MIGRATION, ENVIRONMENT AND CLIMATE CHANGE IN YEMEN

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Cover photo: As part of the ongoing flood response efforts in West Coast, IOM is empowering internally displaced persons (IDPs) through cash-for-work initiatives. Here, community members actively participate in improving their environment, showcasing resilience and collaboration in the face of adversity. © IOM 2024/Majed MOHAMMED

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MiRAC
MIGRATION RESOURCE ALLOCATION COMMITTEE

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As part of the ongoing flood response efforts in West Coast, IOM is empowering internally displaced persons (IDPs) through cash-for-work initiatives. Here, community members actively participate in improving their environment, showcasing resilience and collaboration in the face of adversity. © IOM 2024/Majed MOHAMMED

CONTENTS

LIST OF FIGURES AND TABLES

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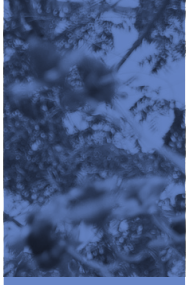


ACRONYMS

CIA	Central Intelligence Agency
CIVIC	Center for Civilians in Conflict
CSO	civil society organization
DCAF	Geneva Center for Security Sector Governance
FAO	Food and Agriculture Organization of the United Nations
FGD	focus group discussion
FSIN	Food Security Information Network
GDP	gross domestic product
GIS	Geographic Information System
GSC	Global Shelter Cluster
IAHE	Inter-Agency Humanitarian Evaluation
ICRC	International Committee of the Red Cross
IDP	internally displaced Person
IHD	Integral Human Development
IOM	International Organization for Migration
IPCC	Intergovernmental Panel on Climate Change
IRW	Islamic Relief Worldwide
ISIL	Islamic State of Iraq and the Levant
KII	key informant Interview
MECC	Migration, Environment, and Climate Change
MENA	Middle East and North Africa
NACRA	National Committee for Refugee Affairs
NASA	National Aeronautics and Space Administration

ND-GAIN	Notre Dame Global Adaptation Initiative
NDC	National Dialogue Conference
NFI	non-food Item
NGO	non-governmental Organization
NOAA	National Oceanic and Atmospheric Administration
NUPI	Norwegian Institute of International Affairs
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
SIPRI	Stockholm International Peace Research Institute
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESC	United Nations Economic and Social Council
UNFCCC	United Nations Framework Convention for Climate Change
UNHCR	United Nations High Commissioner for Refugees
UNY	United Nations Yemen
USAID	United States Agency for International Development
WASH	water, sanitation and hygiene
WFP	World Food Programme

GLOSSARY

Climate change	"[A] change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to other natural climate variability that has been observed over comparable time periods" (UN Framework Convention on Climate Change, 1992, Article 1).
Cross-border migration	A process of movement of persons across international borders (IOM, 2019, p. 23).
Desertification	[L]and degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities (UNCCD, 1994, Article 1).
Disaster	"A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts which exceeds the ability of the affected community or society to cope using its own resources" (UNISDR, 2009).
Economic migrants	The movement of a person or a group of persons, either across an international border, or within a State motivated solely or primarily by economic opportunities. (IOM, 2019).
Environmental degradation	"The reduction of the capacity of the environment to meet social and ecological objectives and needs. […] Degradation of the environment can alter the frequency and intensity of natural hazards and increase the vulnerability of communities. The types of human-induced degradation are varied and include land misuse, soil erosion and loss, desertification, wildland fires, loss of biodiversity, deforestation, mangrove destruction, land, water and air pollution, climate change, sea level rise, and ozone depletion" (UNISDR, 2009).
Environmental migrant	"Persons or groups of persons who, predominantly for reasons of sudden or progressive change in the environment that adversely affects their lives or living conditions, are obliged to leave their habitual homes, or choose to do so, either temporarily or permanently, and who move either within their country or abroad" (IOM, 2019, p. 65).

Extreme weather event	An event that is rare within its statistical reference distribution at a particular place. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile. By definition, the characteristics of what is called extreme weather may vary from place to place. An extreme climate event is an average of a number of weather events over a certain period of time, an average which is itself extreme (e.g. rainfall over a season)" (Intergovernmental Panel on Climate Change (IPCC), 2018).
Human security	Concerns the right of people to live in freedom and dignity, free from poverty and despair, and promotes the protection of their physical safety, economic and social well-being, and human rights. It includes the right of all individuals, vulnerable people in particular, to live free from fear and want, with an equal opportunity to enjoy all their rights and fully develop their human potential. *Adapted from United Nations General Assembly*, Follow-up to Paragraph 143 on Human Security of the 2005 World Summit Outcome (2012) *UN Doc. A/RES/66/290, para. 3(a)*.
Internally displaced persons	Persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters, and who have not crossed an internationally recognized State border (UNESC, 1998).
Internal migration	The movement of people within a State involving the establishment of a new temporary or permanent residence (IOM, 2019).
Livelihood	At the individual and household levels, vulnerability and resilience depend largely on people's livelihoods. Livelihoods comprise the capabilities, material and social assets, and activities required to sustain a means of living (Chambers and Conway, 1991). Livelihood options depend on available [human, social, and financial] capital and on the [socioeconomic, natural] and political context in which people live. They determine how people occupy and use their environment; what options they are faced with in the face of hazards; what impacts they suffer from such hazards; and how effectively they recover (IOM, 2019, p. 23).
Salinization	The accumulation of salts in soils (IPCC, 2018, p. 993).
Slow-onset event	An event evolves gradually from incremental changes occurring over many years or from an increased frequency or intensity of recurring events. Such events include sea level rise, increasing temperatures, ocean acidification, glacial retreat and related impacts, salinization, land and forest degradation, loss of biodiversity, and desertification (UNFCCC, 2011).

EXECUTIVE SUMMARY

The Middle East and North Africa (MENA) region, characterized by its aridity, water scarcity, rapid urbanization, and vulnerability to climate change-induced natural hazards, faces significant challenges that directly impact human mobility. Existing conflicts further complicate these conditions. Within this context, the International Organization for Migration's (IOM) Regional Office for MENA in coordination with IOM Yemen Country Mission undertook desk and original research to support the development of this empirically informed Migration, Environment, Climate Change (MECC) country report on Yemen to inform policy discussions and interventions. This report examines how climate change, environmental changes, and human mobility are interconnected. It responds to the need for policies based on solid evidence, backed by the IOM's dedication to the Global Compact for Safe, Orderly, and Regular Migration (Global Compact for Migration) and the United Nations Secretary-General's Action Agenda on Internal Displacement.

To deepen the empirical data available on these dynamics and their intersection with human mobility, this study leveraged a qualitative mixed-methods approach, integrating 30 key informant interviews (KIIs), focusing on personal, organizational and community-level experiences related to climate adaptation, with findings from 10 focus group discussions (FGDs). The latter explored collective decision-making processes regarding mobility, influenced by environmental changes and other insecurities, with groups representing diverse demographics, including age, sex, ethnicity and livelihood. Collaboratively developed semi-structured protocols guided the data collection process to gather insights on existing initiatives, individual and institutional responses, and programming needs related to environmental and climate challenges as they intersect with human mobility and conflict dynamics.

Analysis used inductive thematic coding to ensure the integrity of the responses, revealing patterns that underscore the critical climate events, successful adaptation programmes, and areas needing enhancement. Limitations include constraints due to the underrepresentation of Muhamasheen and transiting migrants. Additionally, the qualitative approach – focusing on fewer data points and greater depth – may limit the generalizability of insights across diverse groups and contexts within the country.

Key findings

The following represent the effects of extreme weather events:

1. **(Flash) floods:** Floods are increasing in severity and frequency, while factors like illegal logging, groundwater depletion, and unplanned urbanization accelerate and amplify vulnerabilities. The heavy rainfall in 2020 led to significant flooding, causing widespread socioeconomic and humanitarian impacts, including infrastructure damage, health risks, crop and livestock losses, and displacement, all further complicated by ongoing conflict and governance issues.
2. **Cyclones:** Climate change has increased cyclone activity in Yemen, leading to significant damage and flooding, particularly in coastal areas. Cyclones Chapala in 2015 and Tej in 2023 collectively displaced thousands, caused numerous injuries and fatalities, and extensively damaged infrastructure, homes and key economic sectors like agriculture and fisheries.

3. **Hurricanes and tropical storms:** Tropical storms and hurricanes cause flash floods and soil erosion, leading to economic damage, crop loss, and severe impacts on infrastructure and livelihoods. Experts warn of heightened hurricane risks and their adverse effects on security and the fishing industry in the coming years.
4. **Sand and dust storms:** Yemen's frequent sand and dust storms not only raise health concerns due to dusty air exposure but also trigger environmental and agricultural degradation through sudden increases in river flows and flooding. They also significantly impact the fragile infrastructure of IDP camps, complicating daily life and mobility for displaced populations.
5. **Wildfires:** Yemen's western governates have a high wildfire risk. Fire, in general, poses a critical threat in IDP camps, where rising temperatures, flammable materials and close quarters significantly heighten the danger of rapid fire spread and catastrophic damage.

Study respondents named several adaptive responses to extreme weather events, including makeshift shelter repairs, improvised water and heating solutions, and reliance on community support and temporary jobs. However, these measures are often insufficient and unsustainable against the broader backdrop of broader threats to human security, including health-care access issues and persistent food insecurity.

Respondents also addressed slow-onset processes and their impact on security and mobility:

1. **Drought, water scarcity and groundwater depletion:** Yemen's conflict and environmental challenges have led to sharp declines in groundwater levels through the interconnected mechanisms of water infrastructure destruction and disruption, increased groundwater extraction, and population displacement. Reduced rainfall and the cultivation of water-intensive crops like qat, among other factors, exacerbate drought and other sources of water scarcity.
2. **Changing rainfall patterns:** The traditional rainy season has become unpredictable, leading to flooding, locust outbreaks, disruptions to agriculture and livestock, and subsequent shifts in farming practices and livestock management. However, some previously uncultivable desert areas have become fertile, attracting agricultural and nomadic communities for resettlement.
3. **Rising temperatures:** Yemen is undergoing significant long-term warming trends, exacerbating water scarcity by increasing evaporation, disrupting agriculture through changing growing seasons, and damaging biodiversity through impacts like coral bleaching and locust outbreaks. The rising temperatures affect daily life, livelihood decisions and cultural practices, with impacts ranging from health risks in IDP camps to altered routines and the shifting of traditional events like weddings to cooler times or venues due to heat and power constraints.
4. **Soil erosion, declining soil fertility and loss of vegetation cover:** Soil fertility is declining due to factors including climate change, poor land management practices, and ongoing conflict. Desertification, erratic rainfall, temperature increases, excessive groundwater extraction, and harmful agricultural practices such as overuse of fertilizers and pesticides contribute to soil degradation, threatening agricultural productivity, exacerbating food insecurity and complicating sustainable soil management.
5. **Salinization:** Rising sea levels and chronic water shortages exacerbate aquifer salinization and reduce water quality. This is compounded by high soil salinity due to inefficient water management, excessive irrigation, and high evaporation rates. However, recent increases in rainfall and flooding have also reduced soil salinity in some areas, improving agricultural prospects and water levels in wells.

6. **Deforestation, desertification and sand encroachment:** Deforestation and desertification are reducing agricultural and pasture land, driven by fuel shortages leading to increased reliance on wood for energy, lack of regulatory frameworks, and natural adversities like droughts and groundwater depletion. Additionally, sand encroachment significantly disrupts daily life, mobility options and agriculture in affected communities.
7. **Pollution and waste:** Pollution severely impacts environmental and public health, with major issues stemming from water pollution, air pollution exacerbated by waste burning and emissions, and improper disposal practices that harm agricultural productivity and escalate health-care costs. Additionally, the marine environment suffers from phenomena like green tide, while urban and coastal areas like Aden face challenges from industrial waste and oil spills, further compounded by inadequate waste management systems in conflict-affected areas.
8. **Sea-level rise:** By 2100, Yemen's sea levels are expected to rise between 0.3 and 0.54 metres, threatening over half of the coastal regions and affecting more than 55 per cent of the coastal population. This will significantly impact infrastructure like hospitals and schools, particularly in Aden, and pose broader economic and developmental challenges across high-risk coastal governorates.
9. **Coastal erosion:** Coastal erosion in Yemen leads to saltwater intrusion, threatening freshwater resources and agricultural viability, causing significant land loss and fish mortality, and adversely affecting the livelihoods of coastal communities.
10. **Biodiversity loss:** Rising temperatures and altered precipitation threaten unique ecosystems such as the Socotra archipelago and lead to the near-extinction of species like the Dragon Blood Tree. Human activities, including deforestation, habitat fragmentation, and the overexploitation of natural resources, further contribute to biodiversity loss. Invasive species and climate-induced changes are forcing shifts in traditional practices and threatening local ecosystems and economies.

In response to slow-onset processes, study respondents reported engaging in various coping measures driven by necessity. For example, IDP camp residents face challenges such as insufficient shelter, lack of clean water, and the absence of basic health care, which they attempt to mitigate through self-built structures, improvised water collection methods, and community-based resource sharing. Individuals often resort to using firewood for cooking due to irregular gas supply, sew their own shelter materials, and rely on makeshift solutions to manage waste and water. These efforts are complemented by community initiatives such as borrowing essentials from neighbours, selling collected recyclables, and engaging in small-scale crafts or other jobs to support their families. There remains a significant gap between community needs and aid and support capabilities.

Drivers of migration *to* Yemen. Yemen, historically a refuge for those escaping regional conflicts, now faces a severe humanitarian crisis that has led to a reduced asylum capacity and growing intolerance towards the nearly 278,000 migrants, refugees, and asylum-seekers residing mainly in urban and semi-urban areas. These populations in vulnerable conditions, especially women and children, face significant human rights challenges such as human trafficking, kidnapping, and sexual violence, exacerbated by ongoing conflict that hampers anti-trafficking efforts and legislative enforcement. In response to these adversities, participants in focus group discussions expressed a strong desire to return to their home countries, contingent on improved security and economic conditions.

Drivers of migration *through* and *out* of Yemen. Previous IOM research revealed that 97 per cent of surveyed migrants in Yemen were en route to Saudi Arabia, mainly from Ethiopia, driven by unemployment and political instability at home. Coastal areas of Lahj and Shabwah witnessed the bulk of these arrivals (IOM, 2023a). The study also identified an emerging trend of migrants using new routes through the Hadramawt and Al Mahrah governorates, aiming to reach economic opportunities in Oman while avoiding human rights abuses at the Saudi Arabian border. Several migrants interviewed for the present study expressed a continued desire to migrate to other countries for better economic prospects.

Drivers of migration and displacement *within* Yemen. Yemen faces a complex internal displacement crisis, with over 4.5 million internally displaced persons (IDPs) due to diverse factors, including conflict (42% in 2023), disasters triggered by natural hazards (47%), and economic instability (11%) exacerbated by conflict. This situation is compounded by economic difficulties such as unemployment and wage reductions, illustrating how multiple crises – ranging from environmental degradation to economic collapse – blur the lines between forced migration and displacement, driving continuous movement within the country.

Temporary and multiple displacements are driven by this same confluence of factors, compelling various population groups to engage in temporary migration or face repeated relocations. For instance, conflicts and disasters like floods prompt people to temporarily relocate to safer areas, such as moving to higher ground or other governorates. Additionally, ongoing environmental challenges and inadequate infrastructure exacerbate the hygiene and sanitation crises, leading to secondary displacements among IDPs, who frequently encounter heightened vulnerabilities and financial strains due to repeated relocations. Migration journeys are fraught with harsh conditions and a lack of essential services along their routes. Upon reaching host communities, migrants encounter mixed receptions and varying levels of service provision, which can offer some stability or present new difficulties. Furthermore, many IDPs and migrants find themselves "trapped" due to financial constraints and social ties, unable to move away from disaster-prone areas or improve their living conditions, thus perpetuating cycles of vulnerability and displacement.

Cross-sector challenges and responses. Study respondents highlighted that ineffective governance and inadequate public sector responses to climate change intensify vulnerabilities by failing to ensure equitable resource distribution, maintain infrastructure, and promote education and awareness about climate issues. Additionally, extreme weather events, conflict, and resource shortages severely compromise health and human security in Yemen. Populations in vulnerable conditions are particularly affected, facing increased disease risk, malnutrition due to acute food insecurity, and restricted access to health care. These issues also lead to diminished agricultural productivity and push people away from traditional farming towards alternative livelihoods that are often environmentally damaging. This shift, driven by necessity rather than choice, perpetuates poverty and transforms socioeconomic landscapes. Furthermore, housing insecurity, worsened by environmental challenges and frequent evictions, critically affects the well-being and safety of displaced populations and contributes to unplanned urbanization.

Resources and vulnerabilities. Yemen's unique geographical features and climate issues, compounded by unsustainable water practices and ongoing conflict, heighten its vulnerability to environmental and climate stressors. Regarding the conflict, the actions of various groups – both at the national and local levels – have contributed to environmental degradation, accelerated the deleterious effects of climate change, intensified resource conflicts, undermined agricultural and fisheries sectors, and led to widespread displacement. The intersecting effects of climate change, migration, displacement, and armed conflict disproportionately affect women, exacerbating gender-based violence, accelerating early marriages, heightening susceptibility to poverty and displacement, increasing risks of violence and exploitation due to restrictive social norms, and amplifying health-care challenges. Under conditions of environmental migration and/or displacement, children suffer from disrupted education, and the elderly face increased vulnerability to adverse health effects and struggle with mobility and access to essential resources. Both population groups suffer disproportionately in terms of resultant health issues, including malnutrition and chronic diseases.

Based on the above research and analysis, this country report recommends the following:

1. **Integrate climate resilience and migration policy.** Focus areas should include resilient infrastructure, sustainable agricultural practices, and integrated resource management plans to mitigate the impacts of extreme weather events and slow-onset changes while supporting sustainable livelihoods and integrating environmental migration considerations into planning frameworks to support displaced populations better.
2. **Strengthen, support, and extend multi-institutional, multi-hazard early warning systems and disaster response and recovery.** Capacity-building should be enhanced to improve coordination between governmental agencies, local communities and international organizations at all levels, supported by partnerships with organizations and academics using advanced meteorological technologies for accurate forecasting and real-time hazard monitoring. Additionally, participatory community-based training programmes and multi-lingual communication channels should be established to improve local emergency preparedness and response, ensuring timely alerts and integrating these systems into development plans for institutionalized frameworks.
3. **Leverage the Humanitarian-Development-Peace Nexus (HDPN) approach to improve cross-sector and multi-actor coordination, collaboration and concertation.** Implement the Humanitarian–Development–Peace Nexus (HDPN) approach to address gaps created by fragmented and siloed interventions. Enhance resilience, resource allocation, and support for communities facing the interconnected challenges of climate change, conflict and socioeconomic instability.
4. **Identify and strengthen local conflict resolution mechanisms, especially concerning tensions around land and water access.** Strengthen local conflict resolution mechanisms by integrating community-based approaches and traditional mediation practices. Establish transparent, inclusive platforms involving all stakeholders and enhance the capacity of local mediators through culturally aligned training programmes and technological tools like GIS for land mapping and real-time conflict monitoring. Foster effective dialogue, cooperation and dispute resolution.
5. **Leverage participatory environmental peacebuilding approaches to increase the role of women and youth in community resource management.** Establish engagement platforms that include diverse community stakeholders, particularly in areas with acute resource scarcity, and train women and youth in leadership and conflict resolution skills focused on environmental management. Ensure these initiatives involve all community leaders to generate buy-in. Use participatory methods to make processes contextually relevant, integrate host and migrant communities, and mitigate the risk of new conflicts.

6. **Conduct a feasibility study for restoring the Tawila Cisterns in Aden and resettling the populations currently inhabiting the canals.** Evaluate the possibilities for restoring the cisterns to mitigate flood damage and water scarcity, potentially collaborating among UN-Habitat, UNHCR, OCHA, IOM and local officials. Understand the possibilities and limits of this infrastructure to address multiple hazards effectively.

7. **Develop and scale a qat crop substitution programme by implementing a comprehensive strategy that combines agricultural innovation with community engagement and sustainable resource management.** Promoting cultivating drought-resistant crops like millet or sorghum to address water scarcity, food insecurity and economic sustainability, with support in the form of training for farmers on sustainable practices and efficient water use. Community workshops and educational campaigns can raise awareness about crop diversification benefits, involving local stakeholders in decision-making to ensure initiatives meet community needs and leveraging partnerships with local and international organizations for resources and expertise.

8. **Prioritize resettlement of populations in known flood plains to less hazard-prone areas or build necessary infrastructures to redirect and retain flood waters.** Prioritize resettling populations from known flood plains to safer areas to reduce multiple displacements. This strategy should include comprehensive risk assessments, well-planned relocation schemes with necessary infrastructure and services such as water, health care, education, and official documentation, and involve coordinated efforts between government authorities, local communities, and international agencies.

9. **Develop environmental education and awareness programmes tailored to the practices of different population groups.** Develop and integrate comprehensive environmental education into school curricula at all levels, including practical lessons on climate change and sustainable resource management, alongside community workshops tailored to various demographic needs. Launch widespread media campaigns to raise awareness, highlight local success stories, and establish a framework for monitoring and evaluating these programmes, ensuring resources are created through participatory engagement with communities to teach environmental concepts and practices effectively.

10. **Conduct further research on the impacts of climate change on all groups of migrants within Yemen.** Given Yemen's role as a significant transit hub for migrants heading to Gulf countries, further research on the impacts of climate change on these individuals is crucial, as existing data is limited. Design comprehensive studies to inform subregional collaboration to address adaptation needs in both countries of origin and Yemen, enhancing the effectiveness of interventions to support migrants and reduce vulnerabilities exacerbated by climate change.

Yemen faces significant environmental, climate and human mobility challenges that compound its complex sociopolitical and economic issues. The following analysis, informed by discussion groups, key informant interviews, and a comprehensive desk review, responds to the urgent need for holistic, data-driven policies and programmes to effectively address these interlinked challenges and support orderly, dignified and humane migration strategies.

INTRODUCTION

This report represents an empirically informed migration, environment and climate change (MECC) country study on Yemen. It highlights the interconnection between climate change, environmental shifts and human mobility amid regional challenges such as aridity, water scarcity, fragility and conflict. It responds to the necessity for evidence-based policies to address these pressing issues. It aligns with the Global Compact for Safe, Orderly and Regular Migration (Global Compact for Migration), especially its Objective 2, which recognizes the effects of climate change and environmental degradation as the adverse mobility drivers, and the United Nations Secretary-General's Action Agenda on Internal Displacement which calls for reducing the displacement risks posed by climate change and disasters.

Research methodology

In addition to an academic and gray literature desk review (McFee, 2023), ten Focus Group Discussions (FGDs) were conducted to explore adaptation and resilience strategies against the backdrop of MECC nexus dynamics. These discussion groups delved into the collective decision-making processes regarding mobility in response to the interlinked challenges of climate change, environmental shifts, and other sources of insecurity (e.g. physical insecurity and food insecurity). Each group comprised diverse community leaders along the axes of life cycle stages (youth, older adults), ethnicity and other context-relevant criteria (e.g. livelihood, religious community, tribal affiliation). Sex and location demographics of participants varied, with an even distribution between all-male, all-female and mixed-gender groups, reflecting a broad spectrum of experiences and perspectives. These discussions, held in a structured environment to foster open dialogue, aimed to understand the nuanced impacts of environmental changes on collective and individual migration decisions.

To enrich the insights from focus group discussions and desk research, 30 key informant interviews (KIIs) (11 female, 19 male) were conducted with stakeholders and key informants from government and the public sector (17), academia (4), civil society (5) and internally displaced persons (IDP) site administration (4), reflecting a diverse and inclusive array of perspectives on the migration, environment, and climate change nexus in Yemen. The consultant co-designed the KII and FGD protocols with the IOM Yemen mission and experienced field data collection professionals led by Hani Ahmed, PhD, in Yemen. The interviewees were then selected using purposive sampling and provided valuable perspectives on study themes. These interviews aimed to gather detailed information on local climate adaptation efforts, collaborative stakeholder initiatives, the impact of environmental changes on community livelihoods, and the interplay between climate change effects and existing vulnerabilities in Yemen.

All data were analysed using inductive thematic coding and MAXQDA software without interpretive labels to maintain response integrity. This analytic approach involved analysing and categorizing responses based on observed patterns and insights without preconceived categories or theories guiding the process. For more detail on the sample and methodology, see Appendix I: Methodology.

Limitations of the study

Assessing the intersection of migration, environmental degradation, climate change, and other salient factors, notably fragility and conflict in the context of Yemen, constitutes a complex task hampered by the scarcity of up-to-date, comprehensive and reliable data. The present country study responded to calls for qualitative empirical data at the national and local levels (Price, 2022). While the development of the methodological instruments involved comprehensive research on related indicators, some were not included due to length restrictions on the instruments, notably in areas like gender-based violence (GBV) prevalence and poverty.

The limitations of the methodological approach lie with the limited number of interviews and focus groups and purposive sampling, which could introduce an unintended bias, potentially overlooking or underweighting diverse perspectives from underrepresented groups in Yemen. For example, due to sampling restrictions related to the scope of the study, no Muhamasheen[1] or advocates for this population group were included. Furthermore, migrants entering Yemen with the intention of transiting through to other countries are largely absent in the sample. Agricultural communities were also underrepresented. These data gaps result from resource and timing constraints on the data collection process. As such, the analysis does not fully capture the breadth of experiences at the intersection of study dynamics. Additionally, while the qualitative focus offers depth, the methodological design might limit the generalizability of findings, hindering the ability to extrapolate broader patterns and impacts across different contexts within the country. Future studies are recommended to ensure a more equitable representation of these population groups.

As part of the ongoing flood response efforts in South Taiz, IOM is empowering internally displaced persons (IDPs) through cash-for-work initiatives. Here, community members actively participate in improving their environment, showcasing resilience and collaboration in the face of adversity. © IOM 2024/Majed MOHAMMED

[1] The Muhamasheen, also known as "the marginalized ones," are a socially discriminated minority group in Yemen, often facing severe marginalization and exclusion from economic, social and political life. Historically referred to as "Akhdam" (servants), they typically live in informal settlements and suffer from extreme poverty, limited access to education and health care, and are often subjected to various forms of discrimination and human rights abuses.

1. BACKGROUND

Yemen's landscape comprises a predominantly desert climate characterized by arid conditions. It is positioned at the southern tip of the Arabian Peninsula and has a surface area of approximately 527,970 square kilometres. Along its west coast, the climate turns hot and humid due to its proximity to the sea. The western mountains present a more temperate climate influenced by seasonal monsoons. In these areas, the weather exhibits greater variability. Conversely, the eastern regions of Yemen are marked by an exceptionally harsh desert environment, with extremely high temperatures and minimal precipitation. The governorates of the country can be seen in Figure 1.

Figure 1. Governorates of Yemen

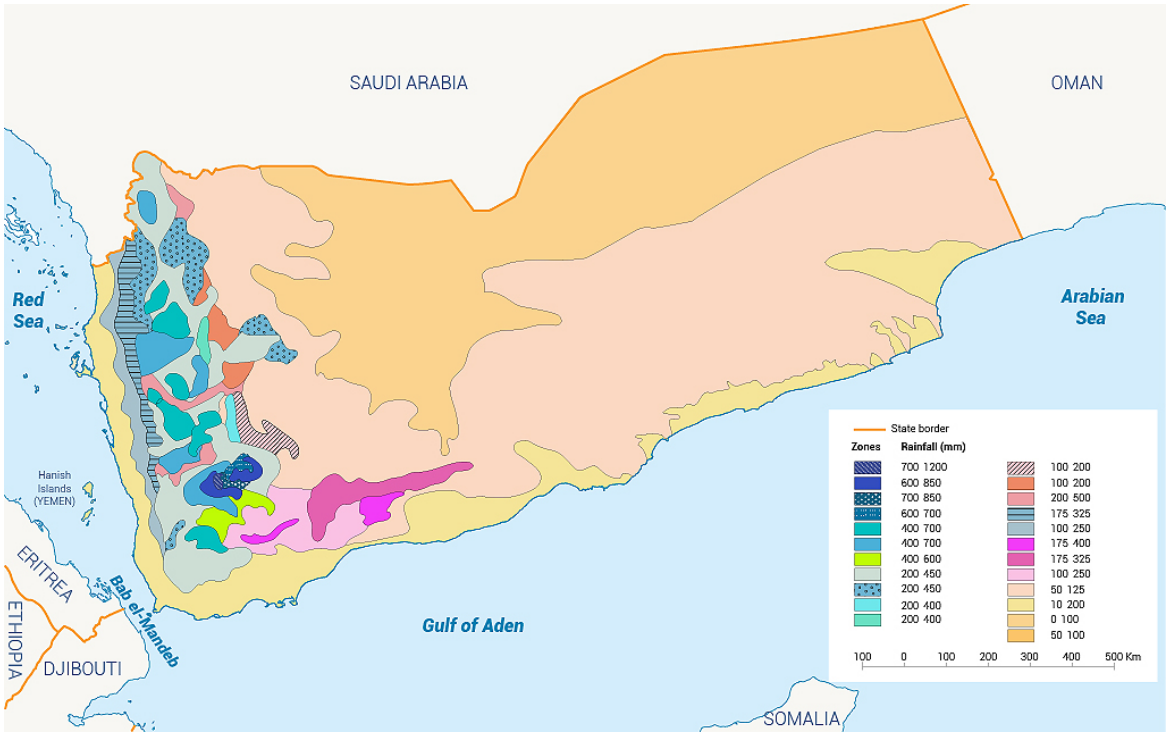
Source: Berghof Foundation, 2024.

Note: This map is for illustration purposes only. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the International Organization for Migration.

The country's estimated population is 31.6 million people as of 2023, and it is distributed unevenly across its varied topography, with notable population centres in cities such as Sana'a and Aden. The population is linguistically diverse, with Arabic being the predominant spoken language. Yemen's ethnic background is predominantly Arab, although there are also Afro-Arab, Afro-Asiatic, South Asian and European groups (CIA, 2023; ICRC, 2021; NUPI and SIPRI, 2023).

Yemen's vulnerability to climate change and its dire consequences remains a persistent concern. The country is facing among the world's worst water and food crises due to its highly arid climate, fast-depleting groundwater reserves, and multiplier effects of strained food security, conflict, and water management shortfalls, ranking as the 12th most water-scarce country in the world (Acacia Water, 2021; FSIN, 2022; Kuzma et al., 2023). Groundwater depletion is alarmingly high in various regions of Yemen, particularly impacting the highlands, where annual declines in the water table range from 2 to 6 metres (FAO, 2023a). Yemen's rainfall patterns and climatic zones can be found in Figure 2.

Figure 2. The rainfall and climatic zones of Yemen



Source: Noaman and Al-Nozaily, 2019.

Note: This map is for illustration purposes only. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the International Organization for Migration.

High water scarcity significantly impacts food security, nutrition, and climate-induced human mobility, as does the ongoing conflict and its effects on water management and other disaster prevention and response efforts. Rising temperatures, unpredictable rainfall, persistent land degradation, increasing sea levels and saltwater intrusion exacerbate water scarcity, deteriorating water quality and reducing agricultural productivity (Lackner and al Eryani, 2020). Rapid population growth puts massive pressure on the limited water resources in Yemen due to over-extraction of groundwater, changing rainfall patterns, and inadequate water management policies. This scarcity has led to conflicts over agricultural and domestic water supplies and has significantly burdened populations in vulnerable conditions (ICRC, 2022).

In addition to water scarcity, factors like environmental degradation, urbanization, demographic changes and migration are intensifying challenges in the country. These shifts are leading to more frequent droughts, damaged infrastructure, coastal deterioration, and the spread of diseases (Al-Akel, 2020; Price, 2022). Additionally, practices such as unregulated overfishing and pollution from hydrocarbon extraction are harming Yemen's fisheries and public health (Zabara and Zumbrägel, 2022).

Yet Yemen is woefully underprepared to confront climate shocks, ranking 174th out of 185 countries on the Notre Dame Global Adaptation Index (ND-GAIN, 2022). According to the European Commission's INFORM Country Risk Profile, the country also ranks as a "Very High" risk class (7th highest globally). Despite its vulnerability to climate change, however, Yemen's contribution to global CO2 emissions remains minimal, accounting for a mere 0.03 per cent as of 2020 (Price, 2022).

The conflict in Yemen, which has been ongoing since 2015, has exacerbated existing environmental stress, leading to potential conflicts over vital resources such as water, arable land, and biomass. The national conflict primarily involves forces affiliated with Ansar Allah and the Government of Yemen, supported by a coalition led by Saudi Arabia. However, there have also been clashes between the Government of Yemen and the Southern Transitional Council, as well as attacks by Al Qaida in the Arabian Peninsula and the Islamic State of Iraq and the Levant (ISIL). An initially promising UN-mediated truce expired in October 2022 and ended in renewed fighting in March 2023 (IAHE, 2020).

Yemen's economy is classified as low-income, and it is consistently ranked as one of the least developed countries in the world (UNCTAD, 2022). Yemen's fragile economy has been impacted by the civil war, resulting in severe damage to its infrastructure, trade networks, and economic institutions as well as a significant level of human capital flight, represented by almost 7 million Yemeni diaspora (Almahdi, 2022). While the country traditionally relied on oil and gas revenues, its reserves have dwindled. The ongoing conflict has exacerbated existing challenges, leading to widespread poverty, food insecurity and unemployment. Furthermore, Yemen faces the issue of high inflation, which further compounds the economic strain felt by its population (ICRC, 2021).

The humanitarian crisis in Yemen has displaced over 4.5 million people. Amidst its own multi-factor crises, the country continues to attract migrants from the Horn of Africa due to political instability, economic turmoil and climate hazards in their countries of origin (IOM, 2023b). As a major transit hub for migrants aiming for Gulf countries, Yemen faces growing pressures as stricter border controls by these nations force migrants to remain within its borders, overburdening its limited resources. Cities like Aden and Marib are particularly impacted, serving as refuges for a diverse mix of residents, returnees, internally displaced persons, and international migrants, leading to social issues such as Housing, Land and Property rights concerns.

As part of the ongoing flood response efforts in West Coast, IOM is empowering internally displaced persons (IDPs) through cash-for-work initiatives. Here, community members actively participate in improving their environment, showcasing resilience and collaboration in the face of adversity.

2. KEY ENVIRONMENTAL, CLIMATE CHANGE, AND ENVIRONMENTAL DEGRADATION CHALLENGES AND COMMUNITY RESPONSES IN YEMEN

Yemen confronts a climate crisis that jeopardizes its environmental, social, and economic stability. The nation's precarious institutional and developmental landscape – among the world's lowest[2] – challenge resilience and response capabilities. The scarcity of recent and reliable climate data significantly hinders effective action, as limited access to comprehensive national and localized climate statistics obstructs understanding of the full impact of climate change.

The desk review conducted for this country report synthesized the current state of knowledge on extreme weather events and slow-onset processes in the country (McFee, 2023); the following analysis synthesizes the original data collected for this study through interviews and focus group discussions. While this section focuses principally on the environmental changes, Section 3: Migration, environmental degradation and climate change dynamics examines their interrelatedness with human mobility patterns in Yemen.

2.1. Extreme weather events

Yemen, a nation already grappling with various complex challenges, faces additional threats to life and livelihood from extreme weather events. These climatic disturbances, though often overshadowed by more overt crises, play a pivotal role in perpetuating land degradation and disrupting agricultural systems across the country. Among these calamities, floods featured most prominently in the 1980–2020 period, constituting more than half of average annual hazard occurrences (Al-Aizari et al., 2022).

2.1.1. (Flash) floods

Climate change is expected to intensify floods in Yemen by altering rainfall patterns and overwhelming soil absorption capabilities, compounded by factors such as illegal logging, groundwater depletion from qat cultivation, urbanization and expanding agro-investments. Additionally, infrastructure damage from heavy rains and flash floods further exacerbates the impacts in affected areas (GSC, 2022; IRW, 2022; Lackner and al Eryani, 2020). A study on flash floods in Tarim City, using machine learning and remote sensing data, identified factors such as rainfall, elevation, topographic characteristics, stream power, drainage density, vegetation, soil, and land use, which influence flood susceptibility (Al-Aizari et al., 2022).

[2] The BTI Transformation Index assesses the extent to which countries in transition are moving towards democracy and a market economy in political, economic, and governance terms. Yemen's ranking for 2024 is 137th out of 137 countries, with subcategories rankings in economic transformation, governance, and political transformation at 135, 130, and 137, respectively (BTI, 2024).

In April 2020, heavy rainfall led to significant flooding. The reports on these floods reveal severe socioeconomic and humanitarian impacts. Extensive damage to infrastructure, including roads, bridges, electricity and water networks, exacerbated the already dire humanitarian situation. Over 100,000 people required assistance, with numerous injuries and at least 15 reported fatalities. Sa'ada, Sana'a, Marib, Aden and Lahj were the most affected governorates. The damage led to increased health risks, widespread crop and livestock destruction and significant displacement, with at least 7,000 people forced to relocate, often to inadequate shelters. This situation was further complicated by the ongoing conflict, which hindered effective response and recovery efforts (ACAPS, 2020; al-Akwa and Zumbragel, 2021).

During the 2020 floods, thousands of IDP shelters were destroyed, and supplies and non-food items (NFIs) were washed away (ACAPS, 2020). Since 2008, floods have led to over 507,000 internal disaster displacements (IDMC, 2023). In 2023, floods triggered 239,000 displacements across the MENA region, a 14 per cent increase from 2022, with the majority reported in Yemen, particularly in governorates already impacted by conflict and violence (IDMC, 2024). Moreover, floods and their risk make land unsuitable for IDP relocations, limiting the availability of relocation land and resulting in multiple displacements. The absence of a national cadastre system and the loss or damage of documentation through displacement and flooding complicate the resolution of territorial disputes and property rights issues (ACAPS, 2020; UNY, 2022).

> *"The heavy rainfall in 2020 caused rockslides and halted traffic. It led to the collapse of many buildings in flood-prone areas, like Sheikh Issa… The heavy rains and winds caused damage to shops and temporary tents for street vendors, thus halting their activities. The planting season was delayed, affecting farmers."*
>
> A representative from the Sanitation and City Improvement Fund.[3, 4]

Aligned with existing quantitative data, respondents for this country study identified floods as among the most significant extreme weather events threatening their security and livelihood (60% of focus group discussions, 87% of key informant interviews).[5]

> *"The level of floods has increased, and they reach places they have never reached before, destroying many homes and farms."*
>
> A member of the Al-Wadi Association for Water Users and Irrigation.

[3] In some instances, small changes to grammar and flow have been made by the report author to improve the flow and readability of quoted text from study respondents. Best efforts have been made to minimize these changes and preserve the statement's original meaning.

[4] Due to some respondents' preference to remain anonymous, the author has left all key informants and focus group participants anonymous in this study.

[5] The extent to which flooding connects to changing rainfall patterns is further explored in Section 2.2.2 Changing Rainfall Patterns.

Yemen's physical land features and rainfall patterns make it particularly susceptible to flooding, especially in areas like Sa'ada, Ta'iz, Aden and Marib (ACAPS, 2020). Interviewees confirmed these geographic tendencies, as one representative from a civil society organization dedicated to women's advocacy shared:

> The areas that experienced increased flooding are in the south of Marib, leading to severe flooding towards the Marib Dam and causing overflow in the areas surrounding the dam. This resulted in damage to the Arqeen area in the valley due to severe soil erosion caused by the heavy rains and floods from Dhamar, Al-Bayda, Rahba and Mahliya.

IDPs and refugees are particularly vulnerable to such events, with their homes being more susceptible to flooding and due to limited access to safe water and food. Focus group respondents living at IDP sites explained how floods pose "threats to their health, safety, and wellbeing." A male displaced person living in the Lahj governate emphasized that *"during the rainy seasons, floods enter the camp and form ponds, causing mosquitoes and insects to gather, which increases the spread of diseases, reptiles, and snakes that pose a danger to the children, as well as making it difficult to move within the camp."*

Floods also increase the risk of water contamination, potentially leading to outbreaks of diseases such as dengue fever, malaria, and cholera, as seen in the widespread 2016 cholera outbreak, which spread to 19 governorates and affected 53,000 individuals (Gadain, 2023). Additionally, flash floods can spread industrial waste into water sources and agricultural areas, compounding public health risks by damaging vital health care, water, sanitation and hygiene (WASH) infrastructure.

> *"Many deaths occurred due to the floods (in 2020), as well as outbreaks of epidemics and fevers due to stagnant water."*
>
> A representative from the Sanitation and City Improvement Fund, part of the local authority management, responsible for coordination with international organizations.

> *"Some areas that used to suffer from drought now experience heavy rainfall. The intensity of this rainfall has led to the emergence of new diseases brought by floods."*
>
> An official in the General Authority for Environmental Protection responsible for planning and information.

These responses illustrate the interconnectedness of climate change, public health and human mobility dynamics.

An official of a local-level instance of the Water and Sanitation Corporation elaborated on how governance, infrastructure, and agroindustry (and its retreat) are simultaneously implicated in the effects of flooding.

> The severity of climate and environmental changes has significantly increased, and I am among those severely affected. My house was completely destroyed due to floods caused by heavy rains due to [infrastructure shortfalls] in water drainage, conversion of farmlands into residential areas and urban expansion. Even the water corporation suffered damage to its networks and main lines, forcing us as an institution to rebuild them – not fully, but in a way that serves the purpose of providing service.

Predictably, flooding also severely impacts socioeconomic conditions, accelerates desertification and land degradation, and leads to agricultural losses, livestock fatalities, scarcity of building materials and increased food insecurity. Given Yemen's dependence on agriculture and subsistence farming, these effects are particularly devastating, and the enhanced difficulty in importing food heightens the risk of famine (FAO et al., 2021; IAHE, 2022; NUPI and SIPRI, 2023; OCHA, 2022).

> *"Farmers who worked for daily wages were unable to reach the farms due to floods, as walking through the mud and high water levels was challenging. The impact of the floods directly resulted in farmers losing their crops – their source of livelihood."*
>
> An official from the Executive Unit for IDPs.

2.1.2. Cyclones

The effects of climate change have resulted in an increase in cyclones, which can result in major damage and flooding in coastal areas of the country, destroy crops and fish stocks, and cause flash floods. In 2015, Cyclone Chapala caused severe flooding and damage in Yemen's southeastern provinces, displacing 18,750 people, causing three deaths, injuring over 200 on Socotra, and leaving the city of Mukalla extensively damaged and "underwater" (Aljazeera, 2015; Sana'a, 2022). Cyclone Tej made landfall on the eastern Yemeni coast overnight between 23 and 24 October 2023, bringing heavy rainfall and torrential showers to Socotra and Al Maharah, causing road blockages (OCHA, 2023a).

The cyclone impacted over 60,000 people across Al Maharah, Hadramawt and Socotra governorates. Civilian homes, public infrastructure, health-care facilities and water networks sustained severe damage, destruction, or flooding. Strong winds and rain also harmed displacement camps in Al Maharah and Hadramawt. The agriculture and fishery sectors in Al Maharah were also damaged. According to the Emergency Operations room of the Governorate Health Office and the Yemen Red Crescent Society, there were 6 deaths and 473 injuries in Al Maharah. At the same time, Socotra reported 31 injuries treated in health facilities due to falls and other causes (OCHA, 2023b).

Over the last eight years, heavy rains, floods, and cyclones have dominated extreme weather events in Al-Mahra, dramatically damaging farmlands and public facilities in their wake (Aklan, 2023). Referencing the heavy rains accompanying cyclones, an official from a local instance of the Water and Sanitation Corporation in Sayoun recounted the devastating effects of Cyclone Megh in 2015 on homes and properties: "In my neighbourhood, 97 houses, including my own, were destroyed. One hundred and fifty-four families were displaced, with 60 per cent managing to rebuild their homes. The other 40 per cent could not."

2.1.3. Hurricanes and tropical storms

Rainfall in Yemen is marked by seasonally intense and short-lived heavy storms. The increasing frequency of tropical storms and hurricanes, attributed to climate change, often leads to flash floods and soil erosion. These floods have resulted in economic damage and crop loss in the past. For instance, a 2008 tropical storm brought 90 mm of rainfall in just 30 hours, causing severe flooding and destruction in the Hadramawt and Al-Mahrah governorates. Broadly speaking, Yemen's coastal areas are exposed to annual monsoon cycles, resulting in devastating hurricanes that have impacted people, infrastructure and livelihoods (GSC, 2022). Two professors from the Faculty of Science at Aden University who participated in interviews for this study warned of increasing hurricane risk in the coming years and their deleterious effects on human security and livelihoods.

> *"There will be an increase in hurricanes, which affects the quality and quantity of fish caught by fishermen, damages their boats and ships, and causes both material and human losses for them."*
>
> Professor from the Faculty of Science at Aden University.

2.1.4. Sand and dust storms

Yemen frequently experiences sand- and dust storms, raising concerns about adverse health effects from dusty air exposure. These storms can also cause sudden increases in river flows, rainstorms and flooding, leading to agricultural damage and environmental degradation (Al-Maqtari, 2012; Keynoush, 2022). Moreover, sand and dust storms pose a significant challenge for those living in IDP camps, as their fragile infrastructure and housing are particularly vulnerable to damage. A female resident of a camp in Lahj governate noted that *"in the windy season, large quantities of sand creep in and accumulate at the entrances and inside the camp, making it difficult for the displaced (people) and cars to move, requiring sweeping the tents and cleaning them several times a day."*

> *"Conditions are weak and unsuitable for living. We are exposed to all disasters and climate changes such as floods, rains, temperature, cold severity, dust storms, and other problems. The current shelters lack security for all community members, without exception."*
>
> Male focus group participant, Altadamon IDP camp.

2.1.5. Wildfires

Wildfire risk is high in Yemen's western governates, with a greater than 50 per cent annual chance of wildfires causing loss of life and property (ThinkHazard, 2023c). In 2022, wildfires resulted in over 1,200 internal displacements (IDMC, 2023). Despite these risks, the only mentions of fires in the data collected for this study were among residents of IDP camps, where the risk of fire and its rapid spread are high due to flammable construction materials and the density of residential structures. Increasing temperatures amplify this risk. One camp representative from the Executive Unit for IDPs recalled that *"..due to the high temperatures,, random fires broke out in camps and houses, resulting in electrical shortages in seven houses."* The outcomes of these fires can be catastrophic, as noted in the following quote.

> *"In this camp, there are many families on a small amount of land, which has led us to build shelters very closely together. As you can see, the shelters consist of wooden huts, exposing us to severe danger if any house catches fire. It would be a disaster for all neighbouring families. Such a disaster occurred, and the fire completely affected seven families, which is very frightening."*
>
> Male focus group participant, Alwahdah IDP Camp.

2.2. Slow-onset processes and environmental degradation

Yemen is also highly vulnerable to slow-onset processes and their consequences, detailed in this section. These processes affect the natural and built environment, public health, economic well-being, and human mobility.

> *"The effects of climate change are continuously increasing. Each year is more severe than the preceding one. They are worsening, whether it's rising temperatures, floods, or 'natural disasters'."*
>
> An official from the Executive Unit for IDPs, Seiyun Directorate.

2.2.1. Drought, water scarcity and groundwater depletion

Fueled by an arid climate, variable rainfall, and poor water management, drought in Yemen recurrently devastates agriculture and livestock, undermining livelihoods and deepening food insecurity and economic instability. The first half of 2022 marked the third driest period in nearly four decades (NUPI and SIPRI, 2023). Drought featured prominently in key informant interviews and also surfaced in one focus group discussion conducted for this study.

> *"Areas that used to experience heavy rainfall have now suffered from drought, and farmers have to adapt to this drought by either planting drought-resistant crops, changing their livelihoods, or migrating to another location."*
>
> A former official from the Local Water and Sanitation Authority.

Recent research has revealed that the water resources situation in Yemen is much more dire than originally forecasted: the water deficit has increased steadily over the past 63 years, and while there are variations from one year to the next, overall, water shortages are significantly intensifying (Gadain and Libanda, 2023). Yemen faces a critical challenge with its rapidly decreasing renewable freshwater resources. This issue is exacerbated by population growth, urbanization, and the detrimental effects of ongoing conflict on water infrastructure. This exacerbates the water crisis, impacting the most vulnerable segments of the population, including women, children, and IDPs. While urban areas in Yemen enjoy better access to water than rural areas, the decline in water availability is more pronounced in urban settings. In Yemen's rural areas, the depletion of wells has dire consequences, leading to escalating social tensions that often erupt into local conflicts (Al-Aizari et al., 2022).

Water scarcity, along with its many causes and consequences, was the most frequently cited environmental and climate change-related challenge among almost all respondents in this study, both from the KIIs and FGDs (among the key informants, a General Authority for Environmental Protection representative) highlighted water access as their primary challenge, exacerbated by rising fuel prices and decreasing water levels. Meanwhile, a representative from the Water Foundation noted that these conditions have forced people to dig deeper wells or travel further to fetch water, resulting in decreased overall water consumption.

Several respondents confirmed that, in response to these challenges, farmers have adapted by planting drought-resistant crops, changing their livelihoods, or migrating to urban areas, with some abandoning agriculture altogether. The combined effects of various struggles with access to water have taken a significant toll on the agricultural sector, as shared by a representative from the Sanitation and Improvement Fund Office in Hadhramaut.

> The impacts of water scarcity on farmers are significant, affecting aspects of life in the Hadhrami community. Drought affects crops, partly because of a lack of electric power for well irrigation due to high fuel or renewable energy costs – like solar panels. Solar panels could also be a solution, but they are not highly effective due to intense sunlight during midday; farmers prefer irrigating at dawn or late evening when solar radiation is lower. Farmers also struggle with rainwater scarcity, a significant problem in Hadramawt, which receives less rainfall than other governorates that get more seasonal rain.

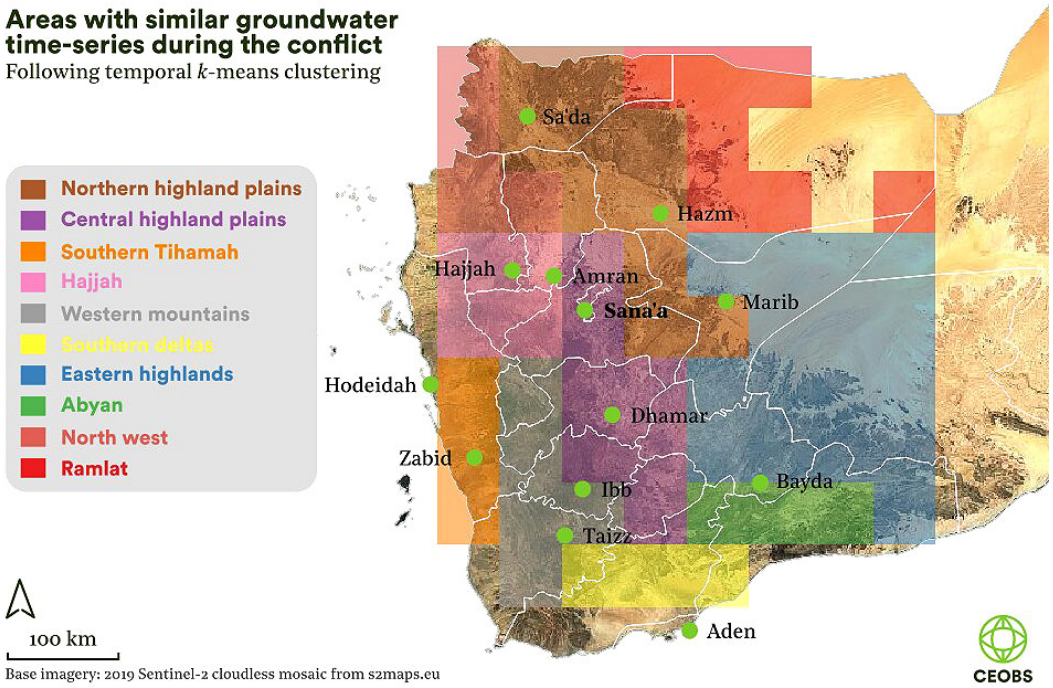
Study participants identified the following human contributing factors to water scarcity: increased population density, excessive drilling of wells, lack of awareness of and practices related to water conservation, and contamination from industrial activities. In urban areas, many neighbourhoods experience a scarcity of commercially available drinking water, which can be a costly and even impossible solution for some.

As one IDP camp manager recounted, *"This past year was one of the hottest. There was difficulty in obtaining gas, and there was reduced support for drinking water for the IDPs."* A female focus group participant in an IDP camp in the Wadi Marib District confirmed that she did not have access to a water tank of any kind or a sufficient amount of treated water. Others reported that pollution impacts potable water availability and contributes to cholera and typhoid outbreaks.

> *My neighbours and I have been without water for 6 years in the Al-Fateh area due to low water pressure, which means I have to buy water through water tankers (bottled water). I have noticed the presence of seventy water tanker trucks, which were not there ten years ago.*
>
> An official in the Ministry of Water and Environment responsible for environmental emergencies and disaster risk reduction.

Groundwater depletion featured prominently in response narratives. The groundwater extraction rate in Yemen is well above its recharge rate (Taher, 2016) and, as of April 2021, it had reached its lowest levels since satellite imagery began in 2002 (CEOBS, 2021). These trends have the greatest impact on the agricultural sector, which is responsible for 90 per cent of water withdrawal (FAO, 2023b). A study conducted by the Conflict and Environment Observatory on Western Yemen examined the groundwater trends in Western Yemen (color-coded geographic distribution according to self-similar patterns of groundwater changes can be seen in Figure 3).

Figure 3. Western Yemen with clusters of self-similar patterns groundwater changes

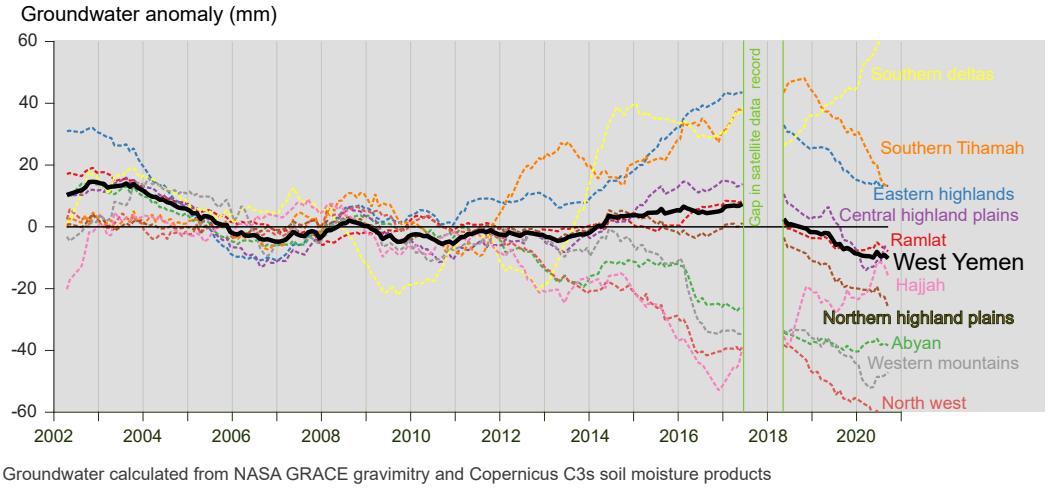


Source: CEOBS, 2021.

Note: This map is for illustration purposes only. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the International Organization for Migration.

With three exceptions (Southern deltas, Southern Tihamah, and Hajjah) and acknowledging annual variability, regional groundwater trends have declined over the last two decades. Figure 4 shows time series data that allows for more nuanced analysis: during the initial phase of the conflict from 2014 to 2017, groundwater levels rose in half of the areas studied, with the southern Tihamah and eastern highlands experiencing significant increases. The central highland plains and southern deltas saw moderate rises, while the increase in Ramlat was minor. Except for the southern deltas, these trends were previously unobserved and marked a significant change in water resource dynamics. However, in the later phase of the conflict, from 2018 to 2020, groundwater levels fell in seven out of ten areas, with one area's levels remaining stable. This pattern of initial increase followed by a decrease suggests that the onset and midpoint of the conflict served as critical turning points in groundwater availability. These fluctuations align with broader regional patterns in western Yemen, though the extent of change varied by location (CEOBS, 2021).

Figure 4. Groundwater changes in self-similar areas of Western Yemen, 2002–2020



Source: CEOBS, 2021.

Multiple respondents in this study named unregulated drilling as a major concern. Decreased rainfall in many areas has led to the need for new wells and resulted in farmers reducing the distance between them from 500 to 300 metres. Mismanagement is evident as farmers dig wells without permits, and the high salinity in some areas forces deeper drilling for viable agricultural water. A male focus group participant from the Majhafa Villages elaborated on the intersection of these factors:

> The community faces several challenges, including noticeably high temperatures and the problem of decreasing groundwater levels due to increased water pumping rates. This includes water pumping from the Maghras Naji area near our village, where many wells pump water in large quantities to meet Lahj Governorate's water needs, affecting the water levels of wells used for agriculture or drinking. There has also been a decrease in rainfall in the past two years, negatively affecting agricultural activities and reducing groundwater recharge and levels.

Urban settings face similar challenges. A former official from the Local Water and Sanitation Authority in Aden shared, *"In 2020, the required water supply for Aden city was estimated at 52,000 cubic metres of water per day, which was sufficient to supply Aden city, but now the demand has increased to 250,000 cubic metres per day. There has been a decline in the water table levels, in addition to random and abusive drilling of wells."*

Separately, the cultivation of qat, a highly water-intensive crop, has increased in Yemen due to its profitability compared to other crops and caused significant land degradation, particularly in the highlands of the country, and left farmers vulnerable to the effects of climate change (FAO et al., 2021). The widespread cultivation of this narcotic consumes almost half of the underground water sources in the country (Acacia Water, 2021). However, it is an important source of income for some populations: one female focus group participant in an IDP camp shared that her two sons sell water and qat in the markets as a source of livelihood.

Several participants in this study highlighted innovative responses to the escalating threat of water scarcity. For instance, a representative from the Water Foundation discussed an initiative in Abyan Governorate that promotes substituting almonds for qat to conserve water. In Dhamar, onion farmers have increased production by forming associations. Additionally, a former official from the Local Water and Sanitation Authority, who now teaches at a university, mentioned a capstone programme where students are mentored by faculty to research solutions for water scarcity issues in Marib Province. Moreover, an official from the Ministry of Water and Environment, focusing on environmental emergencies and disaster risk reduction, spoke about growing calls to restore the ancient Tawila Cisterns in Aden to help control flooding and enhance water storage.

2.2.2. Changing rainfall patterns

Yemen's rainy season runs from March to October, with the southern uplands experiencing the highest average annual rainfall of 561 mm. The central highlands receive most of their rainfall from March to May and July to August. However, climate change has altered these patterns, causing intense and unpredictable rainfall that overwhelms the soil's absorption capacity, leading to flooding and other challenges (ACAPS, 2020; Al-Aizari et al., 2022).

Changing rainfall patterns featured prominently among study respondents, although more frequently in KIIs Rain-fed agriculture is Yemen's most common farming system, practiced on more than half of all arable land. Though precipitation benefits this approach, the intense precipitation events in the summer months often lead to soil erosion and flooding, resulting in massive displacement, crop destruction and loss of human life (FloodList, 2023). In turn, according to those interviewed for this study, soil erosion leads landowners to neglect their lands without attempting to restore them. Farming stops to prevent further erosion until the lands can be repaired and cultivated.

An official from the Directorate of Agriculture, Irrigation, and Fisheries interviewed for this study stated that planting schedules have changed due to the scarcity of rainfall in recent years, coupled with damages to irrigation infrastructures that occur when heavy rainfall leads to flooding. Decreased rainfall has reduced the rate of groundwater replenishment and led to the disappearance of plants in some areas of the country. These dynamics are inextricably connected to livelihood and mobility decisions, as evidenced in the following key informant response.

> *Areas that used to experience heavy rainfall have now suffered from drought, and farmers have to adapt to this drought by either planting drought-resistant crops, changing their livelihoods, or migrating to another location. And some areas used to suffer from drought now experience heavy rainfall, where the intensity of rainfall has led to the emergence of new diseases brought by floods.*
>
> An official in the General Authority for Environmental Protection responsible for planning and information.

Alterations in rainfall patterns also significantly impact livestock management practices. Respondents in this study noted that swathes of lands previously used for grazing have been abandoned due to the scarcity of rainfall. Some pastoralists have migrated to other areas for water, while many have abandoned the practice entirely.

> *There's a noticeable decrease in the water level in wells, coupled with a scarcity of rainfall, which directly affects agriculture and livestock management. Unregulated well-digging and water misuse by farmers exacerbate these issues.*
>
> A representative from a civil society organization dedicated to women's advocacy.

Furthermore, these rainfall patterns have spurred locust outbreaks by promoting rapid vegetation growth and increased moisture, which damage crops and pastoral lands. An FAO early warning bulletin from April 2024 indicated that expected flooding in low-lying areas would likely lead to a surge in pest populations, with locusts appearing along the Gulf of Aden and Arabian Sea coasts and migrating inland to regions like Hadramout Valley and Shabwah, all of which anticipate rain (FAO, 2024).

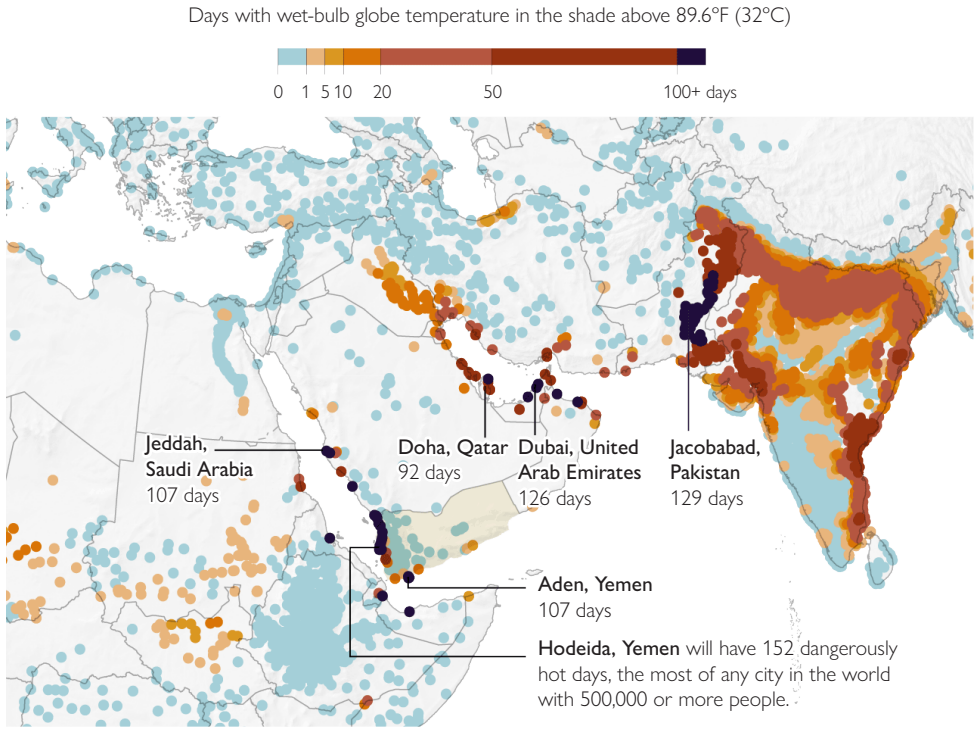
However, the shifting patterns of rainfall have brought certain benefits. Notably, some desert regions that were previously uncultivable have transformed into fertile agricultural lands. According to the president of a community association for water users and irrigation interviewed for this study, the result has been a movement of populations – especially nomadic communities – to settle in these locations for longer periods.

2.2.3. Rising temperatures

Yemen's diverse ecological zones are all experiencing a pronounced long-term warming trend in line with global patterns due to greenhouse gas emissions and consequent atmospheric heat-trapping. A recent study conducted in Al-Hodeidah found that, over the last 35 years, the annual mean temperature has increased by + 2.62 degrees Celsius (Iraqi and Abdallah, 2022). As seen in Figure 5, by 2030, Hodeida is projected to have the highest number of dangerously hot days of any city with 500,000 or more inhabitants (Penney and Kommenda, 2023). By 2060, Yemen's mean annual temperature is projected to rise by 1.2-3.3 degrees Celsius, resulting in significant climate changes, including irregular rainfall patterns and more frequent, intense heat events by the century's end. Warm months will grow longer, and mild autumn months will disappear (Iraqi and Abdallah, 2022).

Rising temperatures intensify water scarcity by increasing evaporation rates and exacerbating the depletion of water resources from over-extraction and reduced rainfall, leading to a drying trend and lower basin water levels that threaten hydropower operations and cause numerous wells to dry up (FAO, 2023b). Intense heat coupled with irregular water and electricity supply impacts livestock production and the agricultural sector by altering growing seasons, reducing crop yields and increasing susceptibility to pests and diseases. Furthermore, these conditions threaten Yemen's wetlands and biodiversity, with higher sea temperatures and rising sea levels degrading coastal and marine environments, leading to coral bleaching and the disappearance of fish species.

Figure 5. Where people will live with dangerous heat in 2030



Source: Penney and Kommenda, 2023.

Note: This map is for illustration purposes only. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the International Organization for Migration.

Respondents in this study cited increasing temperatures as a slow onset process of great significance in its impacts on their everyday lives, livelihood, and mobility decisions (mentioned in 73% of key informant interviews and 40% of focus group discussions). For example, one key informant who works as the head of an IDP camp stated that *"the past year was one of the hottest, which significantly affected the health of children, the difficulty in obtaining gas, and the cutting off of drinking water support for IDPs."* Several interview respondents conveyed a sense that each year is hotter than the previous one.

A programmes and projects director for the Martyr Bin Habrish Foundation for Development (BHF) echoed this trend: *"There has been a noticeable increase in temperatures throughout the year, and the levels of cold have been minimal. Temperatures that used to drop below zero no longer do so."* The effects of these trends span multiple domains, as summarized by a representative from the Water Authority in Marib:

> The temperature has been increasing, especially in the last three years. This affects us by increasing water evaporation, decreasing surface water reservoirs, and lowering groundwater levels. This results in a decrease in water availability in wells in Marib province. Since Marib is densely populated with displaced people, the shelters are lightweight, which affects them even more. This is a serious indicator that affects citizens.

The country has a high-risk extreme heat hazard, which refers to the fact that, based on current trends, it is anticipated that there will be at least one occurrence of heat stress within the next five years due to prolonged exposure to extreme heat (ThinkHazard, 2023b). Additionally, adopting cooling measures is challenging, given that Yemen has notably low rates of access to electricity, only 40 per cent of the population has access to electricity (compared to an average of 85% in the MENA region) (Al-Wesabi et al., 2022).

> *"With the heat, power outages directly affect farmers, forcing them to shift to other fields of work."*
>
> A secondary school teacher.

One respondent for this study – a member of a community association for water users and irrigation – vividly described the compounding vulnerabilities connected to high temperatures:

> Everyone suffers: people suffer from the heat with increasing power outages, varying by area, and the damage differs from one family to another. Some families can afford to buy generators, and some cannot. Some people live in block houses, and some in ground-floor apartments, possibly with an elderly or disabled person. With increasing expenses, they can no longer afford anything; they can't buy batteries, and even batteries can't power an air conditioner with the excessive heat, which worsens yearly.

Given the lack of access to electricity and cooling systems, focus group respondents elaborated on how people in IDP camps often resort to alternative coping strategies such as using wet cloths, taking cold showers, or trying to create as much shade as possible. A male focus group participant living in the Lahj governate explained that IDPs *"spray water around the camp to reduce the temperature of the air and sand to lessen the health effects."* When resources and conditions allow, residents use solar energy to supplement the lack of grid electricity.

Beyond livelihood impacts and the availability of natural resources, temperature changes are resulting in changes in daily life and local customs. As temperatures increase, people's routines are significantly altered. Key informants noted that people often delay going to work or opening shops due to the extreme heat, leading to decreased social and commercial activities. Instead, people stay indoors until the temperature drops after the afternoon prayer. Commercial shops have shifted their operating hours to later at night, as people tend to go shopping during cooler nighttime hours.

Most notably, weddings, a cornerstone of Yemeni culture, have undergone significant changes. Traditionally, weddings were held in people's homes. Still, due to the extreme heat, lack of electricity, and the high cost of generators, weddings are now held at external locations such as party venues. The timing of weddings has also shifted to cooler months to avoid the summer heat and frequent power outages. This change in wedding traditions reflects a broader shift in cultural practices, where weather considerations now play a significant role in people's daily lives (Price, 2022).

> *Rising temperatures will change behaviours, traditions, and dress codes, such as women wearing abayas composed of many layers and in black, which absorbs heat. It may become challenging to continue wearing such garments in the future.*
>
> A representative from the Sanitation and Improvement Fund Office in Hadhramaut.

2.2.4. Soil erosion, declining soil fertility and loss of vegetation cover

The national soil map of Yemen categorizes the soils into groups, including dry, dry sedimentary, limestone, and shallow calcareous, highlighting the diversity that affects both fertility and flooding susceptibility. Soil characteristics such as slope, drainage density, elevation, and fertility impact water infiltration rates and flood risks (Al-Aizari et al., 2022).

Soil fertility is declining due to various factors such as topography, soil type, management practices, and climate change. Climate change processes such as desertification and changing rainfall patterns have particularly impacted soil fertility in the Hadramawt governorate (Zabara and Zumbrägel, 2022). Additionally, climate change-related temperature increases, water scarcity, and shifts in precipitation patterns strain soil resources by affecting water and nutrient availability for crops. This further threatens agricultural productivity and contributes to increased food insecurity and poverty (Price, 2022).

Population practices such as excessive groundwater extraction for irrigation lead to saltwater intrusion, salinizing soils and reducing their fertility (Broussard, 2020), while flash floods and unplanned urbanization exacerbate degradation. Factors like overgrazing, the overuse of chemical fertilizers and improper pesticide management, deforestation, the absence of crop rotation, and poor waste management - including the burning of plastic waste - compound the problem of declining soil fertility (Al-Dailami et al., 2022; FAO et al., 2021). Moreover, the ongoing conflict disrupts agricultural practices and displaces communities, making sustainable soil management more challenging (Zabara and Zumbrägel, 2022).

> *The negative impact* [of climate change on daily life] *includes soil erosion and destruction of vegetation cover and irrigation channels.*
>
> The president of a community association for water users and irrigation.

Key informants interviewed mentioned soil erosion. This is most likely attributable to a limitation of this study (rather than an irrelevance of the phenomenon) regarding the inclusion of agricultural communities and the institutions and organizations that serve them.

2.2.5. Salinization

Rising sea levels and chronic water shortages, particularly in coastal areas like Aden, are worsening aquifer salinization due to inefficient water management and irrigation practices, thereby reducing water quality and availability (Al-Qadhi, 2024; Mustun, 2022). Soil salinity is significantly high along the Tihama Plain and southeastern coastal regions of Yemen, affecting areas in Lahj, Abyan, Shabwa, Hadramawt, and Al-Mahara governorates, with salinity exacerbated by saline water use, excessive flood irrigation, and high evaporation rates, reaching critical levels that impact agricultural viability until addressed by remedial cropping practices. In Wadi Hadhramaut, the main aquifer system experiences increased salinity from downward leakage linked to over-extraction, which causes well abandonment (Acacia Water, 2021; IAEA, 2018).

Three key informants interviewed for this study spoke to salinization dynamics. One representative from a civil society organization dedicated to women's advocacy noted that urban water sources have high salt concentrations. Another representative from the Sanitation and Improvement Fund Office in Hadhramaut elaborated on the impact of the intersecting dynamics of depleting groundwater, urbanization, and salinization on digging. "Accessing water as a natural resource in Hadhramaut Valley has become difficult, requiring deep drilling due to its distance from the surface. Additionally, high salinity levels in the valley's outskirts force farmers to dig deeper wells for suitable agricultural water, which could be costly without state intervention." Respondents only mentioned desalination in the context of critiquing its high cost; none advocated for increased investment in large-scale desalination infrastructures.

However, the changing rainfall patterns and resultant flooding have positively impacted soil salinity in some areas of the country, as reported by a member of a community association for water users and irrigation interviewed for this study.

> There has been an increase in rainfall. The negative impact includes soil erosion, destruction of vegetation cover, and irrigation channels. The positive impacts include increased well water levels and the elimination of soil salinity through flooding, which has enriched the soil and allowed the cultivation of previously uncultivated lands.

Research in other contexts confirms that soil salinity can lower after flooding, with important factors of soil type, alkaline levels, microbial composition changes, and flooding duration impacting the extent to which this occurs and the extent to which it might improve (versus degrade) soil fertility. (Cox et al., 2018; de León-Lorenzana et al., 2017; Taylor and Krüger, 2019)

2.2.6. Deforestation, desertification and sand encroachment

Deforestation in Yemen has reduced available agricultural and pasture land, driven by fuel shortages that push residents towards wood for cooking and logging for employment. The absence of a legal framework regulating forest land and resources, coupled with the frequent death of trees and shrubs due to drought, further compounds the environmental degradation (Aljazeera, 2021; Lackner and al Eryani, 2020). As noted by an IDP camp director in Mariamah interviewed for this study, frequent gas and electricity cuts exacerbate the situation. Afforestation initiatives have occurred, but, as another key informant noted, "these efforts have been limited to city centres, ignoring peripheral areas that face the brunt of sand encroachment and environmental degradation."

Desertification is exacerbated by decreased monsoon rains, droughts, erosion, and groundwater depletion due to natural and human factors like irrigation (Wang et al., 2022). It is leading to significant agricultural degradation – such as soil erosion, sand encroachment, and reduced soil fertility – further intensifying the country's humanitarian, conflict, and economic crises. Projections warn that climate change could extend desertification to 86 per cent of the national territory, posing a threat to nearly 97 per cent of the agricultural land and impacting about 90 per cent of the farming area (al Awsat, 2022; Thamer et al., 2023).

Some key informants and focus group discussions participants addressed desertification. In particular, community members and environmental experts in Marib identified the phenomenon as a pressing concern, exacerbated by a combination of environmental mismanagement and climate change. According to study respondents, initiatives to combat desertification are scarce and poorly executed.

Connected with these dynamics, sand encroachment emerged in two focus group discussions, significantly impacting daily life in the Majhafa and Al-Hamrah villages. Participants in mixed-gender focus group discussions in each site explained that sands continuously move into the village, hindering mobility among displaced populations and vehicles. Furthermore, the accumulation of these sands dries out the agricultural lands and requires the sweeping and cleaning out of camp tents several times each day – activities that add to the task burden of the women in the camps.

2.2.7. Pollution and waste

Pollution presents major environmental and public health challenges, with significant concerns stemming from water pollution due to untreated sewage, industrial discharges, and agricultural runoff. This pollution results in unsafe drinking water and waterborne diseases such as cholera and typhoid. Additionally, air pollution, exacerbated by solid waste burning, diesel generators, outdated vehicle emissions, and industrial activities, leads to respiratory issues, particularly in densely populated areas. The improper disposal of hospital waste and emissions from electricity plants further contribute to the problem, impacting public health and the economy by reducing agricultural productivity and increasing health-care costs (FAO et al., 2021; Lackner and al Eryani, 2020).

Moreover, pollution issues extend to the marine environment, where phenomena like the green tide, caused by nutrient-induced eutrophication, damage coastal ecosystems and diminish fish populations, which are critical to Yemen's economy (Al-Dailami et al., 2022; Zheng and Klemas, 2018). Aden, a major port city, struggles with pollution from ship sewage and waste disposal and has experienced environmental disasters like oil spills from tanker sinkings, further stressing its coastal ecosystems. With high per capita solid waste generation, particularly in urban centres, Yemen faces severe waste management challenges amplified by the ongoing conflict and humanitarian crisis. The lack of effective waste management infrastructure, reliance on landfilling, and associated risks such as leachate, odor and health hazards for nearby communities complicate this crisis (Al-Dailami et al., 2022).

> *Most of the climate changes are caused by human activities, such as the destruction of green spaces, which play a significant role in absorbing many pollutants and car emissions, and the production of quicklime (burning limestone to produce a white substance similar to paint) which has caused suffocation and asthma... The accumulation of waste in cities due to the weak capabilities of the relevant authorities due to the current situation (insecurity) is a serious problem. They need to intensify their efforts, especially in rural areas.*[6]
>
> A representative of the Martyr Bin Habrish Foundation for Development (BHF).

Focus group discussion participants shared that sanitation infrastructures are severely lacking in IDP camps. A key informant working for a local government organization confirmed that there are often only makeshift toilets near their shelters, and sewage often flows into nearby streams. Focus group respondents living at various IDP sites emphasized that there are many issues with pollution, waste, and lack of sanitation/hygiene at IDP camps, which lead to a wide range of health issues. For example, insufficient mechanisms for waste collection at the camps lead to garbage accumulation and waste burning. This, in turn, can lead to respiratory issues, diseases, and other medical risks for residents. Moreover, the lack of sufficient toilets and sewage in camps put IDPs at an increased risk for the spread of cholera and other waterborne diseases.

Some initiatives have occurred to address these challenges. For example, an official from the Directorate of Agriculture, Irrigation, and Fisheries in Tarim noted that the Waddad Development Foundation has conducted training on transforming animal and green waste into organic fertilizer. This not only turns harmful materials into eco-friendly substances but also provides a source of income for many youth, suggesting that expanding such projects could help reduce pollutants and foster youth leadership in the domain more broadly.

2.2.8. Sea-level rise

By 2100, sea levels in Yemen are projected to rise between 0.3 and 0.54 metres, putting over half of the country's coastal regions at risk and affecting more than 55 per cent of the coastal population (Government of Yemen, 2013; USAID, 2016). Rising sea levels and increased storm surge frequency pose significant threats to the country, particularly affecting the governorate of Aden, where key facilities such as hospitals, schools, mosques, and the airport are at risk of flooding (al Saafani et al., 2015). Furthermore, the resultant damage to infrastructure, disruption of transportation networks, and economic setbacks exacerbate the developmental challenges facing nearly all coastal governorates, which are considered high-risk areas for flooding (ThinkHazard, 2023a).

Among those interviewed for this country study, three representatives from local and government offices[7] and one professor in the Faculty of Science at Aden University identified sea-level rise as a concern for Yemen. Data triangulated between the National Aeronautics and Space Administration (NASA) and National Oceanic and Atmospheric Administration (NOAA) over the same time period (2003–2013) reveal that sea-level rise along the coast of Yemen (average of 1.25mm per year) (NOAA, 2013) was only 42 per cent of the average global rates of sea rise for the same period (an average of 2.98mm per year) (NASA, 2024). This may partially explain why the slow-onset process received relatively less attention among respondents' narrated experiences and concerns.

[6] Quicklime is used in water treatment as a caustic agent for Ph adjustment, acid gas absorption, and construction. Its production and use can cause skin and respiratory irritation, serious eye damage, and lung damage through prolonged inhalation exposure; it may also cause cancer (Carmeuse, 2019).

[7] General Authority for Environmental Protection, Ministry of Water and Environment, Sanitation and City Improvement Fund (Aden).

2.2.9. Coastal erosion

Coastal erosion leads to saltwater intrusion into freshwater aquifers, endangering drinking water and agricultural viability due to increased salinity and contamination risks. This erosion causes significant land loss and fish mortality and undermines the livelihoods and stability of coastal communities, particularly affecting fishermen and those dependent on coastal agriculture (Bahakim, 2022). This, combined with the expected intensification of storm surges, threatens marine life, particularly commercially valuable fish species, potentially reducing the fisheries industry's contribution to the GDP and impacting the livelihoods of approximately 80,000 fishermen (ibid.). Coastal erosion was referenced as a key area of concern by some key informant interlocutors.

2.2.10. Biodiversity loss

Yemen is experiencing significant biodiversity loss, amplified by climate change effects such as rising temperatures, changing precipitation patterns, and frequent extreme weather events, which endanger numerous species and threaten unique ecosystems like the Socotra archipelago (Al-Mahfadi and Dakki, 2019). Natural hazards and human activities such as unsustainable approaches to livestock grazing, agriculture, waste disposal, and tourism pose serious threats to these environments, with iconic species like Socotra's endemic Dragon Blood Tree nearing extinction due to increased soil erosion from cyclones (Saraf, 2021).

Additionally, human-driven activities like deforestation, habitat fragmentation and the overexploitation of resources, including timber, marine resources and oil, exacerbate these challenges. Unregulated fishing, wildlife hunting and the misuse of pesticides contribute to species decline, community health issues and environmental pollution (UNEP, 2023). These environmental pressures are intensified by political instability, limited conservation resources, and Yemen's role as a hub for the illegal wildlife trade, further endangering its vulnerable species (FAO et al., 2021).

> *"There has been a decrease in coffee cultivation in Yafa due to climate change, and a negative impact on beekeepers in Wadi Daw'an due to the scarcity of sidr trees in the valley, forcing them to migrate to other areas… Climate change also affects handicrafts, as certain plant species appear or disappear due to hurricanes, leading to the discontinuation of some handicrafts due to the unavailability of raw materials."*
>
> An engineer from the Climate Change Unit
> in the General Authority for Environmental Protection.

Key informants interviewed for this study highlighted the multifaceted impact of biodiversity loss driven by factors like invasive species, climate change, and human activities. These include the detrimental effects of invasive trees like mesquite (*Prosopis juliflora*) and sesbania (*sesbania grandiflora*) on local ecosystems, leading to reduced native flora and fauna, blocked irrigation channels and increased soil erosion.[8] The mixed-gender focus group discussion conducted in the Majhafa Villages also discussed the mesquite tree. In recent years, Majhafa Villages reported facing significant challenges due to the rampant spread of this mesquite, which has blocked agricultural irrigation channels, threatened groundwater, and hindered the growth of other crops. Efforts to combat this invasive species have included organizing community campaigns to clear the Mesquite trees from irrigation channels and village entrances, as well as other initiatives to remove and utilize these trees. They are working to

[8] *Prosopis juliflora* – considered the world's worst invasive plant species – spreads rapidly, often facilitated by grazing animals and outcompetes native vegetation due to its nitrogen-fixing, drought and salt tolerance (Shackleton et al., 2014). It was originally introduced to Yemen to combat desertification and stabilize sand dunes but has been exacerbating flooding issues by compromising the water channels since at least 2002 (The New Humanitarian, 2008).

turn the Mesquite trees into a viable food source for humans and animals and repairing deteriorated irrigation infrastructure, such as casings.

Focus group participants reported concerted efforts to raise awareness about the importance of water conservation and the ecological threats posed by the mesquite trees. The community has also launched awareness campaigns on the benefits of planting other kinds of trees. This can help prevent the shifting sands that threaten the village, thereby fostering a more sustainable and resilient agricultural environment.

Additionally, according to study respondents, climate-induced changes have forced shifts in traditional practices, such as agriculture and animal husbandry, exacerbating the loss of biodiversity and altering local economies and livelihoods. Mangrove preservation also emerged as a key concern. Mangroves are recognized for their ability to absorb and store carbon dioxide underground, helping mitigate the impacts of climate change. Respondents identified initiatives for the restoration and planting of mangrove trees in regions like Dhabab, Mukalla, and Mahra to enhance ecological resilience and support environmental sustainability.

In the ongoing flood response efforts in West Coast, IOM is empowering internally displaced persons (IDPs) through cash-for-work initiatives. In this scene, community members are engaged in enhancing their surroundings, demonstrating resilience and teamwork in the face of challenges. © IOM 2024/Majed MOHAMMED

3. MIGRATION, ENVIRONMENTAL DEGRADATION AND CLIMATE CHANGE DYNAMICS

This section examines the relationship between slow-onset processes, extreme weather events and human mobility within the wider national socioeconomic and political context of Yemen.

3.1. Drivers of migration to Yemen

Various factors drive migration into Yemen, reflecting the complexity of the country's migration landscape. It attracts individuals seeking improved economic prospects. Particularly in urban areas, Yemen's informal labour market can be a desirable alternative for those seeking employment and better livelihoods.

Among non-Yemeni migrant arrivals in 2022, 84 per cent entered the country for economic reasons, while 16 per cent did so for fleeing conflicts (IOM, 2022). Migrant arrivals in Yemen saw a substantial 87 per cent increase between the first two quarters of 2023, marking the highest recorded figures. This surge reflects growing migration challenges in the region (IOM, 2023a).

The desk review conducted for this study and the data collected suggest that environmental drivers are not substantive factors motivating migration to Yemen. However, refugees in Yemen have tended to find employment primarily in the agriculture sector (ACAPS, 2023; CIVIC, 2022), revealing a vulnerability to production losses and climate-induced forced mobility due to productivity and cultivable land declines.

3.1.1. Migration journeys and settlement

Yemen has historically been a nation of refuge, hosting individuals fleeing conflicts and persecution in neighbouring countries. However, the severe humanitarian crisis in Yemen has led to growing intolerance and a shrinking asylum space for those seeking safety and protection. This situation has particularly affected refugees, asylum-seekers and migrants, with Yemen accommodating approximately 138,000 migrants and 140,000 refugees and asylum-seekers, primarily in urban and semi-urban areas (IOM, 2022; UNY, 2022).

Migrants and refugees in Yemen, particularly groups in vulnerable conditions such as children and women, encounter significant human rights challenges, including human trafficking, kidnapping and sexual violence. These issues are compounded by the conflict, which impedes the effective implementation of anti-trafficking initiatives and legislative compliance. Although there are established laws targeting traffickers and smugglers, the persisting conflict and limited oversight continue to leave migrants exposed to heightened risks of exploitation and violence (Bin Wabar, 2023; IHD, 2023; IOM, 2022 and 2023c; Mustun, 2022). In 2022, the UNHCR and NACRA's Participatory Assessment in Sana'a and southern Yemen revealed critical issues for refugees, such as insufficient livelihood opportunities, cash aid, and civil documentation barriers (UNHCR, 2023).

In 2022, significant progress was made in refugee repatriation, with 762 individuals voluntarily returning to their countries of origin in Somalia and Ethiopia. This was facilitated by the resumed Assisted Spontaneous Return programme and the IOM-led voluntary humanitarian return programme after COVID-19 travel restrictions were lifted. In 2023, 6,600 migrants used this programme to return to their countries of origin (IOM, 2024c). These returns were supported through cross-border collaborations and reintegration assistance from international agencies such as IOM, UNHCR, and OCHA (IOM, 2023b; OCHA, 2022; UNHCR, 2023). Among the data collected for this study, six focus group discussion participants expressed an explicit desire to return to their countries of origin. For most, that decision is contingent upon improved security conditions.

> *"We fled because of wars – it was a complete displacement – and we want to return to our country where we have lands and ancestors. But our country has no jobs, so we came to Hadramawt and got some jobs, mingled with its people, and studied in schools. If the situation stabilizes, we want to return to our country."*
>
> Male focus group participant, Maryam IDP camp-Seiyun.

3.2. Drivers of migration through and out of Yemen

In 2023, a comprehensive study by IOM revealed that 97 per cent of surveyed migrants in Yemen were en route to Saudi Arabia, with 92 per cent from Ethiopia and 8 per cent from Somalia. These migrants, driven by high unemployment and political instability in their home countries, sought employment opportunities in the Gulf region. The study highlighted that most arrivals were concentrated along the coastal areas of Lahj and Shabwah, indicating a shift in migration patterns. This change is largely attributed to more favorable sea conditions and smugglers adopting new strategies, including using larger boats and altering routes to enhance efficiency (IHD, 2023; IOM, 2023a).

An emerging migration trend identified in the abovementioned study involves a new route through the Hadramawt and Al Mahrah governorates, driven by the desire to avoid human rights abuses and detentions at the Saudi Arabian border. Migrants increasingly view these areas as gateways to economic opportunities in Oman, owing to their relative stability, fewer military checkpoints, and the local communities' acceptance of migrants. However, despite the perceived safety, these regions still present significant challenges, including limited access to essential services and ongoing human rights concerns.

To curb the influx of migrants primarily heading from Yemen towards Saudi Arabia and other Gulf countries, a joint military operation by Yemeni Military Forces was launched in August 2023. Targeting the Lahj governorate's coast, the campaign detained smugglers and intercepted boats, significantly reducing migrant arrivals. This resulted in a near-complete cessation of migrant flow through this route in the subsequent months, with a single exception in December 2023 when a boat transported 110 migrants ashore (IOM, 2024a). In the focus groups conducted for this study, two male migrants expressed explicit desires to continue on to another country in search of better economic opportunities.

> *I don't want to return to my country; I want to leave Yemen if the opportunity and the financial aspect arise. I will migrate to a better country for a better standard of living and to build my future and my children's future there.*
>
> Male focus group participant, Maryam IDP Camp-Seiyun.

Regarding international migration by Yemenis, the protracted conflict in Yemen, intensified by the Saudi Arabian intervention in 2015, has significantly increased emigration, with about 190,000 Yemenis and foreign nationals fleeing to neighbouring and distant countries, though there are challenges in tracking these movements due to lack of data. Djibouti, in close proximity to Yemen, has become a key refuge, receiving over 37,000 Yemenis by 2020 (IHD, 2023). Somalia has also emerged as an unexpected haven for Yemeni refugees. Over 14,000 Yemeni refugees sought shelter in Somalia, driven by the need for safety amid Yemen's turmoil. Additionally, smaller but noteworthy numbers of Yemenis applied for asylum in Egypt (5,032) and Germany (3,992) in 2018 (ibid.). These figures underscore the global reach of Yemeni emigration as individuals sought security and opportunities abroad, reflecting the profound impact of conflict-induced migration on Yemen's population.

While internal migration and displacement due to climate change and environmental challenges are more common in Yemen, key informants interviewed for this study pointed out that some Yemeni citizens have also migrated abroad in search of better job opportunities or (temporary) relief from the challenging environment in Yemen. However, financial constraints make migration abroad unattainable for many people: clear socioeconomic class distinctions inform whether or not this is an option. A stakeholder working in the public sector explained that "affluent people migrate to Egypt for four to six months" during the hotter periods of the year.

> *Many of my neighbours have travelled to the Gulf or other foreign countries due to the strength of the currency in those countries to find a better livelihood.*
>
> A representative from Lawyers for Legal and Developmental Support for Women.

> *Due to water scarcity, many residents of villages in Yafi' or Hadramawt have migrated to other areas or major cities like Aden or abroad in search of job opportunities and a livelihood.*
>
> An official in the General Authority for Environmental Protection responsible for planning and information.

3.3. Drivers of migration and displacement within Yemen

In terms of internal displacement, Yemen faces a significant crisis, with over 4.5 million IDPs, including 172,000 newly displaced in 2020 and nearly 160,000 in 2021 (IDMC, 2023). In 2023, displacement in Yemen was primarily driven by conflict (42%), natural hazards (47%), and economic factors related to conflict (11%), underscoring the multiple dynamics that force people from their homes. Specifically, combat and shelling accounted for 27 per cent of displacement due to conflict, while general insecurity contributed another 15 per cent.

Due to its severity, Cyclone Tej displaced 4,356 households, mainly in Al Maharah and Hadramawt. Additionally, economic impacts such as unemployment or salary cuts prompted 5 per cent of the displacements (IOM, 2024b). Despite the challenging circumstances among the populations served by UNHCR in the country, refugees and asylum-seekers comprise less than 2 per cent of the nearly 4.9 million person base (IDPs and returned IDPs constitute 85% and 12% of the remainder, respectively) (UNHCR, 2024).

The distinction between displacement and internal migration in Yemen often blurs due to complex crises, including economic collapse, environmental degradation, the COVID-19 pandemic, and escalating conflict, prompting both forced and economically driven human movements. Acknowledging these as distinct phenomena – namely, that displacement is always forced or otherwise obliged – the shared categorization of these movements in this section reflects the ambiguity of participants' own descriptions of their mobility experiences. This sheds light on their journeys' multifaceted nature and challenges, whether they are classified as migrants or displaced persons.

3.3.1. Environmental drivers

One of the significant consequences of climate change in Yemen is the displacement of its population. Extreme weather events have already displaced tens of thousands of Yemenis. This displacement threatens livelihoods, especially in rural areas, strains critical resources in relocation areas, and provides armed groups with recruitment opportunities. For example, in 2022, while conflict-related displacement in Yemen decreased, displacement due to weather-related hazards like floods and heavy rains increased, disproportionately affecting the poor, particularly IDPs and small-scale farmers (IAHE, 2022; OCHA, 2022). Gradual environmental changes, including water depletion worsened by population growth and urbanization, drive mass displacement and heighten conflict risks.

Migration and displacement serve as a crucial nexus between climate change and conflict, potentially intensifying various conflict drivers (OCHA, 2022). For example, a study led by the Center for Civilians in Conflict (CIVIC) identified direct links between climate change, environmental damage, resource shortages, loss of livelihoods, forced migration, and conflict in areas like Aden, Ma'rib, and Ta'iz (CIVIC, 2022).

Of 30 key informants, 26 linked environmental factors to internal migration and displacement. They placed significant emphasis on these trends, noting that environmental changes have made life very challenging in parts of Yemen – particularly for people who work in the agricultural sector – by pushing people away from those areas to regions that are more favorable for agricultural projects or to other vocations altogether. For example, a stakeholder working in the public sector described how "due to water scarcity, many residents of villages in Yafi or Hadramawt have migrated to other areas or major cities like Aden or abroad in search of job opportunities and a livelihood." Similarly, another public sector stakeholder stated, "Many families have migrated from Yafii district and Al-Dhale Governorate to Aden or Lahij Governorate due to the availability of water and job opportunities."

According to study participants, environmental impacts include reduced agricultural activities such as coffee farming in specific regions and disruptions to apiculture where natural vegetation declines, leading beekeepers to relocate. Frequent flash floods have also historically inundated large swathes of the country, damaging vital infrastructure. In some regions, homes constructed in flood-prone zones have been destroyed by unexpected flood events, illustrating the severe consequences of building in vulnerable locations.

Rising temperatures also contribute to internal migration . One former Local Water and Sanitation Authority official stated, *"Every year, the temperature rises, and the influx and migration to the province increase."*

> *"A friend from Al Hudaydah migrated internally due to high temperatures and lack of natural resources for living. He moved to Sana'a, along with hundreds from the same province, to various locations seeking work. Hadhrami nomads migrated from the outskirts of Seiyun to the mountains for protection against floods and disasters."*
>
> A representative from the Sanitation and Improvement Fund Office in Hadramawt.

Key informants have highlighted that while internal migration due to gradual environmental changes is common, acute crises such as floods often catalyse displacement. Flooding in Tarim and Hadramawt in 2008 and 2021, as well as acute water scarcity in Yafi'a, were frequently mentioned by key informants as major drivers of displacement.

> *"Many families left their homes. For example, in 2008, disasters in Hadramawt forced many families to leave their homes and migrate to safer areas. Also, soil erosion and crop destruction occurred, and many animals died, like camels, goats, cows, and bees. Some residents also died."*
>
> An official from the Directorate of Agriculture, Irrigation, and Fisheries – Tarim.

Migration is not always due to pure environmental drivers but is frequently a result of compounded pressures, including ongoing conflict and economic instability. Thus, migration and displacement in Yemen form a complex nexus with climate change and conflict, each influencing and exacerbating the other, creating a cycle of movement and instability influenced by a spectrum of overlapping issues. Additionally, the ongoing conflict has destroyed critical infrastructure, complicating access to water and sanitation and magnifying the impacts of environmental challenges. This devastation has led to a complex migration landscape where motives – both to move and to stay – are mixed. Migration and displacement often occur simultaneously, driven by an amalgamation of environmental, economic and security factors.

> *"We will stay here in the future, where the area's hospitals, treatments, schools, safety, and tranquility are available. Our comfort and our children's comfort here in Hadramout and the availability of water and electricity make us want to continue here in the future."*
>
> Female focus group participant, Maryam IDP Camp – Alquern.

3.3.2. Conflict and insecurity

Seven key respondents identified conflict and physical insecurity as the leading drivers of internal displacement and migration in Yemen. Cities like Aden have seen their populations double as they become a refuge for those fleeing the intense fighting in regions such as Hudaydah and Ta'iz. Moreover, these areas attract individuals escaping violence and those suffering environmental hardships like water scarcity, exemplified by migrants from Yafi and Radfan in Al-Dhale.

A former official from the Local Water and Sanitation Authority elaborated on the challenges this can cause: for example, the influx into Aden, especially into highland areas with challenging geography and inadequate infrastructure, complicates the delivery of essential services like water, stressing the already limited resources and exacerbating the difficulties in accommodating the displaced populations. This situation is further strained by the appearance of informal housing areas, where providing consistent and adequate utilities remains a substantial challenge.

> *"Many people consider migrating from Aden due to the illegal spread of weapons and the brutality of dealing with those who carry those weapons. This prompts many people to migrate to provinces without weapons."*
>
> A representative from Lawyers for Legal and Developmental Support for Women.

Environmental factors intertwine with the conflict, adding a layer of complexity to the patterns of displacement and migration. For instance, the war has led to significant disruptions in essential services like water supplies, particularly in areas like Jawf, where artesian wells are non-operational due to power shortages, forcing families to move in search of necessities.

The harsh climate of regions like Ma'rib poses additional challenges for internally displaced persons who find themselves in drastically different environments from their homes, often without adequate shelter or the means to adapt to the new conditions. Such environmental hardships and the direct impacts of war create a dual force driving displacement, making it difficult for displaced populations to find stability or return to their regions of origin. As an official from the Executive Unit for IDPs recalled:

> In 2016 and 2017, at the start of the displacement and war, not everyone could adapt to the hot climate in Hadramout – suffering and crying for a whole month – which prompted them to move again to other places. However, some people were able to endure and adapt. I am a living example of this. I was born in Sana'a. I initially had a hard time adapting to the climate in Seiyun. Now, after adapting, when I travelled to Sana'a city, I could not adapt there and wanted to return to Seiyun.

The overall mobility of the population is influenced not only by the immediate threats of violence but also by the longer-term impacts of environmental degradation and the lack of infrastructure, which are often exacerbated by conflict. For example, as internal migration increases in Yemen, competition for scarce water resources among tribes with conflicting economic interests has escalated, leading to heightened disputes and the rekindling of historical feuds. These water-related conflicts, often intertwined with land disputes, create a volatile environment ripe for broader conflicts, exacerbated by long-standing grievances (Acacia Water, 2021).

3.3.3. Economic factors

Economic factors also drive internal migration ; according to five key informants, they can constitute the leading driver. The multiple crises in Yemen have devastated the livelihoods of IDPs, refugees, and asylum-seekers, pushing them into harmful coping strategies and increasing their dependence on humanitarian aid (OCHA, 2022; UNHCR, 2022).

Study respondents shared that small-scale mobility decisions may be motivated by investment aspirations, such as leasing out homes and moving into more affordable and climatically suitable housing, such as mud houses, which offer better insulation against heat and cold. Others may be related to periodic migration related to livelihood opportunities, such as teachers who migrate to balance multiple jobs and secure a sustainable livelihood.

Conversely, larger-scale migrations are evident as Bedouin communities and villagers move to urban centres like Seiyun, Tarim and the Qatn area, driven by the allure of improved job opportunities and better services. These migrations also respond to environmental challenges, such as droughts affecting agricultural viability, pushing residents towards areas like Hadramawt Valley, known for its potable water availability and more stable living conditions. The overarching theme is that individual economic pressures and broader environmental factors compel people to relocate, often prioritizing economic stability and essential services over other considerations like climate conditions.

3.3.4. Temporary migration

As noted earlier in this section, some population groups with the means may engage in temporary migration to escape the brunt of harsh climatic conditions in Yemen. According to study participants, however, others engage in temporary migration or are temporarily displaced due to recurring slow-onset processes, extreme weather events, or conflict. For example, a community leader and agricultural researcher shared that recent conflict surges and environmental challenges have forced many to migrate or be temporarily evacuated to safer locations. In 2016, the outbreak of war prompted individuals to leave their homes, moving from Aden to governorates like Hadramawt and Sana'a, where they lived without income and depended on modest savings. When possible, they returned to their homes in Aden.

Others moved to avoid disasters triggered by natural hazards such as floods, with some temporarily relocating to higher ground to escape continued flooding or landslide risks. Additionally, those living near riverbanks or flood-prone areas often seek safer, more distant places to protect themselves and their assets during heavy rains, including livestock, from imminent danger and access essential resources like pasturelands. These movements highlight the multifaceted reasons behind migration and displacement, driven by conflict and environmental factors.

3.3.5. Multiple displacements

The compounded issues of environmental pollution and inadequate infrastructure exacerbate the hygiene and sanitation crises for IDPs, contributing to secondary displacements amid ongoing conflict, with the tracking of such movements hindered by unreliable monitoring systems (IAHE, 2022; OCHA, 2022). Data for this study suggest that secondary displacements are a frequent phenomenon among migrants, refugees, asylum-seekers and IDPs in Yemen.

For example, focus group participants noted that displaced people encounter heightened vulnerability when flooding occurs. Additionally, IDP camp residents have disproportionately high exposure to associated negative health consequences of extreme weather events such as flooding. Two IDP camp managers in Al-Naseen and Al-Jufeina, and a representative from the Water Foundation explicitly referenced instances in which families in the camps were displaced by floods and forced to relocate again to flood-prone regions. Such repeated displacements have led to substantial financial strain, with individuals having to sell belongings or borrow money to cover mobility costs.

3.3.6. Migration journeys

Environmental and security factors heavily influence internal migration journeys. Focus group participants recalled encountering varied climates and strict security checkpoints that scrutinized their movement and intentions as they travelled from one region to another. The lack of essential services like food, shelter and medical supplies was a consistent challenge throughout their migration.

Environmental challenges were also a significant aspect of the migration, with participants noting drastic changes in climate along their routes that affected their comfort and health. Some faced harsh conditions in barren deserts and heavy rains, which made travel more difficult and posed risks to their safety and well-being. The journey, lasting days or even weeks, presented difficulties and transportation was only available sporadically and generally dependent on the goodwill of others. However, upon arrival in host communities, many found a more stable environment with access to basic services like electricity and water, which were absent in their previous locations.

Transitions and settlement in new locations brought a mix of relief and new difficulties; while some respondents appreciated the relative security and tranquility, others were burdened by worsening service conditions over time. Host communities' receptions varied, with some migrants finding support and kindness, particularly from villagers along the way, contrasting with the less welcoming attitudes encountered in more urban settings.

3.3.7. Trapped populations among internal migrants and displaced persons

According to respondents for this study, trapped migrant and IDP populations in Yemen face a cyclical challenge due to their inability to move away from disaster-prone areas, primarily due to financial constraints. Despite being aware of the risks, many residents continue to build or rebuild their homes on flood-prone land because they cannot afford to relocate. This ongoing cycle of destruction and reconstruction in the same vulnerable areas highlights a critical issue: the lack of financial resources not only limits immediate relocation options but also perpetuates residence in high-risk zones, where families repeatedly face the threat of disasters. Key informants emphasize that the poor financial conditions of these residents make it almost impossible for them to secure safer housing in less vulnerable areas.

> *Some people live in hot places without services like electricity and no alternatives like batteries, so many wish to migrate but are held back by financial aspects. Those with capital will move, but people can't afford it.*
>
> A member of the Al-Wadi Association for Water Users and Irrigation.

The barriers to migration are multifaceted and extend beyond mere financial constraints, blurring the line between exercising a decision to remain and being trapped in place. Cultural and social attachments to land and community can also significantly deter individuals from leaving, despite the evident risks and discomforts such as poor ventilation, high temperatures, and inadequate living conditions on lower floors of buildings. These emotional and social ties are compounded by practical considerations such as the proximity of their current locations to essential services like markets and schools, which offer a semblance of stability and convenience that might not be replicable in new locations. Additionally, the logistical costs of moving, which include transportation and the establishment of a new household, are prohibitively high for many, reinforcing their trapped status. As one male IDP in Awahdah Camp in the Wadi Ma'rib district shared:

> In general, our families' needs, even in small amounts, are met. As for leaving or staying in the camp, it is very natural that we cannot move to another community or another camp for many reasons, including our inability to afford transportation or mobility costs and building a new shelter, among others. Additionally, the area we currently live in is very close to the market and school, making transportation and education for our children much easier. Also, drinking water and washing facilities are available, and electricity service is continuous and free. This makes us not think or plan to leave.

The concept of being a "trapped" population thus encapsulates more than the physical inability to move; it includes economic, emotional, social, and logistical layers that make migration unfeasible. Even in cases where basic needs are minimally met, the lack of financial means to cover the costs associated with moving forces many to endure suboptimal living conditions. This scenario is a common narrative among IDPs, who, despite the hardships in disaster-prone camps, find the prospects of moving laden with too many uncertainties and challenges, thereby choosing to stay put as the more viable option.

> *People may want to leave their homes because of temperatures, rains and floods. Every person wishes to improve their living standards, hopes for the end of war, and wants to return to their homes. But circumstances prevent them from doing so.*
>
> A former official from the Local Water and Sanitation Authority.

4. CROSS-SECTOR CHALLENGES AND RESPONSES

The survey responses related to cross-sector challenges predominantly centred around the availability and distribution of resources, infrastructure maintenance, and the threats environmental conditions pose to health, human security, and food security. The following sections underscore the breadth of the Yemeni population's needs to strengthen community capabilities and bolster climate resilience.

4.1. Public sector

Study data highlight significant governance and public sector challenges, particularly in resource distribution and infrastructure maintenance. Respondents have experienced severe shortages in essential supplies such as electricity, water and gas. This has forced them to adapt by using alternative cooking methods like firewood due to intermittent gas supply or relocating due to areas suffering food blockages and being rendered inaccessible following disasters.

> *I could not store food in the refrigerator due to high temperatures and power outages, leading to spoilage. I also see displaced people living in tents during my trips to and from home, suffering from extreme heat and lack of basic necessities, which is much harder than my situation. The lack of electricity is one of our biggest challenges; if electricity were provided, it would improve the situation for many compared to the current state.*
>
> A teacher from a secondary school for girls.

According to study participants, awareness and education about climate issues are notably lacking, exacerbating vulnerabilities to environmental changes. Response data indicate a gap between the intentions of organizations and institutions aiming to raise climate change awareness and their actual impact on the ground, with few visits to affected areas like the camps included in this study. This disconnect points to a broader issue of ineffective communication and engagement strategies within the initiatives to educate and mobilize local populations on climate resilience. One respondent noted, *"The treatments we obtain are through raising awareness, which is the best strategy. The danger is looming, but we can reduce its severity."*

> *We notice a lack of community awareness among decision makers. People's awareness is limited to considering climate change as only a 'natural disaster,' while the concept of climate change is deeper than that. For example, climate change requires delayed planting times. Farmers unaware of climate change plant in April, and the rains fall in July, so there is a need to increase farmers' awareness to adapt to climate change.*
>
> An engineer from the Climate Change Unit in the General Authority for Environmental Protection.

Infrastructure initiatives, while present, are often reactive rather than proactive, suggesting a piecemeal approach to crisis management rather than comprehensive, strategic planning. The efforts described, such as using the Ma'rib Dam's artificial lake to alleviate water shortages, are localized solutions that do not address the root causes of vulnerabilities (discussed further in Section 5. Resources and vulnerabilities). Additionally, study participants conveyed a sense of anticipation and disappointment at unfulfilled commitments, such as a promised but delayed study of the water basin. Local authorities and non-governmental organizations' efforts are fragmented: they lack coordination, consistent quality standards, tangible results and improvements for civil society.

Despite some efforts by the Yemeni government to address climate change, including establishing a specialized environmental and climate change administration and international cooperation on national climate bulletins, there is a notable lack of integrated efforts between organizations, the government and local communities. This condition undermines the effectiveness of initiatives, as does the lack of awareness among decision makers about the importance of prioritizing climate issues alongside immediate needs like food and water. The Yemen Strategic Vision 2025 emphasizes climate issues, indicating a strategic approach towards sustainable environmental practices (Government of Yemen, 2000). However, significant gaps remain in remote sensing systems, early warning systems, and data collection, which are crucial for accurately monitoring climate change and planning appropriate responses.

That said, successes have emerged, such as those shared by a former official from the Local Water and Sanitation Authority:

> We have constructed water barriers in some camps vulnerable to floods. Additionally, we partnered with the Social Development Fund to maintain the channels of the Ma'rib Dam. Furthermore, we diverted waterways away from camps prone to floods. We have also collaborated with local and international partners to relocate some camps to safer locations. Moreover, in cases where camps are at risk from floods or other disasters, we provide equipment like loaders to protect homes at risk. These accomplishments are considered achievements for us as a local authority and with our international and local partner organizations.

Participant responses also pointed to a critical need for laws to regulate technology use to prevent resource depletion. The practical applications of technology in mitigating climate effects are evident, with the use of solar energy to improve access to water and create better living conditions. However, desk research conducted for this study found that there may be a connection between large-scale solar projects and rapid groundwater depletion (CEOBS, 2021). Such linkages require deeper and site-specific case studies.

Furthermore, there is a need for strengthening public sector response and governance more generally, as evidenced by unregulated construction activities in flood channels and the prevalent use of outdated agricultural practices. These activities not only heighten the risk of environmental degradation but also illustrate a lack of foresight and strategic planning in managing natural resources and adapting to environmental challenges. The limited capacity of the Agriculture Office and the absence of effective regulatory measures contribute to ongoing desertification, improper land use, and escalating environmental risks.

4.2. Public health and human security

Logistical issues, supply shortages, and soaring fuel prices compound the difficulties of accessing health care, further exacerbated by a health-care system weakened by privatization, high costs of medication, and disparities between urban and rural areas (Lackner and al Eryani, 2020). The ongoing conflict and spontaneous migration heighten vulnerabilities across health care, food security, and water, sanitation and hygiene (WASH) sectors, leading to only half of health facilities being operational and worsening health conditions, especially in IDP sites (OCHA, 2022).

Responses from focus groups and key informant interviews conducted for this study indicate a direct link between extreme weather conditions and public health and human security issues. The past year's intense heat has significantly affected the health of populations in vulnerable conditions, such as children and the elderly, leading to heat-related illnesses and disruption of daily activities. In contrast, residents in IDP camps that endure cold desert nights have faced shortages of blankets and suitable clothing to cope with the temperature drops. Additionally, gas shortages and interrupted water supplies have forced many to resort to traditional cooking methods, such as using firewood. Flooding is another critical issue, severely disrupting daily life and increasing the risk of vector- and waterborne diseases, such as cholera and typhoid.

Socioeconomic factors compound environmental effects on health and well-being, according to study respondents. The stress of high temperatures affects mental health and workplace productivity, while power outages exacerbate the situation by causing sleep disturbances and additional health issues. Moreover, climate change is driving a rise in viral diseases and fevers, linked to severe weather fluctuations and environmental degradation near pollution sources like oil fields. The accumulation of waste and inadequate local governance capabilities increase these hazards.

Research conducted for the desk review portion of this study triangulates the above claims. Malnutrition rates are expected to increase, posing significant risks to refugees, asylum-seekers, migrants and displaced individuals. Mental health issues, especially among women and girls, are exacerbated by limited mental health-care services and stigma (DCAF, 2022). Additionally, the conflict has led to civilian casualties and internal displacement, stretching already thin resources and compounding challenges with landmines and explosive remnants of war. Climate-induced natural hazards further drive displacement, worsening overall health and human security challenges (ACAPS, 2023; CIVIC, 2022).

Focus group participants also discussed the practical inaccessibility of health-care centres due to prohibitively (and dangerously) long travel times and transportation costs. Access to health care is hindered by the distance to the nearest facility from shelters, making emergency services difficult to reach. Medications are both unaffordable and scarce, often resulting in populations leaving health issues untreated. The high cost of transportation adds to this challenge, and while mobile clinics offer some relief, they typically provide only basic first aid. In severe cases, families resort to natural remedies or borrow money for treatment; otherwise, they will endure the illness until they can find a solution. Participants' health and human security concerns as they relate to rising temperatures, flooding, and various forms of pollution can be found in Table 1.

Local and international entities are involved in efforts to mitigate the impacts through education, infrastructure projects, and direct interventions in health crises. However, a significant gap remains in community awareness and a robust response system, especially in rural areas and among displaced populations where the infrastructure is insufficient to handle the adverse effects of climate change. As with other factors, challenges to health and human security intersect with other dynamics and processes in this study, as illustrated by the following comment by a programmes and projects director for the Martyr Bin Habrish Foundation for Development (BHF):

There's a strong relationship between climate change and health because if the climate is unstable, it will affect local resources, forcing people to migrate due to disasters, affecting agriculture and citizens' health. If agriculture and health are affected, migration will occur, forced or out of necessity, as people look for stable areas to meet their life's requirements.

Table 1. Health implications of slow-onset processes and extreme weather events in Yemen by type, as identified by country study participants

Phenomenon	Health concern	
Increasing temperatures	• Heat rashes • Mental health issues • Respiratory issues • Blisters • Increased mortality • Lack of sleep • Fevers • Viruses	*"Some viral diseases have emerged and spread due to increased temperature and pollution in our area, especially around oil wells and fields."* *"Power outages in summer caused diseases such as difficulty breathing, skin rashes, and blisters due to the heat, especially for those who do not have other means to cope with these conditions."* *"We need adaptation methods to cope with the heat as it affects mental health for both adults and children."* *"Last year was one of the hottest, which significantly affected the health of children, who suffered a rash due to their direct exposure to high temperatures."*
Pollution	• Waterborne diseases (cholera, typhoid) • Epidemics • Fevers • Respiratory and allergic reactions	*"There are difficulties such as environmental pollution, solid waste, and open water that cause diseases such as cholera and typhoid."* *"In the last decade, climate change has led to many diseases and epidemics currently spreading, such as viral diseases and fever, and weather fluctuations that especially affect children and the elderly."* *"There are initiatives to prevent waste dumping near displaced areas, as it leads to diseases and epidemics. They are educated on proper waste disposal methods, which involve collecting waste in bags and disposing of it in distant locations."*
Flooding	• Waterborne diseases (cholera, typhoid) • Vector-borne diseases	*"One example is the heavy rainfall in 2020: many deaths occurred due to the floods and outbreaks of epidemics and fevers due to stagnant water. The Sanitation Fund intervened to drain the water and open the roads."* *"Civil society organizations and volunteer youth groups have undertaken many actions, such as organizing and cleaning flood channels and initiatives in the Al-Suwairi area where they constructed and repaired damaged facilities (following floods). Also, the Directorate of Agriculture, along with the Health Office, carried out fogging operations in swamps left by floods and rains to eliminate mosquitoes and other pests."* *"Climate change has mostly affected the elderly, increasing cases of diseases and deaths among them. The rise in mosquitoes due to swamps has affected people and caused the death of the elderly and those with special needs."*

4.3. Agriculture, livestock and land ownership and use

Yemen's economy heavily depends on agriculture and fisheries, vital for its GDP and food security. However, the sector faces significant environmental degradation challenges, decreased yields, income loss, and heightened poverty. Study participants noted that the mismanagement of natural resources, extreme weather events, and slow-onset environmental processes compound these issues. Soil quality has deteriorated due to poor mineral content, reducing crops' yield and nutritional value. Additionally, unsustainable water usage, including unauthorized well digging, has worsened the scarcity of water resources. These adverse conditions have diminished agricultural productivity and driven land use shifts, with some individuals abandoning traditional farming for more lucrative but environmentally harmful construction activities.

In particular, key informants have observed a significant shift in Ma'rib's socioeconomic and environmental landscape, reflecting a transformation from traditional pastoral activities to alternative livelihoods due to the loss of grazing lands and the implications of water scarcity. This transition, while opening opportunities for education and different forms of employment, signals a deep-seated issue of resource depletion and a move away from traditional practices. This dynamic is illustrative of a broader theme that emerged over the course of data collection: adaptation to changing environmental conditions underpinned by necessity rather than choice.

> *"I have noticed a decrease in palm trees due to water scarcity and farmers abandoning agriculture and selling their agricultural lands, which are then bought for residential construction."*
>
> A teacher from a secondary school for girls.

> *"The palm trees have been destroyed. For example, we used to be self-sufficient regarding dates, but now we import them from abroad. There used to be more than 60 varieties of dates, and now there are barely 30 varieties left."*
>
> An official from the Directorate of Agriculture, Irrigation, and Fisheries – Tarim.

Conflict-induced displacement strips people of their primary agricultural livelihoods, exposing them to various forms of violence and vulnerability as they seek alternative sustenance sources. Lacking the necessary resources to rebuild their livelihoods, this cycle perpetuates poverty (ACAPS, 2023; Camacho et al., 2018; FAO et al., 2021; OCHA, 2022). These dynamics have also taken their toll on the livestock sector, according to a key informant from a civil society organization dedicated to women's advocacy:

> Many people are forced to migrate from fertile areas to Ma'rib Valley due to climate change and the effects of war, which are the two main factors. Initially, Ma'rib Valley had farms but lacked grazing lands, causing displaced people from Raghwan and Sarwah to abandon animal husbandry and move to the desert in Al-Abar, Saffar, and Al-Ruwaik. They are forced to graze their sheep and camels there because camels cannot survive on farms and need open grazing areas. Despite being distant and resource-scarce, people are forced to live there due to grazing needs, facing a severe water scarcity problem. They are then compelled to sell their livestock, resulting in loss of income and stability.

The quote highlights shifting migration patterns among agricultural and nomadic communities, driven by fears of flooding, conflict, and water scarcity that compel them to relocate. This often results in increased competition for scarce resources in new areas. High living costs and inadequate housing in more stable regions force many to make difficult choices between essential needs like food, water, and shelter. These socioeconomic pressures drive families away from agriculture toward alternative employment and often lead to unplanned urban migration. Adding to this, an official from the Directorate of Agriculture, Irrigation, and Fisheries in Tarim said, *"The biggest problem is the conversion of agricultural lands into residential buildings and facilities, which leads to an imbalance in the environmental equilibrium of the land."*

Discussions among focus groups and key informants revealed complex challenges related to land ownership and usage. For instance, a leader from a women's advocacy NGO shared her organization's attempt to address water scarcity through a specific initiative. *"It was difficult to obtain land, despite everyone needing water. They did not allow land acquisition…There are land disputes even at the level of large farms."* In other instances, individuals bought cheap land located in flood-prone areas due to their financial limitations; their homes were demolished during the next storm. Moreover, insecure tenure arrangements – including the risk of forced eviction and lack of formal land occupancy agreements – comprise other forms of insecurity, making it difficult to invest in sustainable agriculture or other income-generating activities.

Despite these challenges, adaptive strategies emerged, such as altering water consumption patterns and agricultural methods to better suit the changing climate. Some communities and organizations also reported advocating for policies that prevent the allocation of lands that permit housing on flood paths. Other IDP camp respondents shared that they negotiated to allow continued residency and collaborated with executive authorities and partners to facilitate relocation and reduce the impact of displacement. However, the effectiveness of these initiatives is limited without systematic support and significant intervention from governmental and non-governmental organizations.

> *"There is a significant disconnect between farmers, citizens, landowners and relevant governmental bodies, indicating a need for stronger cooperation."*

4.4. Food insecurity

Climate change intensifies Yemen's acute levels of food insecurity by reducing agricultural productivity, increasing sea levels, leading to climatic variability, and impacting coastal zones. The convergence of conflict, climate change, displacement, and food insecurity has placed millions of Yemenis on the brink of starvation, and groups such as displaced people, Muhamasheen, and female-led households, are among the most affected (FAO et al., 2021; IAHE, 2020; Rahman, 2023; UNHCR, 2023; UNY, 2022; WFP, 2022).

Eight key informants spoke directly to the urgency of food insecurity in Yemen and its relationship to climate change, though the vast majority of interviewees (93%) underscored the impact of slow onset processes and extreme weather events on agricultural production, which negatively impacts livelihood and food security in tandem. Tellingly, all focus group discussions addressed the challenges at the intersection of climate change and food insecurity.

Key informants reported that water scarcity resulting from altered rainfall patterns has forced farmers to either illegally dig wells or relocate their activities. These environmental stressors reduce food production, strain local ecosystems and water supplies, and threaten agricultural livelihoods and food security. Compounding these issues, unplanned migration disrupts communities, while economic

instability and high unemployment restrict the ability of individuals and families to buy food. Many depend on unreliable and inadequate food aid, worsened by insufficient family incomes, rising living costs, and insufficient government support.

> *Food insecurity in the village led to an increase in malnutrition rates among children, where it used not to exceed 20 per cent of the total number of children. Now, malnutrition rates exceed 40 per cent. There has been a decline in the quantities of cultivated land due to the rise in oil derivative prices and a decline in the quantities of essential crops that were planted, including grains, tomatoes and onions.*
>
> Female focus group participant, Community of Majhafa Villages.

Migration serves as a significant response to these environmental challenges. As traditional agricultural areas suffer from drought or unexpected floods, residents, including nomadic groups, are forced to move in search of better conditions or alternative livelihoods. This mobility is often directed towards areas with better water availability and more stable agricultural prospects. However, new arrivals put additional pressure on the new areas, potentially leading to resource depletion and conflicts over land and water use, thereby creating cyclical patterns of vulnerability and instability in food security.

IDP camps and relocated communities face severe infrastructural deficiencies that worsen their plight. The lack of regular and reliable access to clean water, poor living conditions, and inadequate sanitation facilities increase health risks and complicates food preparation and storage, leading to higher rates of malnutrition and disease. Floods can inflict multiple forms of damage to food supplies.

> *Floods closed all the roads, forcing us to stay indoors. The floods also affected food supplies, forcing some families to borrow from neighbours and try to repay the debt at a later time.*
>
> A camp representative from the Executive Unit for IDPs.

IDP camp inhabitants reported resorting to extreme measures to obtain food, such as scavenging from garbage, begging, diluting meals, relying on leftovers from restaurants, or engaging in minimal trade of scavenged items. Such conditions reflect acute food insecurity and the degradation of social norms and community structures that traditionally mitigated food scarcity through communal sharing and support (though some sharing and borrowing do still occur). Existing coping mechanisms are not durable solutions, as illustrated in the quotes below.

> *Regarding food, most people borrow money to cover basic needs such as food, health, shelter, housing materials and others. Some sell their possessions to meet their family's needs. Also, there is food exchange among families and they cooperate with each other in any way possible.*
>
> Male focus group participant, Maryam camp – Seiyun.

> *The food we get from the garbage. Our main work is begging and asking for money from passersby on the roads. Our children collect anything that can be sold from the garbage to provide for our daily bread. They may search for clothes in the garbage and bring them to us to wash and wear afterward. Sometimes we find some food in the garbage like peas, pasta and some noodles, so we cook and eat them.*
>
> Female focus group participant, Maryam-Algarn camp - Seiyun.

4.5. Housing insecurity and unplanned urbanization

Across the majority of FGDs the role of housing insecurity in their everyday lives was highlighted: inadequate shelter, ranging from a total absence of private housing to reliance on precarious structures like tents and wooden barrels. Many individuals living in IDP camps lack basic shelter materials, such as tents or tarps, exposing families to extreme weather events. These conditions are uncomfortable and often dangerous, with incidents like fires posing a severe risk due to closely built wooden huts and inadequate escape routes.

According to respondents, environmental factors – both naturally occurring and human-made – significantly worsen housing insecurity. Many shelters, including tents and makeshift wooden houses, are susceptible to adverse weather conditions, leading to damage from wind, rain penetration and temperature extremes. These structures lack resilience against environmental challenges such as flooding and severe climate variations, compromising residents' safety and well-being.

> *Our top three sources of insecurity are a lack of tents, using wooden barrels as shelters, and high temperatures with no air conditioning.*
>
> Female focus group participant, Alwadah IPD camp – Wadi Ma'rib District.

> *The kitchen is exposed in our tent. Open sewage water next to us causes foul smells and overflows when it rains. Even when we enter the tent for shelter, water leaks from below, and we cannot sleep.*
>
> Female focus group participant, Community of Majhafa Villages.

The precarious housing situation, characterized by frequent evictions and the threat thereof, exacerbates the vulnerability of displaced populations, driving internal migration as families seek safer and more stable living conditions. This ongoing instability, coupled with high relocation costs and a lack of affordable housing, perpetuates cycles of poverty and displacement.

4.5.1. Unplanned urbanization

Among key informants, 11 interviewees named unplanned urbanization as a growing challenge interlinked with climate change, environmental degradation, and displacement and migration. This shift frequently results in informal settlements with inadequate infrastructure, particularly in flood-prone areas, leading to heightened risks during climate and weather-related events. In cities like Aden, migration for better service access and job opportunities has caused overcrowding and expanded residential zones into previously non-residential areas, including high mountains and elevated regions. Sana'a City is also a major destination for those seeking better economic prospects and livelihoods. Its population has grown from 2.9 million in 2015 to over 7 million by 2021 due to internal migration and the influx of IDPs (ACAPS, 2023). This influx has resulted in heightened demands for housing and essential services, pushing rents higher and straining existing urban infrastructures, such as water supply, electricity services, and waste management systems.

> *"Due to water shortages in some villages, remote areas, and some cities, many people have moved and migrated towards Seiyun city."*
>
> A teacher from a secondary school for girls.

> *"Agricultural lands have been abandoned due to inability to irrigate crops, forcing people to migrate to cities for work."*
>
> A representative from the Sanitation and Improvement Fund Office in Hadhramaut.

> *"People in villages have migrated to cities for work, because of the rains, and due to the difficulty of water access to their homes."*
>
> A member of the Al-Wadi Association for Water Users and Irrigation.

The relationship between climate change and urbanization – both as a catalyst for migration and an ongoing challenge upon settlement – manifests through intensified environmental pressures on these expanding urban landscapes. As cities like Aden grow, they face significant challenges like increased air pollution from automobiles, a noticeable reduction in green spaces, and the inappropriate conversion of agricultural lands into residential areas. These changes disrupt local ecosystems and contribute to broader environmental degradation, including altered climate conditions such as increased temperatures and disrupted rainfall patterns. Such urban expansion exacerbates the vulnerability of these areas to climate-related issues, including water scarcity and the heat island effect, where built-up areas are significantly warmer than surrounding rural areas. As a result of the heat island effect and upward price pressure on land and rent in the city, reverse migration flows have also been observed by study respondents from Aden.

> *"The population is migrating from the districts of the city of Aden to the suburbs of Aden due to the increase in temperature, congestion within the city, lower land prices outside the city, and the search for livelihood and jobs and water availability in those areas. For instance, many people have moved from the districts of the city of Aden to areas such as Al-Mamdara, Bir Ahmed, and Bir Nasir, which are closer to Lahj Governorate. Others are forced to migrate due to floods."*
>
> A community leader and agricultural researcher.

5. RESOURCES AND VULNERABILITIES

This section examines the interplay of migration, environmental degradation, and climate change vulnerabilities. It presents resources identified by key informants and focus group participants that address these vulnerabilities alongside sources of resilience as discussed in interviews and focus groups.

5.1. Gender implications

Climate-related vulnerabilities escalate protection risks, early marriages, and gender-based violence, disproportionately affecting vulnerable groups like women, IDPs, refugees and children. Women are more likely to experience poverty in Yemen, and among displaced populations, 73 per cent are women and girls due to the compounded effects of conflict, poverty, and traditional gender roles that limit their mobility and access to resources (UNY, 2022). Displaced and refugee women and girls are especially at risk of violence and human trafficking, facing numerous obstacles in accessing justice and legal assistance (FAO et al., 2021; IHD, 2023; IOM, 2022; OCHA, 2022). Moreover, restrictions on their rights, such as male guardian requirements in Ansar Allah-controlled areas, compound existing structural inequalities (IAHE, 2022).

The majority of key informant interviews and one out focus group discussions addressed the differentiated way in which climate change and environmental degradation affect women and men. Respondents confirmed the increased risk of gender-based violence under conditions of acute economic insecurity shaped by climate change and disasters. Notably, Seiyun city suffers from the highest rates of gender-based violence in the country. Additionally, they reported that household and care responsibilities become more challenging under conditions of resource depletion and various forms of insecurity.

Traditional roles intensify women's burdens in securing water and maintaining household stability. Additionally, climate change and conflict amplify gender-based risks related to water scarcity and its weaponization, exposing women to threats such as landmines and the need to travel longer distances to collect water. The scarcity of resources like firewood or fodder, which women traditionally collect, further limits their ability to provide for their families and maintain their roles within their communities. Moreover, women's lack of significant participation in environmental decision-making means that their specific needs and perspectives are often overlooked in community responses to climate change.

The intersection of gender challenges with migration and displacement reveals deeper layers of vulnerability, according to study respondents. As families relocate due to environmental degradation or disasters, women face increased risks of insecurity and exploitation. The disruption of social networks and the loss of community support systems disproportionately affect women, who rely heavily on these networks for assistance in child-rearing and managing household crises. There remains a lack of targeted support for women in displacement settings, coupled with their increased exposure to harsh living conditions.

Displaced and refugee women face protection challenges and violence, worsened by restrictive social norms. A female focus group respondent in Seiyun described how she could not ensure her children's education access due to issues with their identification documents. Similarly, another internally displaced woman living in Seiyun explained how many of her family's personal documents were lost during their displacement, making it difficult for them to access education, jobs and basic services.

Furthermore, displacement often forces women into more public roles, which can be a double-edged sword. On one hand, it increases their agency; on the other, it can expose them to new forms of discrimination and violence. One representative from a women's advocacy CSO stated, *"There's been a shift in mindset. Previously, women weren't allowed to leave their homes, but now they're encouraged to study and participate in decision-making processes, reflecting a growing awareness and education in the community."* This mindset, however, is somewhat contingent on the cultural mores of the specific area within the country. In some areas of Yemen, it remains the case that educational and employment opportunities for women are severely limited by societal norms that restrict their interactions and roles, reinforcing gender disparities.

Health-care concerns featured prominently among participant responses. For example, women are often more susceptible to the deleterious effects of displacement and environmental hardships – especially when pregnant – leading to higher risks of miscarriage and other health issues. Internal migration, displacement, and livelihood challenges associated with climate change can also make it harder for women to access vital medical care and personal hygiene products.

> *"Women are more vulnerable to these threats, especially when pregnant. They may experience miscarriages out of place (while migrating), and children may suffer from diseases due to nutritional deficiencies. We hope to pay attention to the women's side in such challenges to try to alleviate the suffering they may face."*
>
> A former official from the Local Water and Sanitation Authority.

Once settled in new locations, additional health challenges emerge. The desk review conducted for this study found that health problems related to climate change, water contamination, food insecurity, and garbage accumulation disproportionately affect women (DCAF, 2022). For example, rising temperatures can lead to shorter gestation periods, pregnancy complications, and stillbirths, further endangering women and children in arid regions (Mustun, 2022). Study respondents nuanced how these differential effects are experienced. As one female focus group participant in the IDP community of Al-Hamrah Village shared:

> We lack a nearby health facility, and it is difficult to reach the nearest one, especially in the case of childbirth or emergency cases. The nearest hospital to the camp is in Al Hawtah, and getting to the hospital requires a motorcycle, which costs money to transport the patient. Additionally, we do not have the ability to buy all the medicines that we need, especially because the hospital does not provide them for free.

At the same time, the desk review for this study found that women have played pivotal roles as first responders and informal peacemakers by mediating disputes, facilitating the release of detainees, negotiating access to natural resources, and preventing the recruitment of children into armed groups in Yemen. Despite being excluded from formal negotiations, women, often leveraging Yemeni tribal principles, navigate their position as "du'afa" to engage in mediation efforts and frequently achieve success.[9] This includes addressing issues such as the limited water supply in conflict-ridden Ta'iz, where a female mediator, Ola Al-Aghbari, brought together a committee of local leaders to negotiate civilian access to water tanks, showcasing the crucial role women play in conflict resolution and resource access in Yemen (UN Women, 2022). According to a former Local Water and Sanitation Authority official in Aden, some efforts have been made to engage youth and women through civil society organizations and volunteer initiatives to address the intersecting challenges of displacement and climate change. Resources are limited, but local authorities are still working to achieve greater inclusion of women and youth in conflict resolution and decision-making roles. Nevertheless, key informants interviewed for this study largely emphasized that women are currently only minimally included in and participating in formal climate change initiatives and stressed the need for greater involvement in decision-making.

5.2. Life-cycle implications

Among focus groups, half spoke to the specific challenges that children, youth, and the elderly face vis-à-vis this study's core themes. In most instances, key informants also raised the issue of life cycle implications, highlighting the importance of youth in reducing vulnerability and increasing resilience.

Study participants reported that migration and displacement compound the life cycle challenges faced by children and aging populations. Displaced families often find themselves in environments that are not conducive to the needs of different age groups, such as inadequate shelter that exposes them to the elements and overcrowded living conditions that lead to social tensions and increased transmission of diseases. The lack of stable employment opportunities for adults in these new settings leads to prolonged dependency on aid, which may not adequately meet the needs of all family members, particularly the young and the elderly. Additionally, the continuous relocation cycle due to environmental degradation or further displacement disrupts community ties and support systems, crucial for managing the complex needs of various life stages within these vulnerable groups.

5.2.1. Children

In Yemen, environmental degradation and climate change have significantly impacted children, leading to high rates of malnutrition due to water contamination and lack of clean food and water. These environmental factors, compounded by the ongoing conflict, have disrupted the education system, with thousands of schools damaged or destroyed, leading to irregular attendance and insufficient resources. The conflict also exposes children to severe risks, including recruitment into armed groups, early marriages, and exploitation (including trafficking and labour), while IDP and disabled children face additional barriers to accessing education, resulting in limited employment skills and poor labour market opportunities. These intertwined crises of environment, conflict and socioeconomic conditions perpetuate a cycle of vulnerability and instability for Yemen's youth (IAHE, 2022; UNY, 2022; WFP, 2022).

[9] In Yemen, "du'afa" denotes marginalized and disadvantaged individuals, encompassing widows, orphans, and people with disabilities, who encounter difficulties such as poverty and social exclusion (Mugahed, 2023; UN Women, 2022).

Respondents in this study noted that children face educational disruptions due to a lack of proper identification and access to schooling facilities while also struggling with issues related to inadequate living conditions that affect their health, such as skin rashes and malnutrition. These conditions are frequently increasing due to decreased agricultural productivity linked to climate change. A lack of official identification documents impedes resource access, including education and health care.

> *Children suffer from the effects of severe heat, vomiting blood and losing their lives due to their families' inability to afford treatment costs. Additionally, many children suffer from chronic diseases like diabetes, hypertension, asthma and blood disorders, which are common among displaced families.*
>
> An official from the Executive Unit for IDPs in Seiyun.

Three male focus group participants in an IDP encampment in Al-Hamrah Village noted particular challenges with bedding and blankets for children. The cold desert nights became difficult when clothes, blankets and sleeping mats that had been soiled due to children's involuntary urination were difficult to clean or replace.

5.2.2. Aging populations

In 2023, among the 7.5 million people in Yemen needing shelter and non-food item assistance due to the adverse health impacts of climate change, 0.6 million comprise aging populations, with the greatest needs in Al Hodeidah, Ta'iz, and Ma'rib governorates (OCHA, 2022). Additionally, the elderly are often less mobile, which makes migration journeys even more challenging and puts them at an increased risk of personal harm when faced with floods or other sudden-onset events. The elderly, among other vulnerable groups, stand particularly susceptible to the adverse health consequences associated with climate change (Price, 2022).

Key informants and focus group participants nuanced the ways in which aging populations are vulnerable to health issues exacerbated by extreme weather conditions, necessitating frequent medical visits and further straining limited financial resources. Furthermore, they suffer from conditions like high blood pressure, which are made worse by heat waves and cold snaps and becoming more severe and frequent due to climate change. Their needs are exacerbated by inadequate access to medical care and basic necessities like blankets, which are essential in cold desert climates.

> *The rising temperature problem has caused high blood pressure for my sixty-year-old father. This forces me to take him to the hospital approximately two or three times a month and incur high costs for transportation and buying medicines.*
>
> Focus group participant, Community of Majhafa Villages.

Aging populations also struggle to meet the physical requirements of their environments, such as fetching water or securing warm clothing. These tasks are made more difficult by environmental degradation and the lack of community infrastructure to mitigate these challenges. These stresses burden families, who must navigate the lack of resources to manage these age-related vulnerabilities independently.

> *I have no job or work. Being elderly, I am unable to perform physical labour. I lack food with no sympathy or mercy among community members. This is the situation for all camp members.*
>
> Focus group participant, Mariamah IDP camp.

5.3. Socioeconomic precarity

Focus group respondents for this country study living in various IDP sites across Yemen noted a lack of consistency in the supply of humanitarian aid to camps, with food assistance being particularly unreliable or absent. Additionally, they emphasized issues with IDP registration, lack of access to crucial medical services and the insufficient nature of the housing.

> *Our sustenance and possessions completely depend on garbage, and we can generate income from selling plastic cans, where we get 5–6 thousand riyals, which is enough to buy children's milk and a dinner meal for the family.*
>
> Focus group participant, Deputy Camp Lead, Community in Mariamah-Algarn-Seiyun.

In the face of the extreme weather events and slow-onset processes described in this report, focus group respondents indicated that camp residents often resort to multiple coping measures. For example, they may turn to alternative cooking methods, such as using wood instead of electricity. A female respondent in Lahj described how IDPs *"make ovens from stones and mud* (clay ovens) *for cooking to minimize the sand blowing onto the food."* Many build shelters from wooden structures covered with fabric or tarpaulins to allow airflow during hot days. When those shelters are damaged by flood or other elements, they are repaired and patched with other fabrics. During cold winter nights, residents cover the shelters with fabrics or tarpaulins to partially protect themselves from the weather. Additionally, respondents emphasized using whatever materials they could find to create barriers around their tents and homes to prevent floods.

Focus group respondents living at IDP camps confirmed the presence of tensions with host communities and local landowners, emphasizing that many of them do not feel accepted by the host community and fear eviction. A male focus group participant living at a camp in the Lahj governate stated: *"The inability to buy gas makes me go to collect wood from faraway places outside the camp, which exposes me to insults and ridicule from local residents and harassment from the landowners where we camp,* [who also try] *to evict us from time to time."* The respondent described how IDPs at their camp contacted the local preacher to preach and convince the landowners to ease pressure on them and not harass them or prevent them from collecting wood. Other respondents confirmed that the daily situation in the camps is often tense, stating that *"social security is weak,there is no integration between* [IDPs] *and the host community," and that "there is no sympathy or mercy among community members."*

In Yemen, as in other comparable contexts, many IDPs live outside of camps, often renting accommodation in urban areas where large-scale displacement has led to fluctuating and increasing rental prices (IDMC, 2018). This situation burdens families with debts from rent, food and medical costs that they struggle to repay. As a result, rent payments become a major financial strain, with some families unable to meet these obligations due to limited livelihood opportunities. This often leads to eviction and increased tensions.

5.3.1. The Muhamasheen

The historically marginalized community, referred to derogatorily as "Akhdam" (servants), adopted the name "Al-Muhamasheen" (the marginalized) to reclaim their identity (Minority Rights Group, 2018). Their plight worsened with Yemen's intensified conflict, especially in cities like Aden, Ta'iz and Hodeida, where they face discrimination that blocks their access to aid and basic services and forces their youth into early marriages or armed groups. Displacement has been disproportionately difficult for this population group due to a lack of equitable access to housing, health care and employment, further deepening their difficulties in accessing housing and land rights (CIVIC, 2022; IAHE, 2020; UNHCR, 2023). The data collected for this country report did not capture Muhamasheen's differentiated experiences or sufficient experiences of persons with disabilities, representing a study limitation.

IOM is actively supporting flood response efforts in South Taiz by implementing gabions to assist internally displaced persons (IDPs). In this collaborative effort, team members work together to enhance shelter conditions while also providing cash-for-work opportunities, delivering essential relief and support to affected communities. © IOM 2024/Majed MOHAMMED

6. RECOMMENDATIONS

The accompanying desk review for this country study outlines the currently existing policy frameworks in Yemen to support mitigating the negative effects of climate change (McFee, 2023). Based on this study's findings, this section provides concrete, actionable, and measurable recommendations for programmes designers and policymakers.

1. **Integrate climate resilience and migration policy.** Adopting a holistic approach that addresses the interconnections between climate change, environmental degradation and human mobility in Yemen is recommended. Key focus domains should include resilient infrastructure and sustainable agricultural practices to mitigate the impacts of extreme weather events and slow-onset environmental changes. Policies should support the transition of communities in high-risk areas to more sustainable livelihoods, reducing dependency on practices that exacerbate environmental degradation and contribute to water scarcity. Develop and implement integrated resource management plans considering the compounded effects of climate change, migration and conflict, focusing on sustainable agriculture, water resource management and alternative livelihoods. It is further recommended that environmental migration considerations be integrated into national and subnational planning frameworks to provide better support and protection for displaced populations, ensuring their access to essential services and opportunities for sustainable integration into host communities or return to their origin communities.

   Potential indicators: Reduction in water scarcity metrics; increase in resilient infrastructure projects; and increased social and economic stability of environmental migrant and displaced populations.

2. **Strengthen, support and extend multi-institutional, multi-hazard early warning systems and disaster preparedness, response and recovery.** It is recommended that capacity-building be supported to enhance coordination between governmental agencies, local communities and international organizations at the national, governorate and community levels. This can take the form of investing in partnerships with organizations and academics with advanced meteorological technologies for accurate forecasting and real-time hazard monitoring. Additionally, participatory community-based training programmes should be established to improve local capacities in emergency preparedness and response (e.g. basic first aid, evacuation procedures, prepositioning of materials, capacity-building and post-disaster recovery planning). Engage multi-lingual and multiple communication channels, including mobile technology, radio broadcasts and community loudspeakers, will ensure that all segments of the population, particularly the most vulnerable, receive timely and understandable alerts. It is also recommended that these systems be integrated into development plans to institutionalize the frameworks.

   Potential indicators: Reduced response time; increased community resilience and preparedness; and increased coverage and reach of multi-hazard early warning systems.

3. **Leverage the Humanitarian–Development–Peace Nexus (HDPN) approach to improve cross-sector and multi-actor coordination, collaboration and concertation.** The increasing effects of climate change on vulnerable populations in Yemen necessitate more concerted and synergized efforts among humanitarian, peacebuilding and development (climate adaptation) actors. Current fragmented and siloed approaches are creating significant gaps in assistance and support, exacerbating the adverse impacts of climate change. Implementing the HDPN approach can address these gaps by fostering collaborative and integrated interventions. This will enhance resilience, ensure more effective resource allocation, and better support the needs of vulnerable communities facing complex and interlinked challenges of climate change, conflict and socioeconomic instability.

   Potential indicators: Reduced climate-induced displacement; improved interorganizational coordination capabilities; and enhanced sense of collective efficacy among institutional and organizational actors

4. **Identify and strengthen local conflict resolution mechanisms, especially concerning land and water access tensions.** To effectively address the escalating tensions around land and water access in Yemen, it is recommended that local conflict resolution mechanisms be identified and strengthened by leveraging community-based approaches and integrating traditional mediation practices with other conflict resolution strategies. Focus on establishing transparent and inclusive platforms that involve all relevant stakeholders, including local leaders, marginalized groups, and women and youth, to foster dialogue and cooperation. Training programmes – adjusted for population learning needs and aligned with cultural norms – can enhance the capacity of local mediators and community leaders, equipping them with the skills necessary to facilitate negotiations and resolve disputes effectively. Additionally, integrating technological tools, such as GIS for land mapping and mobile applications for real-time conflict monitoring, can provide accurate data and enhance the effectiveness of these mechanisms.

   Potential indicators: Number and diversity of stakeholders involved in conflict resolution platforms; resolution rate of land and water disputes; adoption and utilization of relevant, adequate and accessible technological tools.

5. **Leverage participatory environmental peacebuilding approaches to increase the role of women and youth in community resource management.** This approach should focus on establishing platforms for engagement and decision-making that include diverse community stakeholders, especially in regions and communities facing acute resource scarcity. Initiatives should involve training women and youth in leadership and conflict resolution skills tailored to environmental management, such as water and land use. These educational and capability-building spaces should include all community leaders and powerholders to engage them meaningfully, generate buy-in and mitigate the risk of spoilers undermining sustainability. Participatory engagement should be used to ensure that processes, practices, and outcomes are contextually relevant and feasible and do not contribute to catalysing unintended new conflicts. While this can be an opportunity to facilitate the integration of host and migrant or displaced communities, such approaches should be highly participatory from the outset.

   Potential indicators: Number of women and youth involved in training and resource governance activities; inclusiveness of participatory community engagement and conflict resolution activities; sustainability assessment.

6. **Conduct a feasibility study for restoring the Tawila Cisterns in Aden and resettling the populations inhabiting the canals.** A feasibility study (or access existing ones) is recommended to be conducted on restoring the Tawila Cisterns in Aden to confirm that they would mitigate the risks of flood damage and water scarcity in the city. This would constitute a multi-organizational undertaking, likely a cooperation between UN-Habitat, UNHCR, OCHA and IOM, along with local government officials and implicated ministries. Currently, the estimated cost for the infrastructural restoration is USD 600,000 (Reuters, 2022). Relocating the informal settlements occupying the cisterns and removing trash may require significant additional costs and considerations for modernization. Nevertheless, with existing and potentially usable infrastructure in the city, it is recommended that the possibilities and limits of its use be better understood to alleviate multiple hazards.

   Potential indicators: Cost-benefit analysis outcomes; technical assessment of infrastructure validity; social, environmental and stakeholder impact mapping.

7. **Develop and scale a qat crop substitution programme by implementing a comprehensive strategy that combines agricultural innovation with community engagement and sustainable resource management.** This strategy can focus on introducing and promoting the cultivation of drought-resistant crops that require less water than qat, such as millet or sorghum, to address water scarcity, food insecurity and economic sustainability. It is also recommended that extensive training for farmers on sustainable agricultural practices and efficient water use be included, helping to shift agricultural reliance away from qat and improving overall resource management capabilities. Additionally, community workshops and educational campaigns should be developed to raise awareness about the benefits of crop diversification and the environmental impacts of qat cultivation. By involving local stakeholders, including historically marginalized populations, in the decision-making and implementation processes, it will be possible to foster community support and ensure that the initiative meets the needs of the communities – for example, ensuring that the substituted crop will approximate qat profitability for farmers and providing subsequent generations of seeds if needed. Finally, leveraging partnerships with local and international organizations can provide the necessary resources and expertise to ensure the programmes' success and sustainability.

   Potential indicators: Reduction in hectares dedicated to qat production; adoption rate (over time) of alternative crops; community engagement and economic impact assessment.

8. **Prioritize relocation of populations in known flood plains to less hazard-prone areas or build necessary infrastructures to redirect and retain flood waters.** Based on the study findings, it is recommended to prioritize the resettlement of populations residing in known flood plains to areas less prone to hazards – i.e. reduce multiple displacements. This strategy could incorporate comprehensive risk assessments to identify safer locations and develop well-planned relocation schemes, including necessary infrastructure and services to support relocated communities. Services are recommended to include reasonable access to water, health care – including neonatal and reproductive health care for women – education, and official documents and identifications for all beneficiaries. Implementing this recommendation would require coordinated efforts between government authorities, local communities, and international agencies to ensure that the resettlement is safe and socioeconomically viable. The preliminary analysis would benefit from including conflict assessments (both war and intergroup tensions) and developing a comprehensive understanding of populations' cultural and other forms of attachments to their existing land. Site selection, mobility processes

and requirements should be conducted in close consultation with community members, private landholders, and other implicated stakeholders beyond coordinating institutions and organizations. Additionally, the process is recommended to involve continuous monitoring and evaluation to address any emerging challenges and ensure that the relocation leads to improved living conditions and reduced vulnerability to disasters.

Potential indicators: Reduction in multiple displacements; access to essential services; community satisfaction.

9. **Develop environmental education and awareness programmes tailored to the practices of different population groups.** Develop and integrate comprehensive environmental education into school curricula at all levels, from primary to tertiary education. Include practical lessons on climate change and sustainable resource management. Establish a community workshop series and training sessions on sustainable practices, emergency preparedness and climate resilience. Tailor sessions to the unique needs and roles of men, women, youth, aging populations, people with disabilities, farmers on sustainable agricultural practices, and urban residents on waste management and energy conservation. Launch widespread media campaigns utilizing television, radio, and social media to raise awareness about environmental issues and actions individuals can take to mitigate their impact. Highlight local success stories of adaptation and mitigation. Establish a framework for monitoring and evaluating the effectiveness of these environmental education programmes, including participant feedback mechanisms and an assessment of changes in community behaviour and engagement over time. Develop resources in a participatory fashion with communities, including guides, toolkits and digital content, that educators and community leaders can use to effectively teach environmental concepts and practices.

   Potential indicators: Curriculum adoption and participation rates; number of community workshops and training (including learning outcomes evaluations); and media campaign effectiveness (as measured by behavioural changes).

10. **Conduct further research on the impacts of climate change on all groups of migrants within Yemen.** Given Yemen's role as a significant transit hub for migrants heading to Gulf countries, it is crucial to conduct further research on the impacts of climate change on these individuals, as existing data on the complexity of these impacts remains limited. There is evidence that many migrants were affected by climate change in their home countries before transiting through Yemen. Comprehensive data and evidence could inform necessary subregional collaboration to address the adaptation needs in countries of origin and Yemen. This would enhance the effectiveness of interventions aimed at supporting migrants and reducing vulnerabilities exacerbated by climate change.

    Potential indicators: Number of climate change impact studies conducted; representativeness of study participants when compared to migrant populations; instances of integration of study findings into programme and policy design.

Yemen faces a complex array of environmental, climatic, and human mobility challenges, deeply intertwined with its complex political and socioeconomic landscape. Climate change and environmental degradation pose acute challenges, including flooding, water scarcity and dangerously high temperatures, amplifying existing vulnerabilities. More is needed to support resilience and capabilities building and facilitating sustainable adaptation strategies in response to these environmental challenges, alongside the pressures from internal displacement and the influx of refugees and migrants from neighbouring regions. Furthermore, Yemen's national services are under considerable strain. The analysis presented here supports the need for robust, data-driven policies and initiatives to address these interlinked challenges comprehensively and consultatively. This research enhances our understanding of the multifaceted drivers of human mobility in Yemen and underscores the urgent need for holistic policy solutions that address the impacts of climate change and support sustainable, orderly and humane migration.

> *If there is no effective and serious movement regarding mitigating climate changes, the situation in the region – and especially in Yemen – will be significantly affected. I believe the outlook will be difficult because 'natural disasters' are usually harsher than wars. The effects will be stronger if communities do not have high resilience and early preparedness. If we prepare and ready ourselves for the future, we will be able to face any future shocks and prepare accordingly, making the future better – God willing.*
>
> A representative from the Martyr Bin Habrish Foundation for Development (BHF).

Noha Alban, a leader in Lahj, explains how drought has crippled agriculture in her community. © IOM 2022/Majed MOHAMMED

APPENDIX

Methodology

Focus Group Discussions (FGDs)

Ten Focus Group Discussions (FGDs) were conducted to explore the approaches and challenges related to adaptation and resilience in the face of the MECC nexus dynamics. The purpose of the FGDs was to better understand how groups of individuals in the same geographic community organize, prioritize, evaluate and debate factors related to mobility decisions at the collective level in the face of challenges related to climate change, the environment and conflict. The data were analysed alongside the Key Informant Interviews (KIIs) to better understand how environmental changes impact collective and individual decisions to migrate.

Each FGD had 6–11 participants who ideally did not know each other to encourage open and honest discussion. The FGDs were conducted in a comfortable and non-judgmental setting to create a safe space for participants to share their thoughts and experiences. The facilitator served as the conversation moderator, ensuring that all participants had the opportunity to speak and that discussions remained respectful and focused on ideas rather than individuals.

Transcripts from the FGDs were typed, translated and analysed using MAXQDA qualitative coding software. Every effort was made to record participants' responses in their own words. Interpretive categories and labels were avoided whenever possible to ensure the accuracy and authenticity of the responses. The facilitators were trained to encourage participants to speak for themselves and to resist the temptation to synthesize responses in their own words.

The FGDs were facilitated according to best practices in qualitative research methodologies. The focus was on creating a comfortable and nonjudgmental setting, encouraging open and honest discussion and ensuring that all participants had the opportunity to speak. The facilitators also reminded participants that disagreements were acceptable and that the purpose of the discussion was to gather diverse perspectives.

Discussions were organized around prompts and questions that included elements of all three major project themes: migration, environment and climate change. Participants were asked to share narratives and examples of their migration experience, catalysts for migration, challenges faced along the way and sources and forms of support for migrants in Yemen. Ten total FGDs took place, and the breakdown by gender and location can be found in Table 2. Thirty per cent (3) of the focus groups were all-male, 30 per cent (3) were all-female, and 40 per cent (4) were mixed gender. Fifty three per cent of the total focus group participants were male, 47 per cent were female.

Table 2. Breakdown of focus group participants by gender

Gender	Male	Female	N = Total count
Ma'rib	19	19	38
Aden/Lahj	9	5	14
Hadramawt/Seiyun	9	9	18
N = Total participants	37	33	70

Key Informant Interviews (KII)

To supplement the data gathered through the focus groups discussions and extensive desk research, 30 KIIs were conducted with important stakeholders in the government, academia and civil society. The key informant interviews focused on a diverse and inclusive selection of individuals and community leaders that contend with the effects of the migration, environment and climate change domain in everyday life. Interviewees were asked to share examples of local climate adaptation initiatives, elaborate on stakeholder collaborations, discuss the impact of environmental changes on the livelihoods of communities in Yemen, and explain how the effects of climate change in Yemen interact with pre-existing vulnerabilities.

Table 3. Breakdown of key informants by sector

Sector	Academic/ research	(Local) government	Public sector	Civil society	IDP site administration
N = 30 key informants	4	3	14	5	4

Table 4. Breakdown of key informants by gender

Male	Female	Total
19	11	N = 30 key informants

REFERENCES*

Acacia Water (2021). *Water Availability in Yemen: Literature Review of the Current and Future Water Resources and Water Demand in Yemen.* Acacia Water, Gouda.

ACAPS (2020). Yemen: Heavy Rainfall and Flash Floods. ACAPS Analysis Hub.

ACAPS (2023). *Yemen: Challenges to Housing, Land and Property Rights*. ACAPS Analysis Hub.

Aklan, M. (2023). *Extreme Weather and the Role of Early Warning Systems in Yemen: Al-Mahra as a Case Study*. Policy Brief. Sana'a Center for Strategic Studies. Aden.

Al-Aizari, A.R., Y.A. Al-Masnay, A. Aydda, J. Zhang, K. Ullah, A.R.M.T. Islam, T. Habib, D.U. Kaku, J.C. Nizeyimana, B. Al-Shaibah, Y.M. Khalil, W.M.M. AL-Hameedi and X. Liu (2022). Assessment analysis of flood susceptibility in tropical desert area: A case study of Yemen. *Remote Sensing*, 14(16): Article 16.

Al-Akel, A.S. (2020). Short and Long-Term Impacts of Climate Change on Population Health in Yemen. *Journal of Environment and Earth Science*, 10(11):70.

Al-Akwa, K. and T. Zumbragel (2021). *The Disaster of Yemen's Flash Floods: Impact of and Local Responses to the Torrential Rains and Flooding in 2020*. Brief 21, Sustainability Series, 17. Center for Applied Resaerch in Partnership with the Orient (CARPO).

Al-Awsat, A. (2022). Study: Desertification to reach 86% in Yemen due to climate change. News. Asharq Al-Awsat. 11 December.

Al-Dailami, A., I. Ahmad, H. Kamyab, N. Abdullah, I. Koji, V. Ashokkumar and B. Zabara (2022). Sustainable solid waste management in Yemen: Environmental, social aspects, and challenges. Biomass Conversion and Biorefinery.

Al-Mahfadi, A.S. and M. Dakki (2019). Vulnerability of Al-hodidah wetlands in Yemen: Main socio-economic causes. *Materials Today: Proceedings*, 13:515–524.

Al-Maqtari, M. (2012). Sandstorm hits Yemen, triggers panic among residents. *Yemen Times*.

Al-Qadhi, B. (2024). Aden Faces High Climate Risks, Study Warns International Study: Climate Threatens to Deplete Water in Tuban Delta. Humanitarian Journalism Foundation. 7 September.

Al-Saafani, M., H.M. Nagi, A. Alhababy, M.M. Abubakr and A. Hajer (2015). Impact of sea-level rise and climate change on the coastal zone of Aden governorate – Republic of Yemen. *Faculty of Science Bulletin*, 27:15–32.

Al-Wesabi, I., F. Zhijian, C.P. Bosah and H. Dong (2022). A review of Yemen's current energy situation, challenges, strategies, and prospects for using renewable energy systems. *Environmental Science and Pollution Research*, 29(36):53907–53933.

Aljazeera (2015). Deadly cyclone triggers heavy flooding in Yemen. *Al Jazeera*. 12 August.

Aljazeera (2021). With fuel scarce, Yemen's forests are the next casualty of war. *Al Jazeera*. 3 November.

Almahdi, H. (2022). The Yemeni diaspora: An analysis of its history, development, and nature. *Commonspace.Eu*. 26 November.

* All hyperlinks were working at the time of writing this report.

Bahakim, A. (2022). Climate change impacts and vulnerabilities in Yemen. News. South24.

Berghof Foundation (2024). Local governance in Yemen: Resource hub. Local Governance in Yemen: Resource Hub. Berlin.

Bin Wabar, M. (2023). Migration from the Horn of Africa to Yemen: Not just a passing phenomenon. The Washington Institute for Near East Policy. Washington, D.C.

Broussard, E. (2020). Nuclear techniques support crop production on salt-affected soils in Middle East. International Atomic Energy Agency (IAEA). 14 May.

BTI (2024). *BTI 2024 Yemen country report*. BTI Transformation Index.

Camacho, A., M. Bouhenia, R. Alyusfi, A. Alkohlani, M.A.M. Naji, X. de Radiguès, A.M. Abubakar, A. Almoalmi, C. Seguin, M.J. Sagrado, M. Poncin, M. McRae, M. Musoke, A. Rakesh, K. Porten, C. Haskew, K.E. Atkins, R.M. Eggo, A.S. Azman, … F.J. Luquero (2018). Cholera epidemic in Yemen, 2016-18: An analysis of surveillance data. Cholera epidemic in Yemen, 2016–18: An analysis of surveillance datah. *The Lancet. Global Health*, 6(6):e680–e690, June.

Carmeuse (2019). *Safety Data Sheet: Quicklime*. July 11.

Center for Civilians in Conflict (CIVIC) (2022). *Risking the Future: Climate Change, Environmental Destruction, and Conflict in Yemen*. Center for Civilians in Conflict. Washington D.C.

Conflict and Environment Observatory (CEOBS) (2021). Groundwater depletion clouds Yemen's solar energy revolution. Conflict and Environment Observatory. April.

Chambers, R. and G.R. Conway (1991). *Sustainable rural livelihoods: Practical concepts for the 21st century*. Discussion paper 296.

CIA (2023). The World Factbook: Yemen. In The World Factbook, 18. Central Intelligence Agency.

Cox, C., L. Jin, G. Ganjegunte, D. Borrok, V. Lougheed and L. Ma (2018). Soil Quality Changes Due to Flood Irrigation in Agricultural Fields along the Rio Grande in Western Texas. *Applied Geochemistry*, 90:87–100. March.

DCAF (2022). Gender, Climate and Security in Yemen: The Linkages and Ways Forward. DCAF – Geneva Centre for Security Sector Governance. Geneva.

de León-Lorenzana, A.S., L. Delgado-Balbuena, C. Domínguez-Mendoza, Y.E. Navarro-Noya, M. Luna-Guido and L. Dendooven, L. (2017). Reducing Salinity by Flooding an Extremely Alkaline and Saline Soil Changes the Bacterial Community but Its Effect on the Archaeal Community Is Limited. *Frontiers in Microbiology*, 8:466. March.

Food and Agriculture Organization of the United Nations (FAO) (2023a). AQUASTAT – FAO's Global Information System on Water and Agriculture. Data set (accessed June 2024).

FAO (2023b). Being the change in Yemen: Improving integrated water resources management for food security. Blog post. United Nations Yemen. 23 March.

FAO (2024). Early warning: Increased risk of flooding in low-lying areas (Food Security and Nutrition Information System Project (FSNIS)). Agrometeorological Early Warning Bulletin.

Food and Agriculture Organization of the United Nations (FAO), United Nations Development Programme (UNDP) and World Food Programme (WFP) (2021). *Yemen Food Security Response and Resilience Project (FSRRP, P176129)*. FAO, UNDP, WFP and ICRC.

Food Security Information Network (FSIN) (2022). Global report on food crises: Acute food insecurity hits new highs. 4 May.

FloodList (2023). Yemen – FloodList. Database.

Gadain, H. (2023). Being the change in Yemen: Improving integrated water resources management for food security. FAO Country Profiles. 22 March.

Gadain, H. and B. Libanda (2023). *Agricultural Water Deficit Trends in Yemen*. *Atmosphere*, 14(8), Article 8. 9 August.

Government of Yemen (2000). *Yemen's Strategic Vision 2025*. January.

Government of Yemen (2013). *Second National Communication under the United Nations Framework Convention on Climate Change*. Environmental Protection Authority. Sana'a.

Global Shelter Cluster (GSC) (2022). Yemen: Local building cultures for sustainable and resilient habitats. Detailed shelter response profile.

International Atomic Energy Agency (IAEA) (2018). Challenges and Opportunities for Crop Production in Dry and Saline Environments in ARASIA Member States (IAEA-TECDOC-1841; IAEA TECDOC).

Inter-Agency Humanitarian Evaluation (IAHE) (2020). Yemen IAHE combined annexes. Inter-Agency Humanitarian Evaluation (IAHE) of the Yemen Crisis.

IAHE (2022). Inter-Agency Humanitarian Evaluation of the Yemen Crisis.

International Committee of the Red Cross (ICRC) (2021). Country-level | Climate fact sheet: Yemen. Country report. Red Cross Red Crescent Climate Centre.

ICRC (2022). Yemen: Conflict and climate crises push farmers to the breaking point. News release, November 16.

Internal Displacement Monitoring Centre (IDMC) (2018). *Multidimensional Impacts of Internal Displacement*. Thematic series. IDMC. Geneva.

IDMC (2023). Yemen. IDMC. Geneva.

IDMC (2024). *GRID 2024: Global Report on Internal Displacement*. IDMC. Geneva.

Integral Human Development (IHD) (2023). *Migration Profile Yemen*. Migrants and Refugees Section. April. Vatican.

International Organization for Migration (IOM) (2019). *Glossary on Migration*. International Migration Law, No. 34. Geneva.

IOM (2022). Human rights violations against migrants in Yemen increase amid soaring arrivals: IOM warns. Global news. 31 May.

IOM (2023a). IOM Yemen flow monitoring registry non-Yemeni migrant arrivals and Yemeni migrant returns to Yemen in 2022. IOM Displacement Tracking Matrix (DTM), 8 March.

IOM (2023b). Migration along the Eastern Corridor, Report 37. IOM Regional Office for the East and Horn of Africa, 31 March.

IOM (2023c). A decisive year for Yemen: IOM Appeals for USD 183 million to provide relief to over 4 million people in need. Global news. 27 February.

IOM (2024a). Yemen – Flow monitoring registry: Non-Yemeni migrant arrivals and Yemeni migrant returnees in March 2024. March.

IOM (2024b). *Yemen: Annual DTM Report on Displacement 2023*. IOM Displacement Tracking Matrix (DTM). Sana'a.

IOM (2024c). IOM calls for increased support for growing number of stranded migrants in Yemen. Global news, 6 May.

Intergovernmental Panel on Climate Change (IPCC) (2018). Glossary of Terms. Geneva.

Iraqi, A.A. and A.M. Abdallah (2022). Analysis of long-term climatic changes at Al-Hodeidah-Yemen during the period between 1985 and 2019. *Theoretical and Applied Climatology*, 150(3):1067–1081. 29 September.

Islamic Relief Worldwide (IRW) (2022). Yemen's climate crisis is threatening lives, livelihoods and culture. 25 March.

Keynoush, B. (2022,). Severe sand and dust storms are an underrated risk in the Gulf region, despite mitigation measures. Middle East Institute. 14 March.

Kuzma, S., L. Saccoccia and M. Chertock (2023). 25 countries, housing one-quarter of the population, face extremely high water stress. World Resources Institute. 6 August.

Lackner, H. and A. al-Eryani (2020). Yemen's environmental crisis Is the biggest risk for its future. The Century Foundation. 14 December.

McFee, E. (2023). *Report on Migration, Environment, and Climate Change in Yemen*. International Organization for Migration (IOM).

Minority Rights Group (2018). Muhamasheen in Yemen. Minority Rights Group. 31 January.

Mugahed, R. (2023). *Absent from the Negotiation Table and Shunned from Public Life: Yemeni Women at a Crossroads*. Sana'a Center for Strategic Studies. Aden.

Mustun, Z.K. (2022). Climate change, institutional quality and SDGs: A narrative review with a focus on Yemen. *Journal of Emerging Economies and Islamic Research*, 10(1).

NASA (2024). Sea level. NASA Global Climate Change. Data set (accessed June 2024).

NOAA (2013). Relative sea level trend 485–001 Aden, Yemen. NOAA Tides & Currents. Data set (accessed June 2024).

Noaman, A. and F.A. Al-Nozaily (2019). Yemen water report. Fanack Water country report. 10 December.

Norwegian Institute of International Affairs (NUPI) and the Stockholm International Peace Research Institute (SIPRI) (2023). Climate, Peace and Security Fact Sheet: Yemen. Norwegian Institute of International Affairs (NUPI) and the Stockholm International Peace Research Institute (SIPRI). Oslo and Solna.

Notre Dame Global Adaptation Index (ND-GAIN) (2022). Notre Dame Global Adaptation Initiative: Country Index.

Penney, V. and N. Kommenda (2023). Where heat worsens hunger. *The Washington Post*. 13 October.

Price, R. (2022). *Climate Change Risks and Opportunities in Yemen*. K4D Helpdesk Report 1168. Institute of Development Studies.

Rahman, A. (2023). Climate change is intensifying humanitarian crisis in war-affected Yemen. Peoples Dispatch. 19 June.

Reuters (2022). Yemeni city looks to ancient past to survive climate change. *PreventionWeb*. 16 March.

Sana'a (2022). Yemen needs help to avert climate-driven catastrophe. 16 December. Sana'a Center for Strategic Studies. Aden.

Saraf, S. (2021). *Preserving the Perishing Endangered Natural Biodiversity of Socotra Island*. *Open Journal of Ecology*, 11(2).

Shackleton, R.T., Maitre, D.C. L., Pasiecznik, N.M., and D.M. Richardson (2014). Prosopis: a global assessment of the biogeography, benefits, impacts and management of one of the world's worst woody invasive plant taxa. AoB Plants, 6.

Taher, T. (2016). Groundwater abstraction management in Sana'a Basin, Yemen: A local community approach. *Hydrogeology Journal*, 24(6):1593–1605.

Taylor, M. and N. Krüger (2019). Changes in Salinity of a Clay Soil After a Short-term Salt Water Flood Event. *Geoderma Regional*, 19:00239.

Thamer, M.A., A. Ali and I. Al-Aghbari (2023). Agriculture and Yemen's economy. Carnegie Endowment for International Peace. Sada. 16 May.

The New Humanitarian (2008). Invasive shrub blamed for exacerbating recent floods. Environment and Disasters, 8 December.

ThinkHazard (2023a). Think Hazard–Republic of Yemen. Coastal Flood.

ThinkHazard (2023b). Think Hazard–Republic of Yemen. Extreme Heat.

ThinkHazard (2023c). Think Hazard–Republic of Yemen. Wildfire.

UN Framework Convention on Climate Change (1992). United Nations Framework Convention on Climate Change.

UN General Assembly (2012). Follow-up to paragraph 143 on human security of the 2005 World Summit Outcome. (A/66/L.55/Rev.1). United Nations Digital Library.

UN Women (2022). How women made use of tribal norms to mediate conflict in Yemen. UN Women – Arab States. 24 October.

United Nations Convention to Combat Desertification (UNCCD) (1994).

United Nations Conference on Trade and Development (UNCTAD) (2022). *The Least Developed Countries Report 2022*. New York.

United Nations Environment Programme (UNEP) (2023). Yemen—Main Details. Convention on Biological Diversity: Country profiles. Secretariat of the Convention on Biological Diversity.

United Nations Economic and Social Council (UNESC) (1998). Report of the Representative of the Secretary-General, Mr Francis M. Deng, submitted pursuant to Commission resolution 1997/39. Addendum: Guiding Principles on Internal Displacement. 11 February.

United Nations Framework Convention on Climate Change (UNFCCC) (2011). Report of the Conference of the Parties on its sixteenth session, held in Cancun from 29 November to 10 December 2010 Addendum Part Two: Action taken by the Conference of the Parties at its sixteenth session.

United Nations High Commissioner for Refugees (UNHCR) (2022). UNHCR Yemen: 2022 strategy and action plan. Annual report. UNHCR. Geneva.

UNHCR (2023). Annual Results Report 2022: Yemen. Annual report. UNHCR. Geneva.

UNHCR (2024). Yemen. UNHCR. Geneva.

United Nations Office for the Coordination of Humanitarian Affairs (OCHA) (2022). Yemen Humanitarian Needs Overview 2023. ReliefWeb. United Nations Office for the Coordination of Humanitarian Affairs (OCHA). December.

OCHA (2023a). Yemen: Flash Update #1 – Cyclone Tej. United Nations Office for the Coordination of Humanitarian Affairs (OCHA). 24 October.

OCHA (2023b). Yemen: Situation update – Cyclone Tej. United Nations Office for the Coordination of Humanitarian Affairs (OCHA). 5 November

United Nations Office for Disaster Risk Reduction (UNISDR) (2009). Terminology on DRR. What we do, We inform, Terminology.

United Nations Yemen (UNY) (2022). *United Nations Yemen Sustainable Development Cooperation Framework 2022–2024*. United Nations.

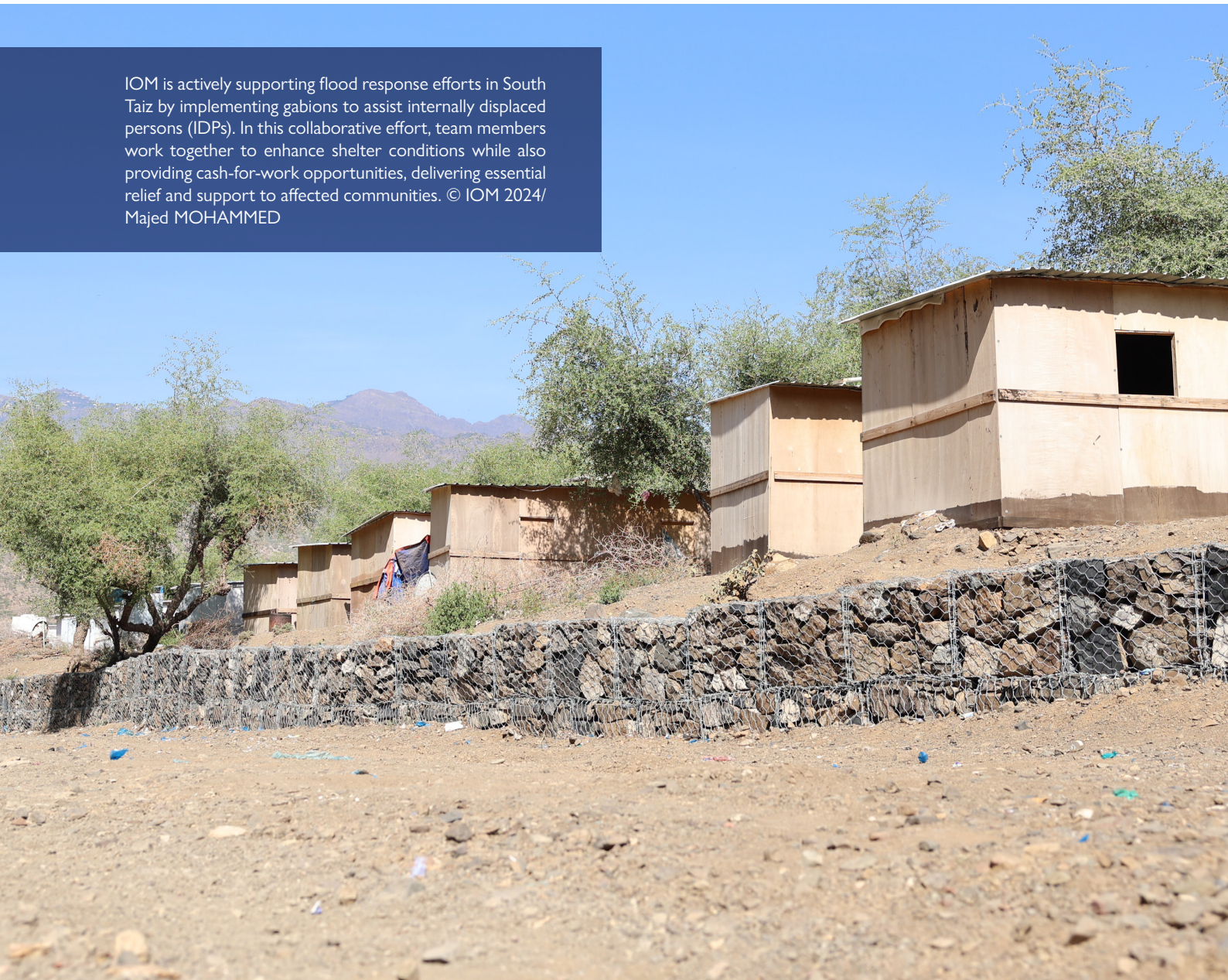
United States Agency for International Development (USAID) (2016). Climate change risk profile: Yemen.

Wang, Y., Y. Zhao, L. Yan, W. Deng, J. Zhai, M. Chen and F. Zhou (2022). Groundwater regulation for coordinated mitigation of salinization and desertification in arid areas. *Agricultural Water Management*, 271. 1 September.

World Food Programme (WFP) (2022). Yemen Annual Country Report 2022: Country Strategic Plan. Annual country report.

Zabara, B. and T. Zumbrägel (2022). The Role of the Environment in Peacebuilding in Yemen. *Sustainability Series*. Center for Applied Resaerch in Partnership with the Orient (CARPO).

Zheng, Q. and V.V. Klemas (2018). Green Tide. Comprehensive Remote Sensing.



IOM is actively supporting flood response efforts in South Taiz by implementing gabions to assist internally displaced persons (IDPs). In this collaborative effort, team members work together to enhance shelter conditions while also providing cash-for-work opportunities, delivering essential relief and support to affected communities. © IOM 2024/ Majed MOHAMMED

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