the conflict, and violence forced half of all facilities in the country to close or operate at reduced capacity by 2018. Existing administrative and logistical challenges were severely

116 World Bank (2024) Charting the Course - A Water Security Diagnostic for Yemen. Washington, DC. World Bank. [link]
117 Sowers, J. and E. Weinthal (2021). Humanitarian challenges and the targeting of civilian infrastructure in the Yemen war. International Affairs, Volume 97, Issue 1, January 2021, Pages 157–177. [link]
118 Bellizzi, S., C. Lane, M. Elhakim and P. Nabeth (2020). Health consequences of drought in the WHO Eastern Mediterranean Region: hotspot areas and needed actions. Environ Health 19(1): 114. [link]
119 Global Burden of Disease Collaborative Network (2024). Global Burden of Disease Study 2019. University of Washington Institute for Health Metrics and Evaluation, Seattle.
120 World Bank. (Forthcoming). An Economic Assessment of the Health Impacts of Climate Change in Developing Countries. Washington D.C.: World Bank.

exacerbated by the conflict, resulting in coverage and quality-of-care losses; an estimated 16.4 million Yemenis lacked access to health services in 2017. Concurrently, Yemen became one of the most dangerous countries in which to practice medicine, as both healthcare facilities and workers were directly targeted by airstrikes and other military operations. This difficult reality, combined with years of missing paychecks for public employees, forced much of the country's trained healthcare workforce to flee to neighboring countries.[121]

The impact of climate change on health challenges in Yemen is loaded with increased health costs and unanticipated issues under the Status Quo. These include increasing the severity and frequency of health problems, with the projections in the section above outlining the more than US$5 billion excess costs due mortality and morbidity from diseases exacerbated by climate change. Under a future climate change scenario (SSP3-7.0), in 2050, a 1-in-100-year flood event[122] would further debilitate health infrastructure putting 433 health facilities (currently operational) in the country at risk of at least 15 centimeters of floodwater depth. Out of 335 districts, 190 (56.7 percent) will have at least one health facility exposed to this risk. Of these, 21 districts (11.1 percent, or 6.3 percent of the total) will have five or more facilities at risk. The resident population in these areas is also exposed and vulnerable to direct injuries, and roads are at risk of floods as well, which can impact the access to health facilities, and supply chains during these events. Climate change will also create a number of unanticipated health problems which could include health issues impacting different groups of people or geographical locations. Resilience of health systems can aid swift action towards changing scenarios.

Figure 3.21. Health Facilities at Projected Risk of at Least 15cm of Floodwater Depth (100-Year Return Period, 2050).



Source: World Bank (forthcoming) Yemen Climate Health Vulnerability Assessment. Washington D.C.

On a macroeconomic level, health challenges only decrease projected labor supply by approximately one percent under the Status Quo scenario. Even though the cost from the health issues is projected to increase, the labor supply impacts of climate change are relatively small. However, household-level and system-wide healthcare effects might still be significant due to continuous increases in mortality and morbidity as a result of climate change. Mortality and morbidity of the water-borne, heath-related, and vector-borne

121 Sowers, J. and E. Weinthal (2021). Humanitarian challenges and the targeting of civilian infrastructure in the Yemen war. International Affairs, Volume 97, Issue 1, January 2021, Pages 157–177. [link]

122 A 1-in-100-year flood event is an extremely intense flood which has one percent chance of occurring in any given year. Under the SSP3-7.0 climate scenario, an intense flood like this would put the health facilities at risk by inundation. This means that the health infrastructure would be severely impacted.

diseases are expected to increase due to climate change. Under the Dry/Hot mean climate scenario, the model (Table 3.5) shows an increase in mortality and morbidity for all four diseases considered. Increases in mortality are anticipated to be largest for heat-related illnesses (+11.9 deaths per 100,000 people), followed by malaria and water-borne diseases, respectively. For malaria, increases in temperature result in conditions that drive increased malaria transmissions. These increases are caused by a positive relationship between disease incidence and temperatures, which continuously increases the fraction of cases that are caused by extreme temperatures above the optimum for heat-related illness and facilitates the spread of pathogens for waterborne diseases. Relative to other disease types, only small changes in mortality or and small increase in morbidity for dengue are observed under the Dry/Hot mean scenario. In large part, increases in mortality and morbidity rates are smaller in the Wet/Warm scenario compared to changes under the Dry/Hot mean scenario, except for dengue.

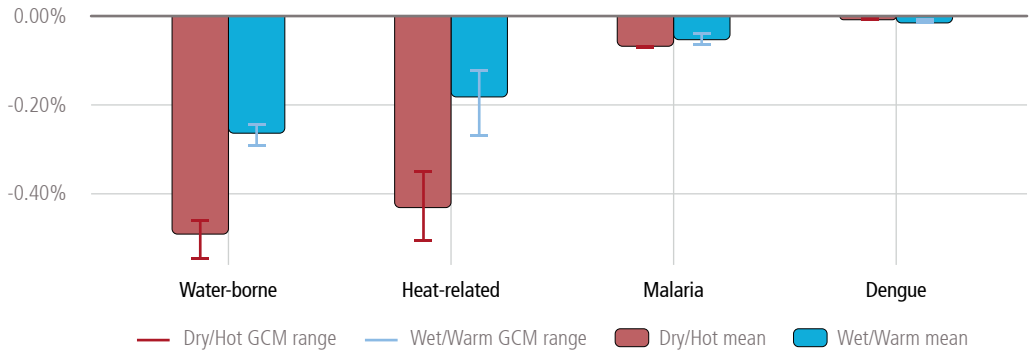
Table 3.5. Change in Mortality and Morbidity Rates (per 100,000 people) by Disease, 2041-2050

Disease	Original Rates		Rate Change in Dry/Hot Mean		Rate Change in Wet/ Warm Mean	
	Deaths	Cases	Deaths	Cases	Deaths	Cases
Water-borne	22.5	137,762	3.3	20,403	18	11,104
Heat-related	6.1	8,513	11.9	16,645	5.2	7,198
Malaria	15.3	2,218	3.6	522	3.1	443
Dengue	0.018	307	0.009	149.3	0.017	294.7

Note: Cells colored red indicate an increase in mortality or morbidity. The values shown represent average annual changes in mortality and morbidity (per 100,000 people) in the period from 2041-2050.

Source: Original for this publication.

Figure 3.22. Average Labor Supply Shock by Disease, 2041-2050.



Note: Figure 3.22 presents shocks to labor supply by disease in the period from 2041-2050 for the baseline scenario with no planned adaptation.

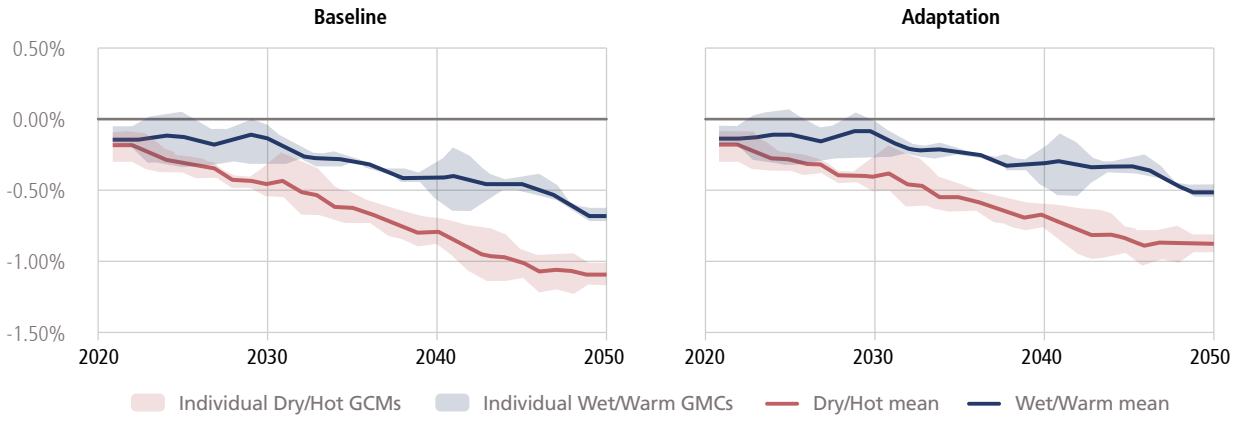
Source: Original for this publication.

Across all four disease categories, water-borne and heat-related diseases are expected to be responsible for the majority of the estimated negative labor supply shock. These are followed by heat-related diseases and malaria, respectively. Dengue imposes negligible labor supply shocks under both mean climate scenarios. Additional disease impacts relative to current conditions are greater under the Dry/Hot mean scenario in

comparison to the Wet/Warm mean scenario. For water-borne and heat-related diseases, this is caused by a positive relationship between incidence and temperatures: every degree above the optimum temperature increases the number of cases of heat-related illness and facilitates the spread of pathogens for waterborne diseases. The change in diseases patterns is likely to impact children disproportionately given their exposure to multiple risk factors. This will further have negative impacts on human capital accumulation.

Under the Adaptation scenario which sees an improvement in mortality and morbidity trends, we anticipate labor supply impacts to improve with respect to the baseline scenario with no planned adaptation. Based on the changes in labor supply due to disease mortality and morbidity relative to current conditions, the overall labor supply in the country is expected to decrease over time as mid-century approaches under the baseline scenario with no planned adaptation, with the magnitude of the decrease across GCMs being relatively small (left panel of Figure 3.23). Throughout the period out to 2050, we expect shocks under the Dry/Hot mean scenario to be more severe than the Wet/Warm mean scenario. By 2041-2050, the Wet/Warm mean and Dry/Hot mean scenarios result in shocks of around -0.5 and -1.0 percent, respectively. For the Adaptation scenario, by the 2040s, the estimated labor supply shocks are -0.4 and -0.8 percent under the Wet/Warm and Dry/Hot means, respectively.

Figure 3.23. Labor Supply Shocks by Adaptation Scenario, 3-Year Moving Average



Source: Original for this publication.

Developing preventive healthcare system will help counteract the impact of water-borne diseases. Considering both mean climate futures, water-borne diseases are likely to experience the greatest increase from current levels as higher temperatures facilitate transmission beyond their already significant fraction of all deaths and cases in Yemen. Heat-related illnesses are also expected to face increases, partly due to very low occurrence under current conditions and partly due to important increases in peak daily temperatures that surpass optimal thresholds more frequently. Malaria suitability is likely to increase due to changes in temperature and precipitation conditions, creating small increases in disease prevalence.

3.3.3. Strengthening Gender and Inclusion

Climate and food security vulnerabilities are multiplied in the increasingly more common female-headed households in IRG areas. This is likely because women have limited access to income generating assets and resources, such as land, financial services and human capital; have less time to spend on income generating activities because of household duties; and face legal and social restrictions. The Yemen Human Development Survey (YHDS) 2021 shows that female headed households are more likely to report exposure to natural disasters. This indicates some clustering of female headed

household in areas with higher vulnerability, potentially due to social exclusion and a lack of coping strategies. A study carried out between 1981-2002 showed women were more likely to have a lower life expectancy than men either due to direct or indirect impact of natural disasters, including, droughts, earthquakes, extreme temperatures, famines, fires, floods, landslides, volcano eruptions, waves/surges, and windstorms.[123] Reasons for this vary with some studies[124] finding that limited access to information coupled with restricted agency and lower socio-economic status makes it challenging for women to make decisions during an emergency.

Sensitivity towards female centric issues can have larger spillover impacts on public good with respect to climate adaptation. Women's issues often exist amidst complex socio-political context that cannot be overlooked. One reason women are unequally impacted by climate disasters is because of lack of mobility.[125] Similar examples can be found in Bangladesh where women face specific hinderances during climate shocks but when flood shelters were constructed and operated with considerations to social norms, it resulted in improvements in lives saved during climate shocks – where cyclones in 1970s could cause up to 300,000 deaths, in 2020 flood related incidences after a cyclone reduced this number to 20.[126] Women can be important agents of change for climate adaptation and disaster preparedness. Discussions with key experts from Yemen reveal that women are not only critical to the community level dialogues for environmental awareness, but also act as interlocutor between parties in local level skirmishes over access to resources. Policies that favor empowerment of women and enable their inclusion as institutional decision makers can improve community level conflict and mitigation of shocks from climate disasters.

Women united in causes for livelihood development and climate activism can have higher bargaining power become agents of tangible change. LLeveraging the collective strength of women, several women groups have emerged in the country with the aim of challenging social norms, improving education, and becoming community leaders.[127, 128] Women organizations can play a significant role in shaping values around climate change. In India, women self-help groups in the state of Odisha[129] have been successful in coastal reforestation, reducing seawater intrusion, and building mechanisms against climate shocks. Moreover, with the rise in the number of female-headed households in the absence of men during the conflict, women can become important partners in value-chain development for several sectors like fisheries[130], coffee[131], and nutritious and underutilized crops like millets and sorghum[132]. An initiative by CGIAR[133] with women's association in Yemen had positive impacts on using climate resilient minor millets as sustainable income generating and nutrition enhancing crops.[147] To ensure women become long-term leaders of change in Yemen for tackling issues of climate and human development it is necessary that they have support to access to large-scale and microfinance to enhance entrepreneurship, and ability to own assets through improvements in legal and social structure around them.

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123 Erman, A.; De Vries Robbe, S.A.; Thies, S.F.; Kabir, K.; Maruo, M. (2021). Gender Dimensions of Disaster Risk and Resilience: Existing Evidence. World Bank, Washington, DC. [link]
124 UN Women (2020). Checklist for Gender Equality and Social Inclusion in Disaster/Emergency Preparedness in the COVID-19 Context. [link]
125 Amnesty International (Accessed Oct 2024). Yemen: One of the Worst Places in the World to be a Woman. [link]
126 Liakath A. (2022). Rethinking shelter: Bangladesh's new approach to protecting lives and livelihoods. Global Center on Adaptation [link]
127 Dutch Relief (2023). Making a different in Yemen, with women in charge. [link]
128 IOM (2024) The Storyteller, Gems of resilience: How Women Craft Hope in War-Torn Yemen. [link]
129 Council on Energy, Environment and Water (2022). Nurturing a Forest How SHGs in Puri Scaled Nature-based Solutions Against Climate Risks. [link]
130 Tietze, U., and Villareal, L. V. (2003). Microfinance in fisheries and aquaculture. Guidelines and case studies. [link]
131 Dreambeans Coffee (2024) A new coffee with a terrific back story. [link]
132 Bioversity International (2018). Kodo and kutki millets in Madhya Pradesh. [link]
133 Gotor, E., Caracciolo, F., Blundo Canto, G.M. and Al Nusairi, M. (2013). Improving rural livelihoods through the conservation and use of underutilized species: evidence from a community research project in Yemen. International Journal of Agricultural Sustainability Volume 11, Issue 4, pages 347-362. [link]

Yemen © Yvonne Wacht / iStock

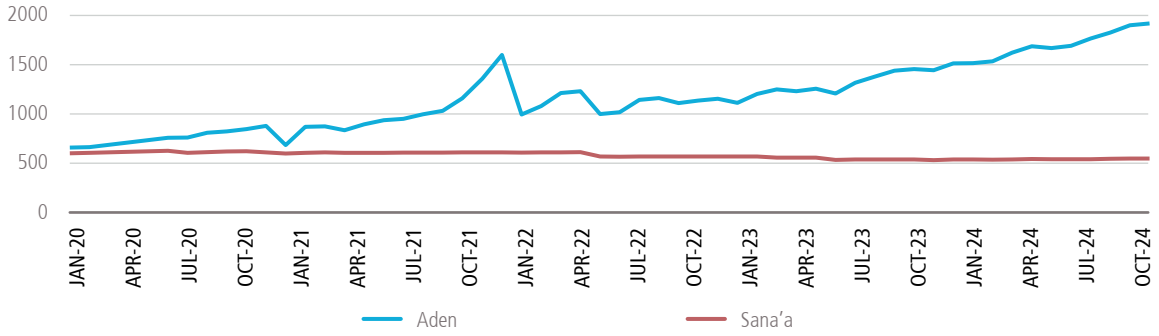
4. The Macroeconomic Implications of Climate Change

4.1. Yemen's Macroeconomic Performance

Yemen's macroeconomic performance is deeply rooted in persistent structural challenges that have been compounded by the protracted conflict. Growth in key sectors, such as the oil sector, depend on Yemen's ability to attract foreign investment which remains contingent on improving security and achieving peace. In addition to the conflict, non-oil activity continues to be constrained by interruptions in essential service delivery, acute input shortages, and widespread corruption.[134] Moreover, reliance on remittances, aid flows, and extreme vulnerability to climate change expose Yemen to a range of external factors. Coupled with the conflict, these have driven a substantial contraction of real GDP per capita since 2015 that can be attributed to a significant decrease in hydrocarbon production, reduced agricultural output, interference in the private sector by competing factions, and deteriorating institutional quality. Lastly, depletion of the country's human capital as a result of the impact of the conflict on schooling, health, and food security of children and young adults, outmigration of the skilled, and extremely limited job opportunities in the country will be a long and scarring legacy of the conflict as evidenced by the decline in Yemen's Human Development Index.[135]

Yemen's economic development is further shaped by significant and increasing political fragmentation. This has created two distinct economic zones, each governed by a unique set of institutions. Houthi-controlled areas are home to some 70 percent of the population and account for around half of the GDP, while IRG-controlled areas hold the country's oil and gas resources.[136] These different zones include competing monetary authorities with very different exchange rates and policies (Figure 4.1), double taxation, market distortions from uncoordinated policies, and the multiplicity of Yemen's institutions, resulting in large and increasing disparities.[137] The complete halt in IRG's oil exports since the end of-2022 has intensified external pressures and led to the further depreciation of the Yemeni Rial in the Aden market. Since October 2023, the escalation of the conflict in the Middle East and in the Red Sea, intensified by direct Houthi involvement, further compromises the already precarious economic and social conditions of the Yemeni people (Box 4.1).

Figure 4.1. Exchange rates across Yemen (YER per US$1)



Source: Original for this publication based on Telegram Exchange Market Group and WB staff calculations

134 Yemen was ranked 176th out of 180 countries on the Corruption Perceptions Index with a score of 16 out of 100, according to Transparency International. [link]

135 Between 1990 and 2022, Yemen's HDI value changed from 0.357 to 0.424, a change of 18.8 percent – positioning it at 186 out of 191 countries and territories as of 2022. [link]

136 Population estimated as per OCHA. [link]

137 The currency has different values depending on the banknote's date of printing.

Box 4.1.Implications of the Middle East conflict on Yemen[138]

The escalation of the conflict in the Middle East and in the Red Sea since October 2023, intensified by direct Houthi involvement, has significantly affected economic activity in Yemen. The resulting, major disruption to international shipping in the Red Sea - a corridor for 30 percent of world container shipping -, highlights the severity of the situation for Yemen and the broader Red Sea region.[139] Although data for Yemen remain limited, available information indicates negative repercussions from Although data for Yemen remain limited, available information indicates negative repercussions from the conflict in the Middle East. The likelihood of the IRG resuming its oil exports in the near term appears slim due to the slowdown in peace negotiations amid the conflict. While Yemen's imports and prices have so far shown relative stability, continued conflict raises the risk of supply shortages and rising import costs due to reduced and more costly imports, increased shipping expenses, including due to rising war premiums and insurance costs. The risk is more prominent in IRG-controlled areas than in Houthi ones, given the latter's control of ports of entry.

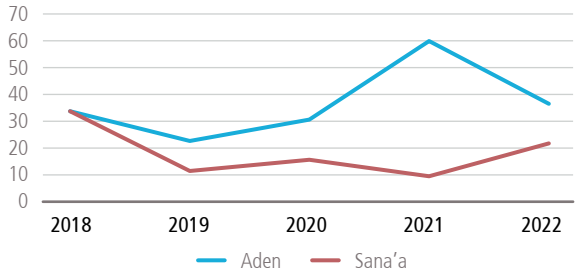
Yemen's economic and social conditions are expected to be further exacerbated due to disruptions in humanitarian aid, essential imports, remittances, and sources of livelihood. These will have cascading effects in a society plagued by widespread poverty, deprivation, and food shortages. The conflict has already inflicted profound and far-reaching economic, social, and humanitarian consequences on the country. Yemenis are increasingly struggling to get the aid they need, in part due to low humanitarian funding. The United Nation's US$4.34 billion aid appeal for Yemen in 2023 was only 40.7 percent funded, marking the lowest funding percentage for a UN Yemen appeal since at least 2008. The risks regarding food insecurity are alarming, exacerbated by the suspension of aid and food distribution by the World Food Programme (WFP) in Houthi-controlled areas in late 2023. Additionally, the recent detention of UN personnel in these areas threatens to further complicate and reduce the provision of humanitarian aid.

Yemen's economic stability has been severely undermined by fiscal mismanagement and inflationary pressures. The growing reliance on the monetization of the IRG's fiscal deficit through withdrawals from its overdraft facility at the Central Bank of Yemen in Aden has significantly contributed to the depreciation of the YER and triggered inflationary pressures,[140] which have eroded domestic consumption.[141] Annual inflation surged from 10 percent in 2012 to around 30 percent in 2021 and 2022 (Figure 4.2).[142] This sharp rise in inflation has led to a catastrophic increase in the prices of goods and services, severely undermining the purchasing power of a large segment of the population.[143] The escalation of the conflict in the Middle East since 2023 is expected to exert upward pressure on consumer prices, particularly in IRG-controlled areas lacking comprehensive price controls. As a result, estimated real GDP growth for 2023 and the growth forecast for 2024 have been downgraded. The ongoing tensions will also likely exacerbate high fiscal, monetary and external pressures in IRG-controlled areas. The fiscal deterioration, particularly if coupled with potential decreases in financing from development partners, could lead the

138 World Bank (2024) Yemen Economic Monitor: Navigating Increased Hardship and Growing Fragmentation. June 2024. Washington, D.C. [link]
139 For an analysis of the broader regional impacts of the Red Sea crisis, see "Dire Strait: The Far-Reaching Impact of the Red Sea Shipping Crisis, MENA FCV Economic Monitor, Issue #1, World Bank. May 6, 2024. [link]
140 Yemen's banking sector allocated 50 percent of its assets to buying government bonds of public debt, making it the top buyer of government bonds out of all investors (ERT 2020).
141 World Bank (2023). Yemen Economic Monitor Peace on the Horizon?. Washington D.C. [link]
142 World Bank (2024). Yemen Poverty and Equity Assessment: Living in Dire Conditions. Washington D.C. World Bank. [link]
143 World Bank (2023). Yemen Country Economic Memorandum: Glimmers of Hope in Dark Times. Washington, D.C: World Bank. [link]

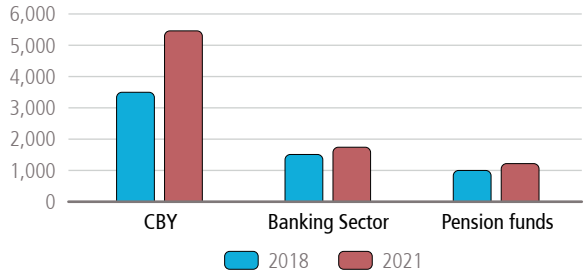
Central Bank in Aden to resort to additional monetization of the fiscal deficit, exacerbating already high inflation, and resulting in further currency depreciation. Notably, the Yemeni Rial continued to depreciate throughout 2024 in Aden.

Figure 4.2. Inflation rate (percent).



Source: Original for this publication based on WB and IMF staff calculations.

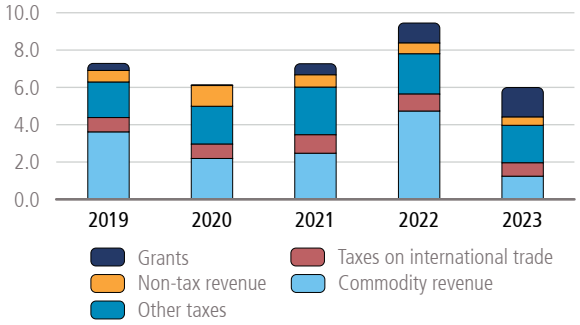
Figure 4.3. Public Debt Ownership (YER billions).



Source: Original for this publication based on CBY-Aden and WB staff calculations.

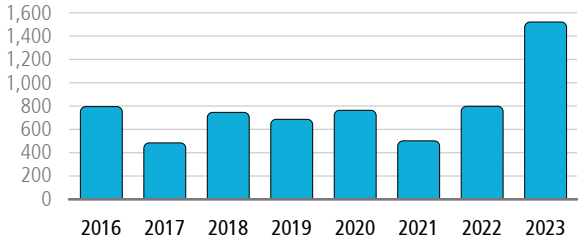
The economic gains following the UN-brokered truce in April 2022 highlight the potential benefits to be realized through a peaceful trajectory. The truce temporarily halted offensive hostilities, reduced conflict-related fatalities, and resulted in signs of economic improvement. The Yemeni Rial appreciated both in Aden and Sanaa shortly after the announcements were made at the beginning of April 2022. This was expected to help stabilize the exchange rate and improve fiscal balances, while easing upward pressure on consumer prices in local markets, which presented an upside risk to the food security crisis. The prospects of peace also brought with it the likelihood of large financial packages from regional partners, rising remittances, and the potential for increased hydrocarbon exports that could accelerate growth over the medium term. However, peace has remained elusive. The truce expired in October 2022, and although an informal truce remained in place, the situation has worsened due to a Houthi-imposed blockade on IRG's oil exports.[144] This blockade dramatically impacted national growth in 2023 and exacerbated the IRG's fiscal and monetary challenges, with fiscal revenues, including grants, declining by over 30 percent in 2023 to 6.9 percent of GDP (Figure 4.4). As a result, the IRG's fiscal deficit expanded to approximately 3.9 percent of GDP in 2023 (on a cash basis) from 2.7 percent in 2022. The budget deficit was financed primarily by increased domestic financing through CBY-Aden (Figure 4.5).

Figure 4.4. IRG Fiscal Revenues (percent of GDP).



Source: Original for this publication based on MOF; WB and IMF staff calculations.

Figure 4.5. CBY Net Domestic Claims on Government (increase, bns of YER).



Source: Original for this publication based on CBY-Aden and WB staff calculations.

144 The Houthis imposed an embargo on IRG oil exports through three drone attacks on Yemeni oil exports in the months following the expiration of the UN-sponsored truce. The Houthis demand that the government pay the salaries of civil servants in Houthi-controlled areas. [link]

4.2. Economic Challenges and Opportunities of Climate change

Climate change presents significant uncertainty for Yemen's future development prospects, with complex interactions between the various sectoral impacts. Yemen's already fragile economy could face additional constraints due to the impacts of climate change under more pessimistic climate scenarios. As shown in Chapter 3, the country's extreme water scarcity and limited arable land, compounded by economic challenges, leaves communities trapped in a cycle of poverty. Climate change threatens to exacerbate these challenges by imposing further constraints on the agricultural sector. While increased precipitation could reduce unmet demands, rising temperatures, longer dry periods and unpredictable precipitation increase the risk of heat stress for rainfed crops, which could undermine agricultural productivity. Furthermore, Yemen's fisheries, essential for food security and employment, face threats from rising sea levels and changing ocean temperatures, potentially disrupting exports and livelihoods. Urban areas are particularly vulnerable to worsening floods, as decades of conflict have weakened infrastructure, leaving cities and transport networks exposed to climate-related hazards. In contrast, Yemen has the potential to leverage climate change for economic gain if it can realize effective climate adaptation strategies and investments that enable it to capitalize on the opportunities while minimizing economic losses. For example, solar power can strengthen the country's energy system, reduce its reliance on traditional fuels, and create jobs, while reducing Yemen's exposure to global energy price fluctuations and helping to stabilize the economy. Similarly, investments in climate-smart agriculture could mitigate the negative impacts on crop production while improving food security. However, these opportunities are closely tied to the country's ability to manage the health impacts of climate change, particularly the rising incidence of waterborne diseases and heatwaves that threaten to reduce labor productivity and increase healthcare costs.

4.3. Modeling an Uncertain Future

The macroeconomic situation within Yemen creates a complex context within which to estimate long term climate damages. The assessment of the macroeconomic impacts of selected climate change damages, along with the effects of the proposed policies and investments to mitigate these shocks, is based on simulating their potential outcomes across the three distinct scenarios: "Peace and Prosperity," "Status Quo," and "Escalation and Intensification." Although the extent of climate change effects remains consistent across these scenarios, the impacts and Yemen's level of vulnerability differ, as do the potential interventions and response mechanisms. Each scenario represents varying levels of preparedness to address climate change. So, reflecting different resource and capacity and institutional conditions, the peace and prosperity scenario is assumed to ensure better preparedness and lower vulnerability than the status quo scenario, and preparedness and vulnerability are assumed to be lower still in the escalation scenario. While these scenarios do not serve as political predictions or development forecasts, they provide a valuable framework for exploring different policy options under different climate impacts and conflict and institutional conditions. This approach allows for flexibility in responding to the profound uncertainty surrounding the country's future governance and may help inform the design of appropriate interventions.

Peace is critical to Yemen's economic and social recovery and reduced vulnerability and climate impacts. The escalation scenario illustrates in stark terms the massive cost of conflict, particularly when compared to the full peace and prosperity scenario, with status quo providing only a modicum of potential growth (Figure 4.6). The scenarios show that with peace and prosperity, Yemen can attain 5 percent annual average growth over the next fifteen years, compared with a further annual 2 percent decline in the escalation scenario. As a result, in 2040, peace and prosperity could help Yemen achieve real GDP three times higher than under a scenario of escalation and intensification, and 50 percent higher than the status quo scenario. While climate

impacts could negatively affect growth across all three scenarios, adaptation measures to reduce Yemen's vulnerability are envisaged only under the status quo and the peace and prosperity scenarios (Figure 4.7).[145] Achieving peace is also essential for Yemen's fiscal sustainability, with the potential to reduce Yemen's unsustainable debt to 2016 levels (Figure 4.8). This outcome would be driven by stronger economic growth, increased domestic revenue mobilization – extending beyond oil revenues -, and additional support from development partners unlocked by the prospects of peace (Figure 4.9).[146] Conversely, under the escalation scenario, debt levels would continue to rise to unsustainable levels, as GDP contracts and the tax-to-GDP ratio further declines.

Figure 4.6. Growth Projections Vary across the Three Scenarios. Real GDP Growth and Real GDP Per Capita Growth (Average 2025-2040).

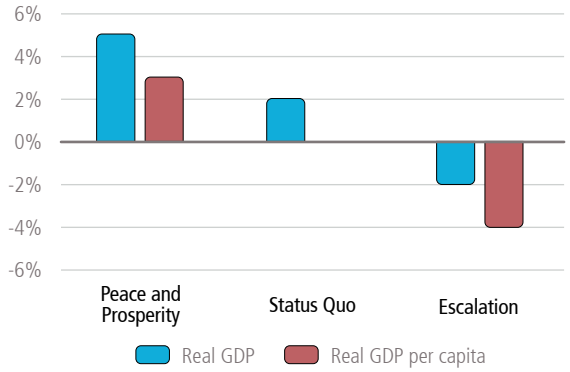
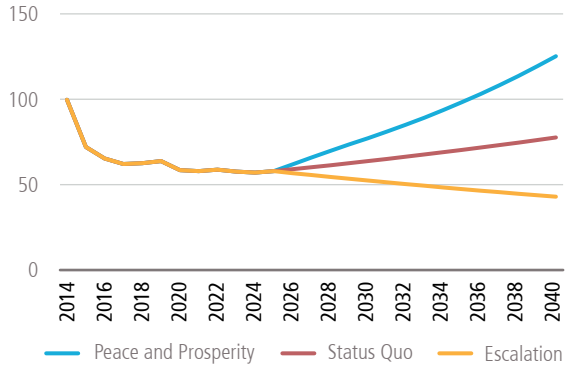


Figure 4.7. Analytical Framework to Mapping Potential Pathways for Yemen's Future Development. Real GDP Growth (Base 100 in 2014).



Source: Original for this publication.

Figure 4.8. Debt-to-GDP Ratios under the Three Scenarios (Percentage).

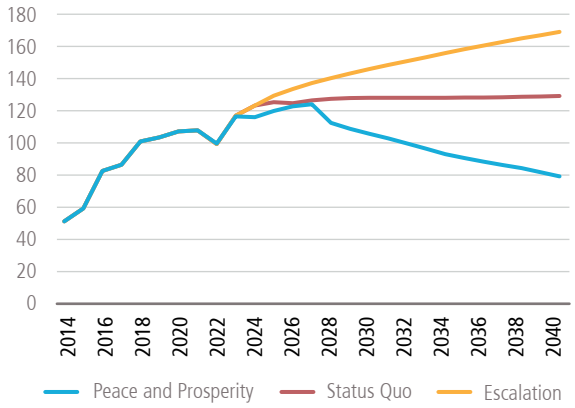
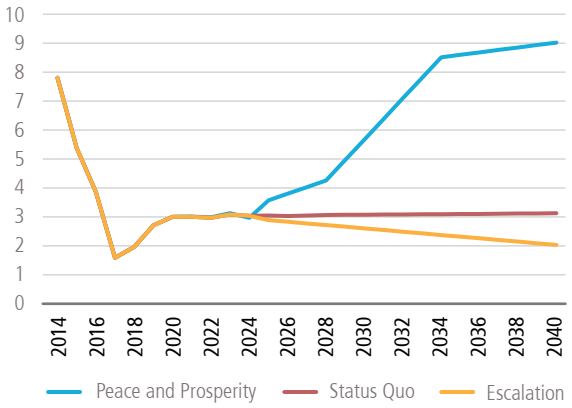


Figure 4.9. Tax Revenues as a Share of GDP under the Three Scenarios Percentage).



Source: Original for this publication.

145 The growth projections presented here are grounded in the analytical work from the latest Yemen Country Economic Memorandum (July 2023). For detailed information on the assumptions and methodology used, please refer to Yemen Economic Monitor. [link]

146 Estimates in 2024 indicate that Yemen's oil production could cease entirely within the next ten years without new investments. Consequently, this CCDR does not emphasize oil revenues, given the uncertainty surrounding their resumption and long-term viability. Similarly, the CCDR does not address issues such as the high carbon intensity of Yemeni oil and its potential impact on carbon competitiveness in export markets that may introduce carbon taxes or border adjustment mechanisms. The full implementation of these regulations would likely extend beyond the ten-year timeframe projected for the cessation of oil production.

The scenario-based approach, including macroeconomic projections, is informed by the unique socio-economic characteristics and geo-political circumstances of Yemen and used to navigate uncertainty in order to inform recommended climate investments and reforms. Key factors include the entrenched fragility and fragmentation linked to the political, military, and near-conflict economic environment and the limited scope to define and implement cohesive, uniform public policies against the backdrop of weak institutions and skills, and severe constraints on transport, finance, and trade. Significant effort has been made to expand the inclusion of FCV factors by incorporating qualitative scenarios that attempt to identify the non-linear ways in which FCV threats can alter development and translate these into a series of assumptions around the drivers of macro-economic growth in each of the scenarios (Table 4.1). Given Yemen's long history of instability, these scenarios are crucial for understanding the trade-offs between adaptation and mitigation strategies. However, integrating the implications of future FCV-related threats, such as political instability, armed conflict, or forced displacement, into these scenarios is very challenging. This is particularly relevant for a country such as Yemen with a long history of FCV, and where instability can persist for decades, impacting all aspects of society and the economy. Despite these challenges, these scenarios provide a valuable framework for exploring different policy options and understanding their potential outcomes in a highly fragile context.

Table 4.1. Assumptions around the Drivers of Macro-Economic Growth in Each of the Scenarios.

Scenario	Assumptions
Status Quo	**The "Status Quo" scenario represents a "modest-to-moderate-growth" future for Yemen.** This scenario entails a continuation of the current situation, where the conflict/near conflict situation persists without a political settlement. International support remains focused on humanitarian responses and the provision of basic services. The lack of reforms and difficulties in attracting financing would negatively affect both the fiscal and external stances. Limited fiscal space, coupled with an impaired banking sector, implies insufficient funding for capital expenditures, energy transition, and climate adaptation. Public and private sector investment would remain stagnant, confined to small and medium size local companies, with minimal FDI. This financing constraint would lead to anemic economic growth, stagnating at around 2 percent, leaving the economy fragile and unstable. With unchanged population growth, per capita growth would be around or barely above zero.
Peace and Prosperity	**The "Peace and Prosperity" scenario represents an aspirational "high-growth" future for Yemen.** In this scenario, a settlement is achieved between all the warring factions —and implemented—physical barriers to free movement of people and goods are removed, and economic space of Yemen is reintegrated, with full recovery of trade, finance, and transport across the national territory. International support inevitably increases, transitioning from short-term humanitarian aid to reconstruction of key transport routes and critical infrastructure and basic services to long-term development assistance, facilitating enhanced access to climate financing. With restored peace and security and lower cost of trade and transport, both national and international companies drive a surge in public and private sector investments, accompanied by increased FDI. Expanded oil production and exports bolster economic growth, enabling fiscal consolidation and a reduction in the debt-to-GDP ratio. Over time, external arrears are cleared, and debt restructured, providing additional fiscal space to be used for social and infrastructure development. Under this scenario, GDP experiences robust growth over the fifteen-year period 2025-2040, averaging 5 percent annually, reinforcing economic and social stability.
Escalation and Intensification	**The "Escalation and Intensification" scenario represents a "growth-decline" future** in which the situation in Yemen worsens as political tensions escalate, leading to full-scale internal hostilities and violence and possible, further fragmentation. Internal hostilities may accompany external tensions and hostilities with involvement of external actors. As a result, international development financing support and economic aid would contract, with a near complete reliance on humanitarian assistance and extremely limited prospects for development assistance or access to climate financing. Public and private sector investment would decrease, restricted to micro- and small enterprises primarily providing essential services such as water, energy, and food, with no FDI. Reduced oil revenues contribute to a widening fiscal deficit, resulting in increased debt. GDP growth would decline by around 2 percent annually, weakening the economy further with increasing fragmentation and instability. Per capita GDP would decline by a staggering. 4 percent per year, likely resulting not only in the environment of extreme conflict conditions but also a real threat of famine in the areas worst affected.

4.4. Modelling the Macroeconomic Impact of Climate Change

The approach explicitly defines the channels through which climate change will affect social and economic activity and estimates economic damages from climate change to Yemen's economy. These climate priorities were identified through expert review and a survey of national experts, development partners and World Bank sector specialists as detailed in Chapter 2. Quantifying the damages imposed by climate change was determined in four stages, specifically: (i) obtaining gridded historical and projected climate data for a set of climate scenarios; (ii) selecting, tailoring, and/or developing biophysical models that convert changes in climate data into biophysical shocks for each of the impact channels evaluated for the country; (iii) aggregating grid-level biophysical shocks to national and/or sectoral scales using high-resolution geospatial data; and (iv) producing shocks that serve as inputs into the macroeconomic model. Results are aggregated either to national scale inputs (e.g., capital or labor) or to economic sectors (e.g., agriculture) to match the macroeconomic model's resolution. Wherever possible, the scenario analysis reflects the structural characteristics of key sectors and considers the following different types of shocks that have also been detailed in Chapter 3 (Table 4.2).

Table 4.2. Overview of Impact Channels Evaluated.

	Name of Channel	Description of how Climate Change Translates to Damages
	Water and Natural Resources	
1	**Water Availability**	Shock to water-dependent sectors' productivity. Uses a Water Evaluation And Planning (WEAP) model to evaluate unmet demand.
2	**Crop Production**	Shock to crop revenues through changes in yields. Based on the Food and Agriculture Organization's crop-specific yield response functions to water availability and heat stress. Water availability for irrigated agriculture is estimated through a Water Evaluation And Planning (WEAP) model.
3	**Fisheries**	Shock to fish production due to the impacts of changing ocean temperatures on the stock of natural marine capital.
	Infrastructure	
4	**Urban Flooding**	Shock to capital from peak precipitation events that result in pluvial and fluvial flooding. Flood depths are obtained from Fathom output and depth-damage curves are used for damage estimation.
5	**Roads**	Shock to capital due to damages to and increased maintenance of road, as modeled using the Infrastructure Planning Support System model. Also considers labor supply effects of road disruptions.
6	**Bridges**	Shock to capital due to damages to and increased maintenance of bridges, from changes in the recurrence of peak precipitation events that result in fluvial (riverine) flooding.
7	**Sea Level Rise and Coastal Flooding**	Shock to coastal capital from changes in periodic storm tides as a result of climate change, using output from Fathom.
	Human Capital	
8	**Heat and Labor Productivity**	Shock to labor productivity from daily heat stress to both indoor and outdoor workers. Considers occupation-specific work ability curves from the ILO.
9	**Water, Sanitation, and Hygiene**	Shock to labor supply from changes in diarrheal incidence and mortality due to investments in improved water supply and sanitation coverage.
10	**Human Health**	Shock to labor supply from changes in the incidence and mortality of vector-borne (malaria and dengue), water-borne (i.e., diarrheal), and temperature-related diseases.

The macro-modeling assesses the implications of climate change on the economy using the scenario based approach for Yemen's future development. This approach combines tools from mainstream macroeconomic analysis with methodologies that account for the specific impacts of climate change and environmental degradation within Yemen's fragile context. The shocks induced by climate change through these channels are quantified based on changes in climate variables (e.g., monthly precipitation, daily maximum temperature) for two climate scenarios spanning a 30-year period from 2021 to 2050, relative to a climate baseline from 1995 to 2020. The "optimistic" scenario is a "wet and warm" scenario (SSP2-4.5 and RCP2.6), which anticipates a significant increase in precipitation and a moderate rise in temperatures. Conversely, the "pessimistic" scenario is "dry and hot" (SSP3-7.0 and RCP8.5) predicting a slight increase or even a decrease in precipitation accompanied by a substantial rise in temperatures. These findings serve as inputs for the existing country-level macroeconomic model. Specifically, the scenario analysis combines two modeling exercises:

(a) climate change impact channel modeling, which uses climate scenarios and biophysical effects to quantify economic damages caused by climate change (also called "climate change shocks on the economy").

(b) building upon this, macroeconomic modeling, utilizing the MANAGE-WB CGE model based on the new Social Accounting Matrix (SAM) outlined in the last Yemen Country Economic Memorandum (CEM),[147] which models the linkages between the economic damages caused by climate change, adaptation/ mitigation policies, and macro-fiscal aggregates.

4.5. Macro Impacts of Climate Change Shocks with No Adaptation

The impacts of climate change shocks on economic output in the absence of adaptation vary significantly by climate scenario.[148] The individual and combined impacts on real GDP at market prices (level) for Yemen for the medium (status quo) growth baseline under the two climate scenarios (dry and hot/pessimistic and wet and warm/optimistic) show significant divergence after 2030 (Figures 4.10 and 4.11). Under the more optimistic scenario, crop production shows a significant positive impact due to increased precipitation, although this is only one among many possible realizations and could be driven by natural variability, as well as assumptions around groundwater recharge rates. However, the more pessimistic scenario shows negative impacts on GDP across all sectors. Crop production declines due to drier conditions, and fisheries, labor productivity, human health, and infrastructure (roads and bridges) also deteriorate, leading to significant GDP losses. Yemen's heavy reliance on agriculture makes it particularly vulnerable to climate change, with the heat-labor productivity losses hitting hardest in sectors reliant on outdoor workers, such as agriculture and industry. Human health also deteriorates more severely under the pessimistic scenario, further amplifying the negative economic impact. Meanwhile, the effects of flooding on GDP remain minimal or negligible in both scenarios.

The economic output associated with each of the impact channels also varies significantly by growth scenario. The effects of selected impact channels on real GDP at market prices for Yemen vary by as much as 0.6 percent in the case of labor heat stress and human health between the low (Escalation), medium (Status Quo) and high (Peace) growth baselines under the "dry and hot" climate scenario (pessimistic) (Figure 4.12). Labor heat stress and human health have a more significant negative effect under the escalation scenario compared to the peace scenario because escalation is more labor-intensive (lower investment, higher labor intensity). Conversely, flooding and damages to roads affect the peace and prosperity scenario more than the escalation scenario because peace is more capital-intensive (rebuilding efforts necessitate higher investments). Damages to fishing impact the escalation scenario more severely than the peace scenario, as the escalation scenario is associated with a higher propensity to consume, making a negative productivity shock in fishing more detrimental.

147 World Bank (2022). Yemen Country Economic Memorandum "Glimmers of Hope in Dark Times". World Bank, Washington DC. [link]

148 Damage scenarios modelled here only include the change in disasters frequency and intensity and not the full cost of all disasters, i.e. including those that are not climate related.

Figure 4.10. Annual Real GDP at Market Price Loss (% Deviation from the Baseline) from the Impact Channels - Dry and Hot Scenario – Status Quo.

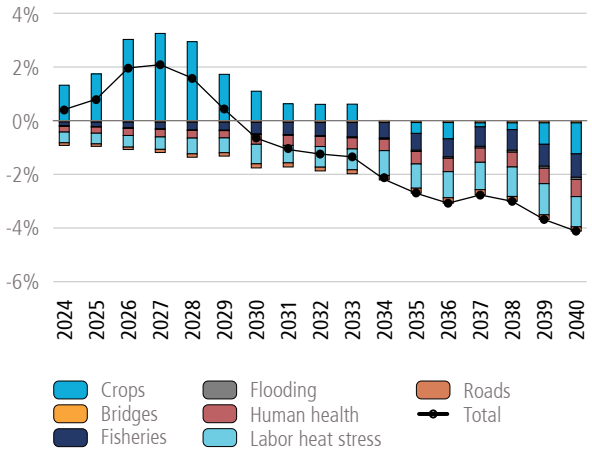
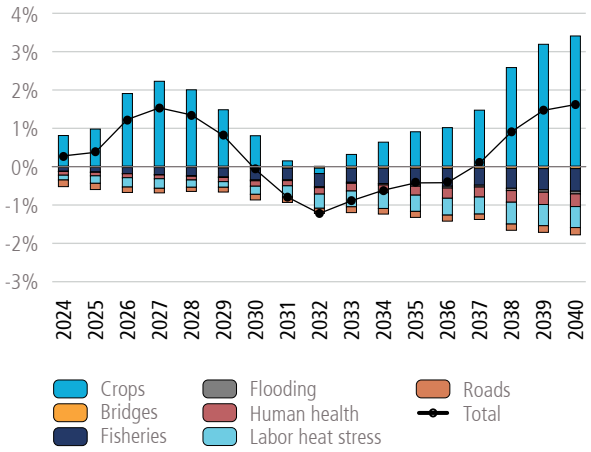


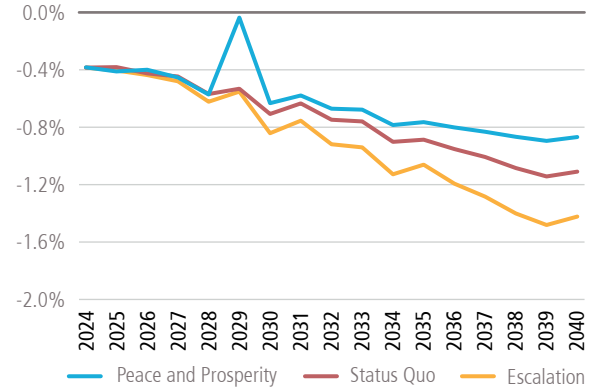
Figure 4.11. Annual Real GDP at Market Price Loss (% Deviation from the Baseline) from the Impact Channels - Wet and Warm Scenario – Status Quo.



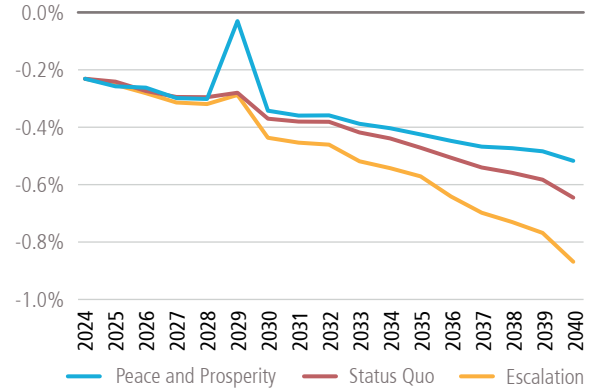
Source: Original for this publication.

Figure 4.12. Annual Real GDP at Market Price Loss (% Deviation from the Baseline) from Selected Impact Channels under the "Dry and Hot" (Pessimistic) Scenario.

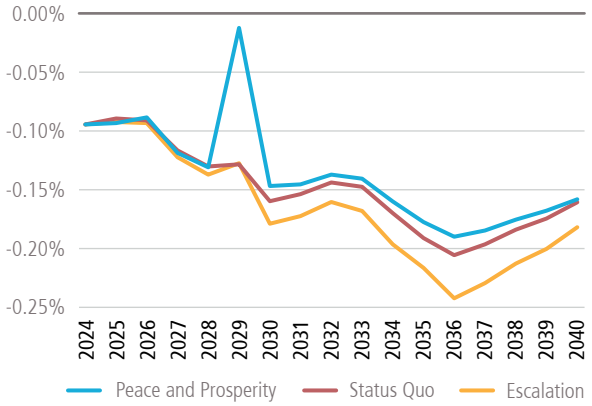
Labor heat stress



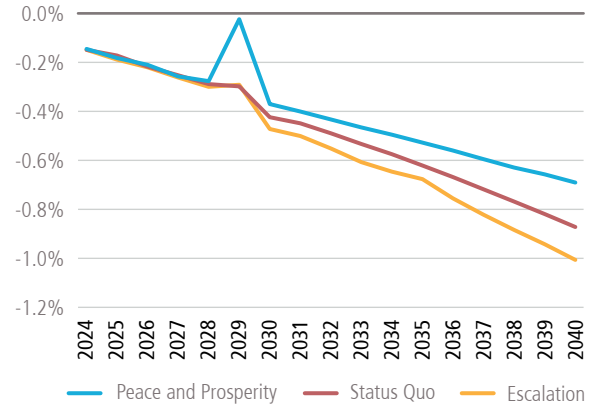
Human health



Roads



Fisheries



Considering the combined effects of the impact channels, climate change is expected to cause contrasting outcomes in Yemen depending on the climate scenario. Under the "dry and hot" (pessimistic) scenario, Yemen is projected to experience significant output losses. The total negative impacts increase over time, leading to an average annual GDP reduction of 3.9 percent by 2040 across all three political scenarios compared to the baselines. These estimates likely underestimate the economic losses from climate change, as they do not account for other impact channels and the magnifying effects of climate-induced changes in ecosystems, increased conflicts, and migration shifts. Conversely, under the "wet and warm" (optimistic) scenario, crop production increases, and the negative impacts of other channels are smaller. The increase in crop production is substantial enough to offset the negative effects of other impact channels. Consequently, in the "wet and warm" optimistic scenario, Yemen experiences an average GDP increase of 1.5 percent across all three political scenarios compared to the baselines.

Under the dry and hot (pessimistic) climate scenario, the annual GDP losses (relative to the baseline) are higher for the low-growth scenario (escalation and intensification) compared to the medium (status quo) and high (peace and prosperity) growth scenarios. Figures 4.13. and 4.14. show the combined impacts on real GDP at market prices for Yemen for the low (escalation), medium (status quo) and high (peace) growth baselines under the two climate scenarios (dry and hot/pessimistic and wet and warm/optimistic). In the low and medium-growth scenarios, minimal structural transformation occurs, and the economy remains dominated by the agriculture sector, which faces larger negative shocks. Under the high-growth scenario, the impacts are mitigated as the economy diversifies away from agriculture. This illustrates how growth and development can enhance economic resilience.

Figure 4.13. Annual Real GDP at Market Price Loss (% Deviation from the Baseline) from the Impact Channels, with No Planned Adaptation under the Optimistic Scenario (Wet and Warm).

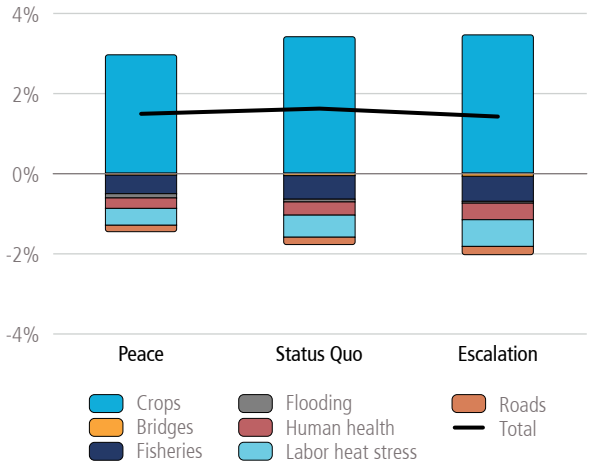
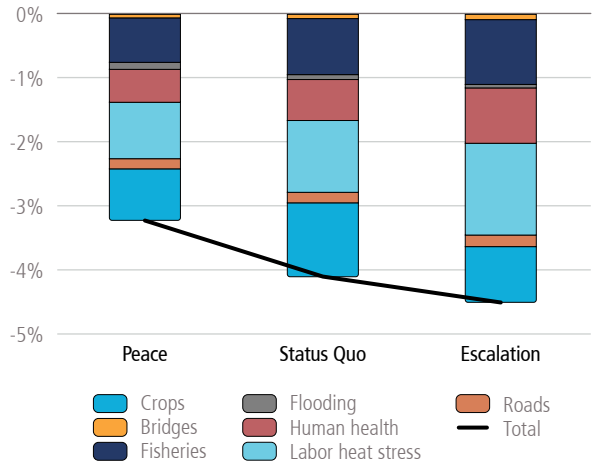


Figure 4.14. Annual Real GDP at Market Price Loss (% Deviation from the Baseline) from the Impact Channels, with No Planned Adaptation under the Pessimistic Scenario (Dry and Hot).



Source: Original for this publication.

Despite the efforts to account for the considerable uncertainty in the models, the scenarios remain limited compared to the multitude of possible futures for Yemen, and there are a number of unpredictable elements that influence socioeconomic performance. Future FCV threats are particularly difficult to predict, defying even the best conflict-monitoring systems, and economic growth projections can only partially account for them. FCV dynamics can significantly impact the trajectory of climate and development outcomes, particularly in countries where fragility and insecurity are likely to persist for decades. Therefore, the CCDR macro-modeling proposed here explicitly addresses the constraints and assumptions adopted.

For example, the political scenarios have been associated with projections for growth, the evolution of the economy's structure, and public finances—which could differ significantly from the assumptions made here. For instance, the Escalation scenario assumes a moderate decline in GDP per capita, which could be much higher if the country were to return to full-scale conflict and insecurity.

4.6. Modeling Adaptation to Climate Change – Selected Interventions

Significant economic impacts from climate change are expected in Yemen, making critical adaptation interventions necessary. These measures will help to harness the opportunities offered by climate change under the "wet and warm" (optimistic) scenario while effectively mitigating its associated risks under the "dry and hot" (pessimistic) scenario. Priority should be given to climate investments that deliver the most benefits, in terms of economic gains achieved and damages avoided, at the lowest costs. Analyzing potential adaptation interventions across key impact channels reveals significant opportunities. These interventions include expanded irrigation for both rainfed and irrigated crops, improvements in water, sanitation, and hygiene (WASH) systems to prevent waterborne diseases—a major driver of human health impacts—investments in climate-resilient roads and bridges, measures to reduce the vulnerability to coastal and urban flooding, and initiatives to mitigate heat stress on outdoor workers. These interventions can significantly enhance the benefits of climate change adaptation or substantially reduce the associated damages.

Yet, the nexus between development, conflict and climate presents a number of challenges for estimating adaptation costs. While the benefits are clear, there is an historical infrastructure deficit associated with persistent development challenges that prevailed prior to the conflict. Since the onset of the conflict in 2015, this deficit has only grown with significant damage to the infrastructure and institutions that are needed to ensure resilience to climate change. Similarly, the capacity of local communities to adapt has also been eroded as people exhaust their savings and are forced to sell off assets. The incremental cost of adaptation is substantial and adds to the existing development and conflict inflicted challenges, while increasing the financial requirements. Adaptation costs are expected to increase substantially over the next few decades, while the capacity to finance these will diminish the longer the conflict draws out, further widening the development gap and increasing vulnerability to climate change with time. Addressing these incremental costs will require significant international support and innovative financing mechanisms to ensure Yemen can build resilience while continuing to address the cost of the conflict and bridge persistent development challenges.

No comprehensive costing for climate adaptation in Yemen appears to have been conducted, and existing estimates likely underestimate the actual needs. Yemen's NAPA, which identifies priority sectors and outlines target projects for climate change adaptation, estimates total project financing needs at around US$30 million—significantly below what is required. In contrast, the Green Climate Fund (GCF) country program estimates adaptation needs at roughly US$300 million for the 2025-2030 period, or approximately US$60 million per year. Additional calculations from this CCDR, obtained on just five of the ten impact channels— labor heat stress, roads, bridges, coastal flooding, and urban flooding — align with these estimates. However, these estimations do not consider all potential interventions and would undoubtedly rise substantially if investments for crops and WASH, which are harder to quantify but have the most significant impact on Yemen's GDP, were included. Comparisons with similar countries, both in terms of GDP and vulnerability to climate change, suggest that adaptation costs could range between 1-5 percent of GDP annually.

Accelerated adaptation, achievable only under a peace and prosperity scenario that expands fiscal space and stability, highlights substantial economic gains from investing in climate resilience. In the "dry and hot" (pessimistic) scenario, the negative impacts of climate change could be largely mitigated through adaptation investments, resulting in an average annual GDP increase of 2.6 percent above baseline, as opposed to a 3.2 percent decline without adaptation (Figure 4.16). It is important to note that these estimates overstate the benefits of adaptation, as they exclude the costs associated with investments in crop and health-related

adaptations. Nevertheless, they underscore the potential of adaptation to safeguard Yemen against the adverse effects of increasing drought and heat. In the "wet and warm" (optimistic) scenario, the positive effects of climate change (stemming from improved crop yields) could be further enhanced by adaptation investments, potentially boosting annual GDP growth to 5.6 percent above baseline, compared to just a 1.5 percent increase without such investments (Figure 4.15).

Partial adaptation under the status quo scenario demonstrates some economic gains from adaptation investments, though these are smaller compared to the accelerated adaptation envisioned in the peace and prosperity scenario. In the partial adaptation scenario, only half of the potential adaptation benefits are realized, as Yemen faces fiscal constraints and limited international financing, which reduces the scope of adaptation efforts. In the "dry and hot" (pessimistic) scenario, partial adaptation investments help mitigate the negative impacts of climate change but do not lead to economic growth compared to the baseline (Figure 4.18). Under the "wet and warm" (optimistic) scenario, adaptation investments amplify the positive effects of the climate, potentially increasing annual GDP growth by 4.4 percent above baseline, compared to a 1.6 percent increase without such investments (Figure 4.17).

Figure 4.15. Annual Real GDP at Market Price Loss (% Deviation from the Baseline) under the Optimistic Scenario (Wet and Warm) in the Peace Scenario.

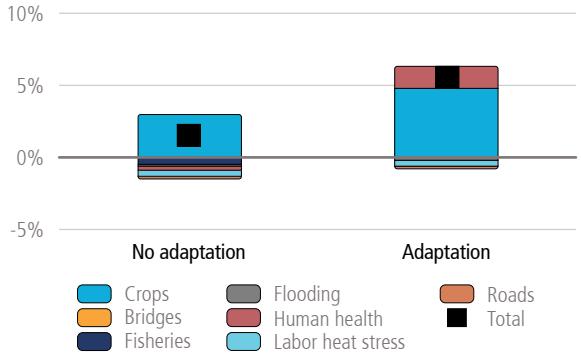
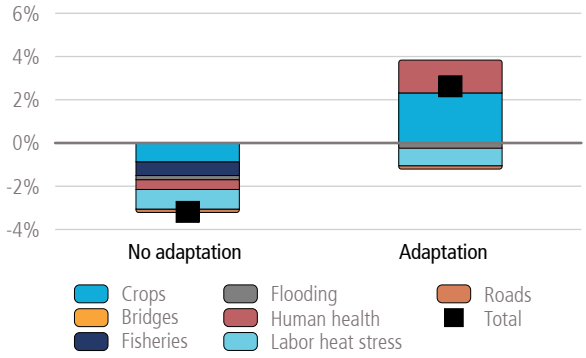


Figure 4.16. Annual Real GDP at Market Price Loss (% Deviation from the Baseline) under the Pessimistic Scenario (Dry and Hot) in the Peace Scenario.



Source: Original for this publication.

Figure 4.17. Annual Real GDP at Market Price Loss (% Deviation from the Baseline) under the Optimistic Scenario (Wet and Warm) in the Status Quo Scenario.

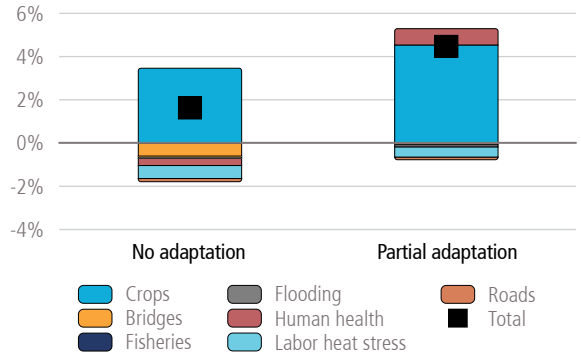
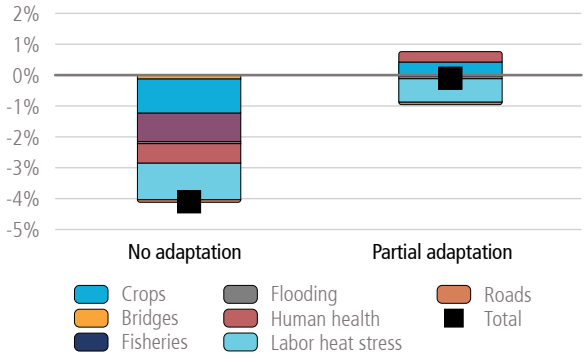


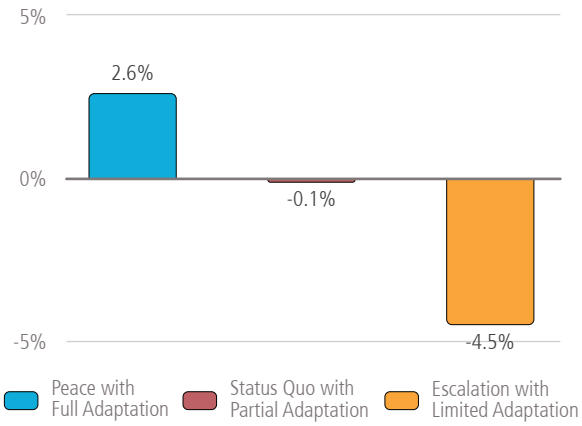
Figure 4.18. Annual Real GDP at Market Price Loss (% Deviation from the Baseline) under the Pessimistic Scenario (Dry and Hot) in the Status Quo Scenario.



Source: Original for this publication.

The analysis highlights the significant economic gains that peace could bring to Yemen. Under the peace and prosperity scenario, Yemen would unlock financing for adaptation investments, enabling it to both harness the opportunities of climate change and mitigate its risks. In contrast, an escalation of conflict would lead to severe economic losses, worsened by climate change, particularly under the pessimistic scenario where Yemen's economy would struggle without the fiscal space or attractiveness to secure vital adaptation financing. Although some adaptation measures could still be implemented, they would be severely constrained as resources shift from climate resilience and development to sustaining the conflict economy. Comparing the projected growth rates for three development pathways—peace with accelerated adaptation, status quo with partial adaptation, and conflict escalation without adaptation—underscores the economic dividends of peace (Figure 4.19). Under the "dry and hot" pessimistic scenario, if the conflict escalates, Yemen's real GDP could decline by 4.5 percent annually relative to the baseline. However, with peace and adaptation investments, GDP growth could exceed the baseline by 2.6 percentage points. The gap between the escalation scenario with no planned adaptation and peace with accelerated adaptation reaches a 7 percentage points annually, underscoring the substantial benefits of achieving peace and investing in resilience.

Figure 4.19. Annual Real GDP at Market Price Loss (% Deviation from the Baseline) under the Pessimistic Scenario (Dry and Hot).



Source: Original for this publication.

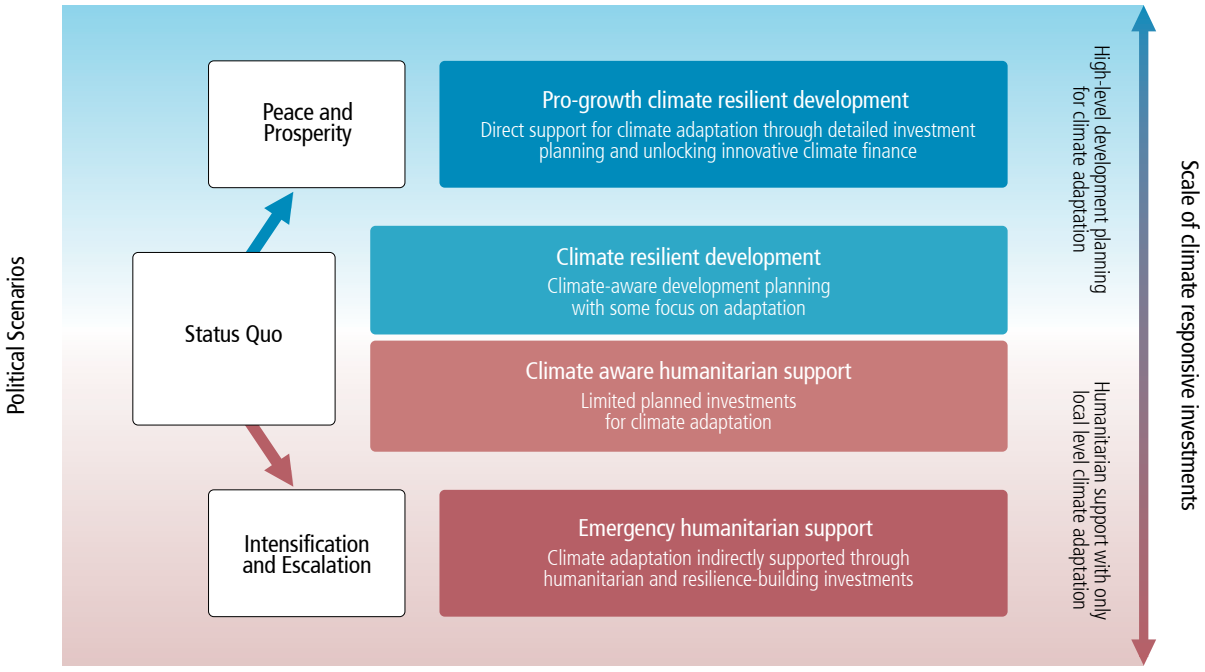
Yemen © Misha Martin / iStock

5. Enabling Action and Building Adaptive Resilience

5.1. An Agile, Whole of Society Approach to Building Resilience Amid Uncertainty

Yemen's uncertain future necessitates an agile approach to development and climate action that can respond to the changing enabling environment and mobilize stakeholders. The CCDR's approach to mapping the adaptation measures to the level of fragility in the context of Yemen (Figure 5.1) acknowledges the inherent uncertainties associated with climate action and investments for resilience in Yemen and is anchored in an area-based approach that prioritizes needs in geographical areas and specific by local communities to address these challenges. The framework highlights that the prospects of successful climate action are associated with the shift away from conflict and instability. The analyses presented here consider the "Status quo" without adaptation to be the baseline. Notwithstanding the challenges, there are a number of resilient development measures that can be implemented within the context of the status quo to improve adaptive capacity to climate change. In the more pessimistic scenario of intensification and escalation, the investment actions need to safeguard basic humanitarian services and leverage the resilience of local institutions, communities and civil society; conversely, peace and prosperity would have a significant dividend, unlocking incremental resources that allow for more sustained climate adaptation actions, leading to resilient development and economic expansion.

Figure 5.1. Risk-Informed Approach for Scaling Climate Responsive Investments



Source: Original for this publication.

The benefits that arise from the cessation of conflict can create incremental opportunities to build resilience to the impacts of climate change and deliver a substantial "peace dividend". The earlier truce has highlighted the potential benefits, with the cessation of hostilities providing a critical window to implement strategies that build resilience to climate change through strengthened governance, trust-building, integrated climate actions, access to additional financial resources and increased private sector engagement. However, the

prolonged conflict is delaying economic development, forcing the prioritization of investments in safeguarding basic humanitarian needs, compounding the pre-existing challenges around socio-economic development and local livelihood improvements that were prevalent prior to the conflict. While the longer the conflict endures, the more difficult it will be to transition from humanitarian to development, there are opportunities to leverage humanitarian efforts to include climate-related activities that deliver co-benefits to help address the underlying drivers of FCV while simultaneously seeking to promote adaptation-related objectives.

Uncertainty in Yemen requires an area-based approach that can optimize the targeted allocation of resources within the prevailing operating environment to promote climate responsive development. An area-based approach can address multiple challenges within a specific geographic area and leverage synergies between different interventions implemented by various stakeholders, leading to more comprehensive, systematic and integrated solutions that enhances the overall impact. Ensuring an objective set of criteria to identify priorities and allocate resources to areas where they are most needed, and where they can have the greatest impact, can help ensure the efficient and effective use of limited funds. Clear criteria that take into account knowledge of local conditions, capacities and availability of resources for prioritization of climate actions also enhance transparency and accountability in the decision-making process. However, such processes ultimately need to consider the enabling environment and be adjusted to the local context in order to increase the likelihood of successful implementation and sustainability.

Recognizing the local conditions and involving stakeholders through participatory approaches can foster community support and participation, improving efficiency and increasing the likelihood of success. Interventions will also need to be scaled based on the availability of financial resources with clear, transparent mechanisms in place to ensure accountability in the allocation and utilization of climate financing, and facilitate adjustments in the scope and coverage as funding levels change. While such an approach allows for flexibility to adapt to changing circumstances or new information, making it possible to scale up or down as needed, it also raises several equity considerations. These include geographic inequity and the potential for exclusion of marginalized or vulnerable populations that need to be addressed to ensure fair and inclusive outcomes. This requires a deliberate and inclusive approach to involve local policy makers, civil society and community based institutions, as well as community leaders and representatives, to assess climate vulnerabilities, prioritize, plan and budget for climate interventions, contribute towards implementation through community-led actions, and monitor the results of an area-based approach to ensure that their benefits and positive spillovers are shared broadly and fairly.

To prepare for better access to climate finance, Yemen must reestablish a credible macroeconomic framework and enhance governance capacity. Strengthening fiscal and monetary policies to achieve price stability and reunifying state institutions under a single authority for monetary policy and financial regulation are crucial steps. This will facilitate the transition from a wartime economy to one focused on peace and prosperity, creating a conducive environment for foreign direct investment and climate financing. Additionally, Yemen should improve coordination mechanisms at both the national and sub-national levels, enhance public financial management, and develop robust regulatory frameworks. These efforts will lay the groundwork for a more resilient and climate-adaptive Yemen, ready to capitalize on climate finance opportunities when peace is achieved.

5.2. High Level Objectives to Catalyze Adaptive Action Amid Uncertainty

Five High Level Objectives (HLOs) are proposed that retain the agility of action under the three scenarios. These HLOs and priority interventions (Table 5.1) reflect (i) the analytical findings presented in the CCDR, (ii) feedback and needs communicated by Yemeni experts for various agencies and institutions, and (iii) extensive multi-stage consultations and workshops with different social groups, including women, youth, academic experts, etc. The framing of these scenarios is not intended to provide predictive depictions of

Yemen's future, but merely capture the range of possibilities within the development-conflict-climate nexus. This approach allows for a nuanced exploration of how different levels of adaptation and conflict resolution efforts can shape the country's future. The foundation of the recommendations is building on community-level resilience. The recommendations in the "Status Quo" build on these foundations and scale these to a regional level. Similarly, the recommendations under "Peace and prosperity" build upon the regional recommendations and scale these up to include national level interventions. While these are not linear processes, the Yemen CCDR provides an agile sliding scale of policy recommendations and investments that can be referenced under different scenarios (detailed in Annex I).

HLO 1: **Develop spatially targeted, scalable area-based approaches to build resilience and reduce multidimensional poverty.** A critical step is to develop an area-based approach for building climate resilience, starting with the establishment of a strong institutional foundation. This includes enhancing the capacity to collect, monitor, and process climate change data while integrating a range of quantitative socio-economic indicators to quantify the relative vulnerability and priority of sub-national districts. The priority areas identified through these objective technical elements will need to be considered within the enabling environment and ranked based according to the available resources to support implementation. To protect the most vulnerable populations, adaptive social protection mechanisms, such as cash transfer programs, could be scaled-up and coupled with labor intensive investment programs targeted to those areas most exposed to climate shocks. Additionally, establishing a social registry that tracks exposure to climate hazards in relation to residential and occupational locations will enable targeted and effective interventions.

HLO 2: **Improve water and food security and build a resilient fisheries sector amid uncertainty.** Assessing and rehabilitating critical water infrastructure, including natural and built storage, and enhancing groundwater recharge will help improve water security and agricultural productivity. Preparing farmers, especially smallholders and women, to adopt climate-resilient practices — such as improved irrigation technologies, enhanced soil and water management techniques, and adoption of drought-resistant and heat-tolerant crops — will be vital. Moreover, enhancing food security through grain storage and robust food management systems in key districts, along with improved linkages to markets, will ensure that food crises can be managed more effectively, particularly in areas with high conflict incidence. Building resilience in the blue economy, particularly through regulations to prevent coastal development in vulnerable areas and by establishing financial mechanisms such as microfinance, insurance, and grants to support small-scale fishers and coastal communities will further strengthen Yemen's adaptive capacity. Building resilient infrastructure to enhance processing and value added, while supporting fisherfolk through access to sustainable fishing gear, training on sustainable practices, will help in adapting to climate change and economic shocks. Regulatory requirements should mandate that new infrastructure be located outside of flood-prone areas, and as financial markets stabilize, insurance programs should be developed to protect household and business assets.

HLO 3: **Promote disaster risk management and climate-resilient power service provision centered around renewable energy.** Strengthening early warning systems and modernizing disaster risk management strategies will be essential for reducing vulnerability to climate hazards and promoting climate-resilient infrastructure. A well-structured approach will enhance collaboration among local authorities, communities, as well as national and international partners, enabling more effective responses to climate hazards and improving overall resilience. Ensuring a prioritized approach to investing in climate resilient network infrastructure, such as logistics, transport and telecommunications, will be key to improving access to markets and ensuring access to public services, while promoting greater social inclusion, reducing the risk of accidents and injuries, and minimizing weather-related delays and damage. Prioritizing the rehabilitation of road networks based on their criticality and vulnerability to flooding will be crucial for protecting people and maintaining the foundation for a private sector-led recovery as climate impacts intensify. In terms of electricity service provision, the 'Peace and Prosperity' scenario delivered lower power sector emissions while meeting higher levels of demand. Annual power sector emissions by scenario over the modelling period.

HLO4: Foster adaptive human development by advancing health and human capital, prioritizing women and vulnerable groups. Safeguarding human capital will require targeted measures that address the limitations on health issues coming out of climate change, and human capital accumulation for the youth, and productive engagement for women, in order to realize their full potential and be champions of climate change mitigation. This will require an emphasis on the roles of women and youth, as these groups are disproportionately impacted by displacement and extreme events and will be key to developing effective climate-responsive policies in Yemen. Efforts need to be developed to enhance employment opportunities in sectors such as agriculture and blue economy value-chain development and protect the most vulnerable groups through adaptive social protection mechanisms, such as cash transfer programs. The foundations for this lie in establishing a social registry that tracks exposure to climate hazards in relation to residential and occupational locations and ex-ante mechanisms that can build resilience and compliment ex-post disaster response to smooth consumption and protect assets.

HLO 5: Scale up innovative climate finance and empowering the private sector. Promoting private sector engagement in climate adaptation and mitigation efforts, particularly in agriculture, water, and energy sectors, will be essential for sustainable development. To prepare for better access to climate finance, there is a need to reestablish a credible macroeconomic framework and enhance governance capacity. Strengthening fiscal and monetary policies to achieve price stability and reunifying state institutions under a single authority for monetary policy and financial regulation are crucial steps. This will facilitate the transition from a conflict economy to one focused on peace and prosperity, creating a conducive environment for foreign direct investment and climate financing. Additionally, there is a need to improve coordination mechanisms at both the national and sub-national levels, enhance public financial management, and develop robust regulatory frameworks. Such efforts will lay the groundwork for a more resilient and climate-adaptive Yemen, ready to capitalize on climate finance opportunities when peace is achieved.

Table 5.1. Policy priorities and investments

Reforms and capacity development	Complementary capital investments
HL01: Developing spatially targeted area-based approach to build resilience and reduce multidimensional poverty	
Data: Enhance the capacity to collect, monitor, and process climate change data while integrating a range of quantitative socio-economic indicators to quantify the relative vulnerability and priority of sub-national districts	
Area-based approach: Adopt an area-based approach that can target the most vulnerable households, while responding to the enabling environment and be scaled according to the availability of financial resources, including capacity building of government and CBOs/NGOs	
HL02: Improving water and food security and build a resilient fisheries sector amid uncertainty	
Farmers: Prepare farmers, especially smallholders and women, to adopt climate-resilient practices — such as improved irrigation technologies, enhanced soil and water management techniques, and adoption of drought resistant and heat-tolerant crops	**Water:** Assess and rehabilitate critical water infrastructure, including natural and built storage, like the Marib dam, and enhancing groundwater recharge through catchment-based planning and investments to increase recharge
Blue economy: Build resilience in the blue economy, particularly through regulations to prevent coastal development in vulnerable areas	**Food:** Enhance food security through grain storage and robust food management systems in key districts, along with improved linkages to markets
Microfinance: Establish financial mechanisms such as microfinance, insurance, and grants to support small-scale fishers and coastal communities	**Fisheries:** Build resilient infrastructure to enhance processing and value added, while supporting fisherfolk through access to sustainable fishing gear, training on sustainable practices

Reforms and capacity development	Complementary capital investments
HL03: Promoting disaster risk management and, climate- resilient power service provision centered around renewable energy	
Early warning system: Strengthen early warning systems and modernizing disaster risk management strategies	**Logistics and Transport:** Rehabilitate transport infrastructure, prioritized based on their criticality and vulnerability to flooding
Electricity: Develop short-medium term electricity investment plan, and a renewable energy strategy to reduce the need of expensive fuel imports.	**Electricity:** Country-wide power infrastructure assessments and rehabilitation plans, led by the Ministry of Electricity and Energy.
HL04: Fostering adaptive human development by advancing health and human capital, prioritizing women and vulnerable groups	
Women: Prioritize women (and vulnerable groups) in climate policy and financial provision—by enhancing employment opportunities in sectors such as agriculture and blue economy value-chain development	**Social protection:** Protect the most vulnerable populations through adaptive social protection mechanisms, such as cash transfer programs
Social protection: Establish a social registry that tracks exposure to climate hazards in relation to residential and occupational locations	**Health:** Build health system capacity for preparedness and resilience against climate change related health outbreaks and diseases, and ensure interoperability with early warning systems and digital health systems
HL05: Scaling up innovative climate finance and empowering the private sector	
Macroeconomics: Reestablish a credible macroeconomic framework and enhance governance capacity	
Fiscal: Strengthen fiscal and monetary policies to achieve price stability and reunifying state institutions under a single authority for monetary policy and financial regulation	
Coordination: Improve coordination mechanisms at both the national and sub-national levels, and enhance public financial management, and develop, implement and monitor robust regulatory frameworks	
Private sector: Foster private sector engagement in agriculture, water, and energy sectors	

5.3. People-Centered Approaches Aimed at Protecting Human Capital

Safeguarding and sustaining human capital will be a critical cross-cutting consideration for all HLOs. It is essential to establish mechanisms that support actions that can build resilience at the local level in a conflict- and climate-sensitive manner, focusing on the most vulnerable groups. This includes facilitating farmers' access to early warning systems through digital tools, particularly targeting small farmers and women-headed businesses, to protect crops and livestock. Maintaining and preserving existing infrastructure critical to essential services, such as roads crucial for humanitarian corridors and food supply, is equally important. By prioritizing these assets in key geographical areas, Yemen can safeguard the delivery of vital services despite the challenging circumstances. Rolling out capacity building programs on disaster preparedness, emergency procedures, and climate change adaptation, particularly in high-risk areas, will equip vulnerable groups with the knowledge and skills necessary to manage and adapt to climate risks. Community-level nature-based solutions can pave the way for climate-resilient planning at the local level. Increasing reliance on microfinance institutions can further support vulnerable groups by providing access to essential resources and financial services. Empowering community participation is also crucial; for

instance, engaging local communities in maintaining rooftop solar systems in clinics, schools, and water wells ensures the continuity of critical services. This community involvement, supported by international partners and third-party monitors, can foster a more inclusive and resilient approach to climate adaptation, ensuring that Yemen's most at-risk populations are better prepared to face future challenges.

Yemen receives 80 to 90 percent less climate finance than countries with the lowest climate vulnerability despite high needs. There are a number of barriers to scaling up climate finance for Yemen, including low absorptive capacity and weak appetite among financing institutions due to high perceived and real risks, as well as the lack of effective coordination mechanisms at the national and sub-national levels. These factors, individually and collectively, deter climate investments, despite Yemen's disproportionate vulnerability to the impacts of climate change. Strengthening the capacity of the private sector, which has already been crucial to economic development under increasing fragility, can advance a climate resilient future. Providing comfort to the private sector through guarantee instruments and facilities could provide the path toward increasing investment and insurance products, while a peace agreement has the potential to unlock a range of innovative climate financing tools, including access to global funds, debt swaps and diaspora bonds. There are also emerging instruments, such as climate resilient debt swaps, that are aimed at supporting vulnerable countries against economic shocks. While these are focused primarily on fiscal crises due to natural disasters and climate related hazards, they could be adapted to provide a range of co-benefits and incentives linked to milestones within the peace process for FCV countries.

Securing a lasting peace agreement is critical to unlocking the full potential of adaptation strategies and tapping into new financing streams, including those from the private sector. Projected investment needs are subject to the prevailing conditions, with the basic humanitarian needs under the "Status Quo" scenario estimated at US$2.71 billion in 2024, of which roughly 30 percent has been secured. While enduring peace remains elusive, a climate responsive recovery and reconstruction will need to account for the historical infrastructure deficit due to persistent development challenges and the accumulated reconstruction costs associated with damages due to the conflict. There are a number of "no regret" measures that can be implemented under the status quo to increase resilience to exogenous shocks, such as climate, with a number of development co-benefits. These incremental costs of climate responsive investments are estimated to be less than 3 percent of the basic humanitarian needs, although could range between 1 and 5 percent of GDP annually. All scenarios for Yemen's future development will require significant commitments from national factions and the international community, and while humanitarian and peacebuilding efforts having the potential to indirectly support the ability of households to cope with climate shocks and build broader resilience. securing sustainable peace will be required to unlock new and innovative sources of financing in the amounts needed to build resilience to climate change. While climate change adds a layer of uncertainty to Yemen's developmental trajectory, strategic investments in priority areas, underpinned by reliable data and robust monitoring and evaluation frameworks, present multiple opportunities for a brighter and more resilient Yemen.

Annex I. Detailed Recommendations

HLO 1: Develop spatially targeted, scalable and people centered area-based approaches to build resilience and reduce multidimensional poverty.

Peace & Prosperity	Status Quo (no regret measures)	Escalation & Intensification
1. Expand institutional capacity building to include national planning, development strategies and monitoring of budgetary processes, climate-smart resource governance, and strengthening social protection systems. 2. Introduce disaster risk finance and insurance mechanisms tailored based on a region-climate risk matrix. 3. Expand emergency cash transfers to protect Yemenis exposed to climate shocks. 4. Introduce spatially sensitive passive and active labor force interventions (with focus on jobs aligned with climate change and just transition).	1. Create an institutional foundation that is essential for both development and effective climate action (for both short- and long-term climate change impacts). Focus on building capacity to collect, monitor, and process climate change data, and build linkages with other socio-economic indicators. 2. Pilot adaptive social protection mechanisms offering emergency cash transfers to protect most vulnerable groups exposed to climate shocks (focus on most vulnerable governates to climate shocks) 3. Establish social registry that includes data on climate hazards for residence and work location exposure.	1. At the local level, create mechanisms to support humanitarian action in both a conflict and climate sensitive manner, with focus on short-term climate shocks and the most vulnerable and exposed groups to these shocks. 2. Leverage partnerships with international development partners to tackle climate shocks amid conflict and adopt scenario based interventions. 3. Roll out information resources for disaster preparedness, emergency procedures, adaptation to climate change, especially targeting high risk areas, and vulnerable groups residing in these areas.

HLO 2: Improve water and food security and build a resilient fisheries sector amid uncertainty.

Peace & Prosperity	Status Quo (no regret measures)	Escalation & Intensification
1. Strengthen water governance and consolidate an integrated water resources management framework. 2. Expand artificial aquifer recharge nationally and deploy nature-based solutions. 3. Invest in desalination 4. Promote climate-smart agriculture with focus on balancing food security and export competitiveness. 5. Invest in the installation of new irrigation infrastructure and processing facilities to bolster production and support higher value crops and exports. 6. Provide targeted investments in Yemeni coffee sector and its global positioning (focusing on super aggregators for higher competitiveness and efficiency). 7. Explore opportunities to promote circular economy, especially around waste within the agri-food value chain, municipal solid waste and wastewater.	1. Promote area based "catchment to coast" approach that integrates priority interventions around water management areas 2. Invest in regional data and information management systems that can help build resilience 3. Prepare farmers, particularly smallholders and women, to adapt to climate change by providing information and support to implement effective practices like enhanced soil, water, and adoption of appropriate irrigation technologies; and improve crop choices, including drought-resistant and heat tolerant varieties. 4. Assess and rehabilitate existing critical structures, including dams (such as Marib dam) 5. Pilot artificial aquifer recharge interventions in key regions, including terracing, percolation ponds, groundwater dams, and injection wells to increase the fraction of precipitation that recharges groundwater. 6. Increase resilience of water supply and sanitation services 7. Deploy strategic grain reserves and food storage management systems for food crises, especially in the governorates of Saadah, Hajjah, Amran, Marib, Hodeidah, Raimah, Dhamar, Al Dhale'e and Abyan, some of which also experience high numbers of conflict incidence.	1. Promote local water supply and sanitation service providers 2. Invest in local level storage infrastructure to increase resilience to exogenous shocks, such as small dams and rainwater harvesting, local land-use improvements 3. Facilitate farmers' access to early warning systems to protect crops and livestock through digital tools, especially to small farmers and women-headed businesses 4. Promote water harvesting practices to avoid overlapping conflict and climatic shocks. 5. Develop early warning systems for fishers and build capacity around climate vulnerabilities 6. Resilient infrastructure, including solar powered off grid cooling facilities, local processing capacity 7. Engage local communities (especially women) in conservation and sustainable management of fisheries

HLO 2: Improve water and food security and build a resilient fisheries sector amid uncertainty.

Peace & Prosperity	Status Quo (no regret measures)	Escalation & Intensification
8. Support for aquaculture production through providing incentives for sustainable fishing quotas, and insurance schemes tailored to fishers and fish species. 9. Support aggregation and use of joint processing facilities to minimize operational costs, supported by cold storage and transport 10. Support market-based value chain development for the fisheries sector 11. Invest in small- to medium-scale biorefineries for fish processing byproducts (e.g., oil, collagen, amino acid, mineral production) in jurisdictions with enforced sustainable fishing quotas 12. Invest in sustainable aquaculture production of high-value niche products, such as crustaceans, sea urchins, ornamental corals, and fish.	8. Explore possibilities to support middle- and large-scale farmers tap into level of climate resilience, higher efficiency gains and market opportunity. 9. Introduce regulatory requirements for new coastal development projects to be located outside the historical 20-year floodplain. 10. Conduct studies to assess fish stock assessment and monitoring. 11. Invest in resilient infrastructure, such as solar powered local cold storage and processing facilities 12. Explore possibilities to provide insurance schemes tailored to small-scale fishers reduce risks of coastal hazards to fishers, with the goal of replacing critical losses to essential equipment such as boats or motors and avoiding a spiral into poverty or more destructive fishing practices 13. Engage local communities (especially women) in conservation, restoration, and sustainable management of fisheries entire value chain.	

HLO 3: Promote disaster risk management and climate-resilient power service provision centered around renewable energy.

Peace & Prosperity	Status Quo (no regret measures)	Escalation & Intensification
1. Integrate climate-responsive principles into national territorial planning to ensure that development and service delivery are adaptive and resilient to the impacts of climate change. 2. Expand institutional capacity building to include a nationally coordinated Early Warning System and climate-aware management of public assets (e.g., infrastructure). 3. Modernize hydromet and EWS systems by installing additional automatic climate stations to improve meteorological coverage, with a focus on high-risk and flood-prone areas. 4. Establish a national disaster risk management, reconstruction, and recovery fund to provide financial resources for responding to and recovering from climate-related disasters.	1. Regional flood resilient infrastructure programs in Dhamar, Abyan, Hadramawt, and Al Maharah governorates, and other priority areas 2. Build an institutional foundation for a resilient development, including an Early Warning System that can be accessed by entities (NWRA, MAI, etc) and population across Yemen. 3. Update Civil Defence Law (RDC 24/1997) and its bylaw (RDC 201/1998) enabling DRM coordination and EWS. 4. Enhance the technical capacity of CAMA by improving weather and climate alert systems, as well as software tools for meteorological, hydrometeorological, and climate forecasting (including downscaling and local models).	1. Updating hazard maps and practical tools to enhance public awareness and preparedness 2. Introduce community level Nature-Based Solutions (NBS) to mitigate flood risks 3. Implement a capacity-building program to establish dedicated community committees and develop community-based flood hazard maps, enhancing flood management and public awareness. 4. Provide flood resilient infrastructure at a minimum in highly vulnerable cities of Dhamar, Abyan, Hadramawt, and Al Maharah governorates. 5. Develop an Early Warning System prototype using global data sources that can be replicated by local and regional authorities and build capacity among beneficiaries to prepare for climate disasters using these resources.

HLO 3: Promote disaster risk management and climate-resilient power service provision centered around renewable energy.

Infrastructure and Mobility

1. Rehabilitate damaged network infrastructure (logistics and transport, electricity, telecommunications) infrastructure with climate and disaster risk mitigation measures. The priority for logistics and transport infrastructure works should be in strategic areas for Yemen's recovery and reconstruction, serving areas with export-oriented agriculture activities, for example.
2. Floodproof existing vulnerable buildings, which would provide the highest level of resilience by mid-century while benefitting the owners and the municipalities of the higher asset values.

1. Institute regulatory requirements for constructing new infrastructure to be outside the historical 20-year floodplain
2. Once a stable financial market can be established, insurance programs to protect the assets households and businesses
3. Invest in increasing the resilience of road assets to the significant impacts of flooding expected in the future under climate change (rehabilitation of assets should be prioritized based on network criticality among other policy priorities)

1. Maintain the existing infrastructure and buildings necessary for essential services within the available resources will also be important to preserve the assets and provision of such services. Labor-intensive maintenance methods can be employed to also create employment opportunities and support vulnerable groups with limited resources to cope with shocks.
2. Preserve the existing critical infrastructure assets in priority geographical areas. This includes critical road assets that are important for humanitarian corridors and food supply

Energy

1. Establish a National Renewable Energy Agency.
2. Review and update the Renewable Energy Strategy and devise a long term RE investment program.
3. Ensure a diversified energy mix based on least-cost modeling.
4. Country-wide infrastructure assessments and rehabilitation plans, led by the Ministry of Electricity and Energy.
5. Grid extension to highly dense areas and Increased presence of solar mini-grids in remote areas.
6. Establish national electricity information management system.
7. Launch strategy and programs to promote green and resource efficient buildings (especially for water and energy)
8. Explore projects to reduce gas flaring.
9. Launch a strategy for geothermal exploration, including feasibility studies, pilot projects (especially for critical facilities like hospitals), and partnerships with private sector investors.

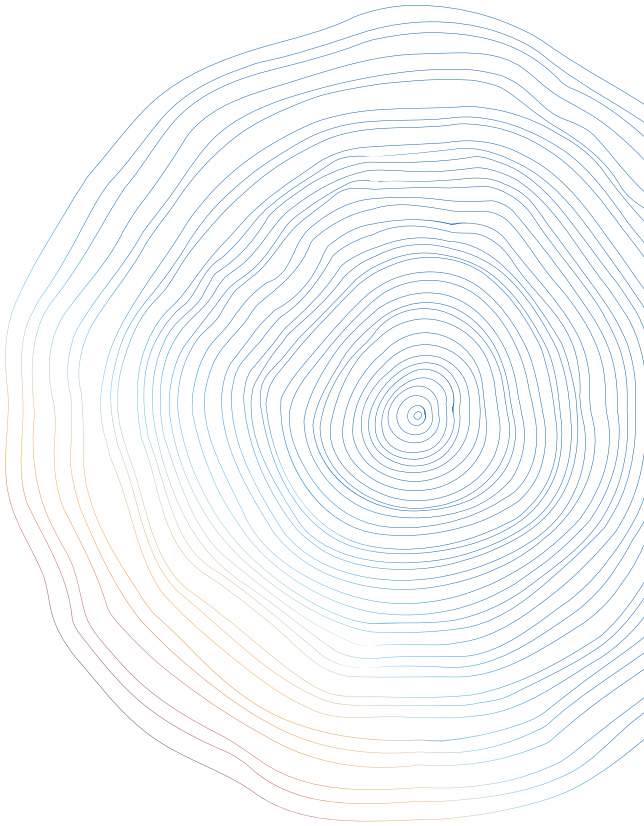
1. Develop short-medium term electricity investment plan.
2. Develop a renewable energy strategy to reduce the need of expensive fuel imports, thus reducing pressure on government budget.
3. Strengthen existing government institutions (PEC and the General Authority for Rural Electrification), while continuing to engage with local communities.
4. Country-wide infrastructure assessments and rehabilitation plans, led by the Ministry of Electricity and Energy.
5. Continue partnership agreements with the private sector (MFIs) to provide small solar systems in rural areas.
6. Establish national electricity information management system.
7. Update national map of solar/wind potential using ESMAP tools.

1. Decentralized service delivery – mainly individual/small solar systems
2. Empower Community participation to maintain rooftop solar systems in critical service facilities such as clinics, schools, and water wells; and increase reliance on local community engagement, citizen surveys, and monitoring mechanisms financed through UN agencies and supported by TPMs.
3. Maintain O&M of electricity facilities within their areas using available resources.
4. Strengthen support to local institutions and communities. Increase reliance on Microfinance institutions to reach vulnerable groups.
5. Local electricity infrastructure assessments and rehabilitation plans at the local communities' level with support from humanitarian agencies).

HLO 4: Foster adaptive human development by advancing health and human capital, prioritizing women and vulnerable groups.

Peace & Prosperity	Status Quo (no regret measures)	Escalation & Intensification
1. The HNAP would integrate climate-health adaptation into national health planning, providing a foundation for climate-resilient health services. 2. Improved data integration will strengthen early warning systems for climate-sensitive diseases, enhancing proactive health responses. 3. Ensure health infrastructure aligns with adaptation and mitigation goals, incorporating energy efficiency and climate resilience. 4. Prioritize women (and vulnerable groups) in climate policy and financial provision—by enhancing employment opportunities in sectors such as agriculture and blue economy value-chain development	1. Strengthen MoPHP capacity and increase coordination of climate-health initiatives. 2. Establish focal office/contact for development partners, private sector, and other organizations on health and DRM. 3. Invest in proactive responses and enhance climate-resilient infrastructure for healthcare facilities 4. Develop targeted strategies that address the needs of women, children, the elderly, and other vulnerable groups who are disproportionately affected by climate change and health-related issues 5. Establish a robust monitoring and evaluation framework to track the progress of implemented strategies and assess their impact on improving health outcomes in the context of climate change 6. Use digital tools for health for adaptation, mitigation and resilience	1. Enhanced targeting can reduce health disparities by addressing climate-related health risks among Yemen's most vulnerable. 2. Invest in local facilities that can withstand extreme weather events and ensure the continuity of essential health services. 3. Rehabilitate damaged health infrastructure as a result of climate-shocks

HLO 5: Scale up innovative climate finance and empower the private sector through people centered approaches.		
Peace & Prosperity	**Status Quo (no regret measures)**	**Escalation & Intensification**
1. Develop a comprehensive reform plan aimed at stabilizing and revitalizing the macroeconomic environment, focusing on enhancing domestic resource mobilization, boosting growth and productivity, and strengthening public financial management. 2. Develop strategy to support aggregation within targeted industries (energy, fisheries, coffee, etc.) 3. Explore PPP projects, tax incentives, policies and laws that create an enabling environment for smaller and larger scale investments. 4. Support private sector in exploring the issuance of green sukuks and sustainability-linked loans 5. Deploy guarantee instruments to facilitate private sector investments	1. Reestablish a credible macroeconomic framework by strengthening fiscal and monetary policies to achieve price stability and reunifying state institutions under a single authority for monetary policy and financial regulation 2. Raise the awareness of the private sector about climate risks and climate opportunities to encourage private sector investment in key adaptation and mitigation sectors such as agriculture, water, and energy 3. Focus on building the fundamentals to prepare the country for better access to climate finance when peace is finally achieved 4. Improve coordination mechanisms at the national and sub-national level. 5. Prioritize large capacity development programs on climate finance, addressing policy fragmentation, developing regulatory frameworks for climate change (i.e climate change laws and decrees) 6. Develop data and information to support project design, establishing inclusive coordination mechanisms for project preparation and implementation, putting in place FCV-sensitive policies for accessing climate finance such as FCV responsive ESS and gender policies 7. Improving Public Financial Management by putting in place clear accountability mechanisms to ensure that climate finance is received, allocated, and spent effectively and efficiently 8. Support community-to-community financing mechanisms, whereby rich and technically advanced communities or cities from around the world are paired with communities or cities in Yemen, or through (ii) the capacity building funding windows of multilateral development partners and dedicated climate funds 9. Incentivize private sector investments through A2F funding from banks and MFIs (for smaller scale projects, especially in rural areas) 10. Provide political risk guarantees (through MIGA for example) to private investors for projects that have development, climate, and peace co-benefits, such as climate resilient infrastructure projects.	1. Work with local communities, humanitarian and peace-building organizations to understand and assess the needs and ensure funding decisions and allocations are climate-sensitive and target the most vulnerable communities. 2. Development partners to channel climate funding support to Yemen through humanitarian projects, ensuring that projects are climate responsive, where applicable.



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