

Rising Temperatures, Falling Resources:

Climate Change Impacts on Yemen's Agrarian and Coastal Communities



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Introduction

As the world continues to grapple with the effects of climate change, Yemen finds itself in a particularly vulnerable situation. The country is already facing several challenges, including an internationalized civil war and severe economic crisis. Climate change is likely to further exacerbate existing problems, with extreme weather events such as flash floods and droughts, as well as rising sea levels, already occurring in some parts of the country. This report focuses on two districts in Yemen which have been particularly affected by climate change and are likely to suffer further consequences in the future: Hajar district in Hadhramaut governorate and Tawahi district in Aden governorate. Through a series of in-depth interviews and dialogues with local stakeholders, this report seeks to identify the direct and indirect impacts of climate change in the districts, as well as to highlight potential solutions and strategies for mitigation and adaptation.

The report's findings suggest that climate change is already having a negative impact on the research districts, with some effects including reduced water availability and quality, decreased crop yields and fish catch, and an increase in vector-borne diseases, food insecurity and unemployment. Furthermore, these effects are likely to worsen over time as the impacts of climate change become more pronounced, multiplied by a host of other factors such as poverty, conflict, and disintegration of environmental governance structures.

At the same time, despite the fact that establishing a strong link between climate change and armed conflict has been a contentious issue among scholars and policymakers for many years, the conversation has been shifting to focus on how climate change can act as a 'threat multiplier', exacerbating pre-existing tensions and making societies more vulnerable to conflict. A 2014 report by the United Nations Intergovernmental Panel on Climate Change (IPCC) captures this well, stating: "The evidence on the effect of climate change and variability on violence is contested. Although there is little agreement about direct causality, low per capita incomes, economic contraction, and inconsistent state institutions are associated with the incidence of violence."¹

In the agrarian context of Hajar district, flash floods and landslides have been a major concern, leading to the destruction of water infrastructure, farmlands, and properties. Changing weather patterns such as rising temperatures have also impacted the health and productivity of crops and livestock, with a consequent decrease in food availability and quality. For example, the recent floods in 2020 and 2021 have led to the destruction of thousands of palm trees, reducing date production by more than 60 per

¹ IPCC. (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. <https://www.ipcc.ch/report/ar5/wg2/>

cent. This has had a direct impact on the local livelihoods of people who rely heavily on agriculture and livestock herding for income. With high levels of poverty reported among the locals, the climate-related losses are further compounded by an inability to cope and adapt as well as a weak and slow government and international response. As a result, outward migration of farmers to other parts of the country has been a frequent occurrence due to a lack of robust resilience structures.

In contrast, the coastal Tawahi district is experiencing a different set of climate-related challenges driven by rising sea levels, increased salinity of drinking water, and the degradation of marine ecosystems due to the destruction of coral reefs as well as coastal erosion. The local fishing industry, which is one of the main sources of income for coastal communities, has been severely affected by the changing climate, with a reported decrease in fish catches and subsequent rise in seafood prices. Moreover, increased instances of flash floods have caused the destruction of infrastructure and properties and further displacement of local populations. Given its urban setting, the district is also faced with the increasing pressure of rapid population growth coupled with inadequate sanitation and waste management systems. Residents of unplanned houses on the mountain slopes are particularly vulnerable to water shortages and are more exposed to vector-borne diseases such as dengue fever and malaria, due to the pools of stagnant water commonly found in their areas.

Based on these findings, this report provides a series of policy recommendations that can better equip local stakeholders in both districts with the necessary tools to cope and adapt to the changing climate.

Methodology

This report utilized a participatory action research approach to understand in detail the impact of climate change on natural and human systems in Hajar district, Hadhramaut, and Tawahi district, Aden. Specifically, the research design, including the selection of targeted areas, was informed by desk research, observations by field researchers, and preliminary consultations with key informants in both governorates.

The research for this report takes an integrated approach to understand these districts' vulnerability to climate change, considering both the physical and the social aspects of vulnerability, and how this in turn might lead to social and political stresses. This means looking at the districts' exposure to hazardous events (e.g., sea level rise, coastal erosion, floods, landslides) and how this affects people and infrastructures, while also considering the social and political factors that shape people's ability to access resources and cope with and recover from these events.

To collect data, semi-structured interviews were conducted with a sample of 40 key informants, 20 in each governorate. All research participants were chosen from a pool of experts and stakeholders, including climate experts and academics, government officials, representatives from non-governmental organizations (NGOs), and members of civil society groups such as community activists. Additionally, secondary data was collected from various reliable sources, including governmental bodies and NGOs as well as reports and studies from academic institutions.

Finally, a set of recommendations to address the impacts of climate change were developed based on the findings of the research. These recommendations were developed in close consultation with local stakeholders and further informed by two community dialogues conducted in each district to ensure their effectiveness and relevance.

HAJAR DISTRICT

Located in the west of Hadhramaut governorate, Hajar district is exceptionally vulnerable to climate change impacts. With a small population of around 40,000 people² working mainly in agriculture and livestock herding, the livelihoods of residents are highly dependent on the natural environment. The district's long-standing agricultural tradition is due to the area's geological conditions, which include a year-round supply of water from the Wadi Hajar. However, the area is particularly susceptible to floods, droughts, and landslides, which have become more frequent and intense in recent years due to climate change. Without adequate infrastructure and disaster preparedness measures, the district is ill-equipped to deal with such extreme events and its residents are often left struggling to cope in the aftermath of extreme weather events. It is also important to note that climate change-related impacts are likely to interact with sources of political and socio-economic inequalities in the district.

The district lies approximately 160km to the southwest of Hadhramaut's provincial capital Mukalla. It consists of a cluster of villages built around the Wadi Hajar, a valley which flows down to discharge into the Gulf of Aden.³ Wadi Hajar is known for being one of the few exceptional wadis in Yemen that still has running water all year round. The 200km long wadi carves its way through the 32,000km² district of Hajar.⁴ This wealth of water has allowed agriculture to flourish, making it one of the most agriculturally productive districts in Hadhramaut, notably for the production of dates.

Along with the rest of Hadhramaut, Hajar district is situated in an area long known for its ancient irrigation systems that date back to the pre-Islamic era. Out of this history emerged complex water management practices and an extensive knowledge of the local water resources. This allowed Hajar's residents to develop their own traditional irrigation and water harvesting systems, some of which are still in use today. Local residents have also managed to form strong social networks and support systems, which have helped them to adapt to the unpredicted changes in their environment and build resilience in the face of shocks and stress.

From the Wadi Hajar, water is appropriated for irrigation through a complex system of channels that provide water to farmlands located on either side of the wadi. The district irrigation system also relies on rainwater harvesting, which has become

² WASH Cluster (2020) "Yemen WASH Needs Tracking System (WANTS) Hajar District, Hadramawt Governorate - December 2020" <https://reliefweb.int/report/yemen/yemen-wash-needs-tracking-system-wants-hajar-district-hadramawt-governorate-december>.

³ A wadi is usually a dry valley, except during periods of rainfall.

⁴ Salem Baras. Hajar Directorate... The Lost Jewel. Hadhramaut Center for Historical Studies, Documentation and Publishing. <https://hadramout.center/articles/7269> https://res.cloudinary.com/nhd-2019/image/upload/v1617019321/ASAS/مجلة_أساس_العدد_الأول_n2tg2p.pdf

increasingly challenging as rainfall has become more erratic in recent years due to climate change. During drought periods, water from the wadi is used to supplement household and irrigation needs. Those who have access to groundwater through wells also rely on this source during times of scarcity. Residents' relationship to water sources and irrigation practices are well ingrained in the local culture and folk wisdom. One of the interviewees quotes a saying:

إن مطرت وإلا سنيننا

(ونحن) إن مطرت وإلا بكينا،

'If it rains (good)! Else we water by well.

If it rains (good)! If not, then we weep.⁵

This saying encapsulates the importance of water in the district and how people have a long heritage of adaptation in times of scarcity.

Water management is influenced by long-standing social traditions and customary laws that promote equity and efficient use of water resources. In most areas, water is managed by khiyyls, local water managers appointed by farmers with substantial landholdings. The khiyyl ensures that water is distributed fairly among the farmers in his area, based on traditional norms of equity. Sometimes, the khiyyls head water users' associations, known as lijan, whose members are also elected by landholders.⁶

Yet, despite the district's long history of water management, the current water situation in Hajar district is far from ideal. Water availability is not the issue, but rather access to water has become increasingly difficult and unreliable, affecting agricultural production, livestock herding, and domestic water needs, among others. This is due to a number of factors, chief among them being climate change, which has led to more erratic rainfall, increase in temperatures, more frequent and intense flash floods, and longer periods of drought. The problem is compounded by the lack of proper infrastructure to transport water from source to farms and households. There is also a lack of proper storage facilities, such as dams and reservoirs, to store water for use during the drier seasons. This has led to a decline in agricultural production and an increase in water scarcity, as well as a whole host of other problems discussed below.

⁵ Serjeant, R. (1964). Some Irrigation Systems in Hadramawt. *Bulletin of the School of Oriental and African Studies*, 27(1), 33-76. doi:10.1017/S0041977X0010028X.

⁶ Harrower, M. (2016). Water histories of Southwest Arabian kingdoms (and the American West). In *Water Histories and Spatial Archaeology: Ancient Yemen and the American West* (pp. 112-152). Cambridge: Cambridge University Press. doi:10.1017/CBO9781316471142.005.

The Impacts of Climate Change on Hajar

The effects of climate change are already being felt in Hajar district. The district is exposed to a range of natural hazards, including floods, landslides, and droughts. These hazards are expected to become more frequent and intense in the future as a result of climate change. In particular, rising temperatures and changes in precipitation patterns are likely to cause more of these extreme weather events.

Interviewees stated that they have already seen an increase in temperatures during recent years, with some parts of the district reaching above 40°C during summer months. These levels are unusual in an area with an average temperature of 25-30°C during the summer months (April-October).⁷ They also reported that the rains have become more erratic, with longer dry periods followed by heavy downpours.

Hajar district is particularly vulnerable to flash floods due to its location in a valley between mountain ranges. When it rains heavily, the water runs down from the mountains and into the valley, causing the Wadi Hajar to overflow its banks. This has led to several flash floods, which have increased in frequency and intensity over the past decades, culminating in the major floods of 2008 and 2020. These flash floods are known for being dangerous because they combine the destructive power of a flood with incredible speed and unpredictability.⁸

In October 2008, a major tropical storm caused disastrous flooding in Yemen, with an estimated total damage cost reaching \$1.6 billion. Hadhramaut governorate incurred most of the damages, estimated at around 70 per cent of the country's total damages.⁹ These included the loss and destruction of human and animal lives, the destruction of critical infrastructure (transport, power, water and sanitation, and telecommunications), and the decline in agriculture and livestock productivity. Similar impacts occurred during the June 2020 flooding, damaging dozens of houses and farms and washing away hundreds of palm trees. One official noted that the floods resulted in the displacement of 450 families from Mayfa village in Hajar district alone.¹⁰

These flash floods can be especially damaging to the district's water and irrigation systems. Interviewees describe how the floods have damaged irrigation canals, water pipelines, and other water infrastructure, including water barriers in Haseen and Jazol

⁷ Balatif, N., 'Date Palms in Hajar Valley, Hadhramaut,' *Asas*, 2021. https://res.cloudinary.com/nhd-2019/image/upload/v1617019321/ASAS/مجلة_أساس_العدد_الأول_n2tg2p.pdf.

⁸ ShelterBox. DISASTERS EXPLAINED: FLOODS. <https://shelterbox.org/disasters-explained/floods/>.

⁹ Global Facility for Disaster Risk Reduction (August 2014), "Tropical Storm, October 2008: Recovery Framework Case Study." <https://www.gfdr.org/sites/default/files/publication/rfcs-2014-yemen.pdf>.

¹⁰ Batati, S., "Flash floods in southern Yemen kill five, displace hundreds," *Arab News*, 2020. <https://www.arabnews.com/node/1685061/middle-east>.

areas.¹¹ This damage has not only destroyed crops and caused financial losses for farmers, but it has also made it more difficult for them to access water for irrigation. Often, the repairs necessary to restore the infrastructure can be too costly for farmers, leading to prolonged periods of water scarcity that can be damaging to the soil.

As flash floods disrupt the irrigation systems in the district, rainwater harvesting has become an increasingly important water-management strategy for farmers and households. Rainwater harvesting in Hajar involves either collecting the runoff from the roof of a house and storing it in a large tank or container, or digging a pit, enclosed or semi-enclosed by walls of cement blocks or concrete brick to minimize runoff, on the land to collect water. Depending on the amount of rainfall and the size of the tank, one such system can provide households with up to six months of water mainly for drinking.¹² Yet, this practice too has been made more difficult by climate change. Interviews reveal that the rains have become less predictable while periods of drought have become longer and more common, making it difficult to store enough rainwater to last through the dry season. As a result, large swaths of farmland, especially those that mainly rely on rain-fed agriculture, have become unusable.

Even groundwater has become increasingly inaccessible due to extreme weather events. In particular, the water table has been declining due to the prolonged periods of drought, requiring farmers to drill deeper wells to access water. This has led to an increase in the cost of irrigation, further exacerbating the financial burden on farmers. Furthermore, interviewees report that recent flash floods in the district have not only damaged the pumps and wells used to access groundwater but also contaminated these water sources. Saeed Badubais, Chairman of the Planning and Development Committee of the local council, reported that the water quality of one of the wells in Jazol area was completely ruined after the 2020 flash floods, where a change of water color and smell was observed. The water became undrinkable and unsuitable for irrigation, initiating the search for alternative sources of water for the area.¹³

Landslides have been a problem in Hajar district for many years, but the changing climate has accelerated their frequency and intensity in recent years. They are often caused by heavy rains, which can loosen the soil on the steep slopes of the mountains. The resulting rockslides and mudslides can damage homes, crops, and infrastructure. In some cases, they can also cause loss of life.

¹¹ Interview with Rappea Hasan, project manager at Khair Coalition for Humanitarian Aid, Hadhramaut (August 2022).

¹² Interview with Hussien Saleh, director of the secretarial and technical follow-up department in Hajar district, Hadhramaut (August 2022).

¹³ Interview with Saeed Badubais, Chairman of the Planning and Development Committee of the local council of Hajar, Hadhramaut (August 2022).

Loss of Livelihoods and Increasing Food Insecurity

In addition to the physical damage – particularly to agriculture – caused by these extreme weather events, the loss of livelihoods has had a significant impact on the district's economy, and food insecurity has become a major concern. While figures regarding the share of the district's population working in agriculture remain unclear, interviewees' estimates vary greatly, from around 40 to 80 per cent, of which almost half are reportedly women. Some interviewees note that the percentage of farmers has been decreasing in recent years, as the high costs and risks of farming have driven some to abandon their land and migrate to urban areas, including Mukalla, in search of work. In addition, because of damage to infrastructure, farmers are not able to access water for irrigation, which further contributes to the decline in jobs and incomes for farmers. This migration could explain the large difference in the estimates of the district's population working in agriculture.

The series of floods that hit the district in 2008, 2020, and later in 2021 have had a devastating effect on the agricultural sector. In addition to destroying irrigation systems, the floods have also left significant damage to agricultural production, reducing agricultural output almost by half. In the past, an estimated three million date palm trees had allowed Hajar to export premium dates to other parts of the country. Yet, the date industry was hit hard during the 2020 and 2021 floods, with interviewees reporting the destruction of thousands of these palm trees, resulting in a decrease of production from 1,000 baskets a day to almost 300 baskets. This loss of palm trees is further exacerbated by the fact that it takes around five to seven years for a palm tree to mature and start producing fruit, as one expert explained. This not only reduces date farmers' incomes but also the employment opportunities for those working in the date industry.

The district's agriculture-based economy is also vulnerable to changes in precipitation patterns and higher temperatures. As the rains become more erratic, it is difficult for farmers to predict when they will need to sow their crops or harvest them. For example, Badubais notes that palm tree season in Yun area starts much earlier than it used to, a phenomenon that he links to climate change.¹⁴ In addition, higher temperatures can decrease the yield of some crops while increasing the incidence of pests and diseases. Some of these crops have particular requirements in terms of temperature and moisture that make them more vulnerable to climate change. For example, interviewees report that rising temperatures have negatively impacted the production of wheat, corn, watermelon, and seasonal vegetables, including tomatoes and onions. This inconsistency and unpredictability in growing seasons and increase in

¹⁴ Interview with Saeed Badubais, Chairman of the Planning and Development Committee of the local council of Hajar, Hadhramaut (August 2022).

temperatures can significantly disrupt supply chains, as farmers are unable to sell their crops when demand is high.

The Dubas bug, a pest of date palms, has also become more prevalent in recent years, particularly after the floods of 2020 and 2021, as the insects have taken advantage of the wet conditions to reproduce. A climate expert explains that dates infected with this bug lose their sweetness and become sour, making them unmarketable. Locals call these dates 'Khumqa', which means rotten. One study in Oman, whose climate is similar to that of Hajar, found that the Dubas bug could reduce the crop yield of date palms by 50 per cent under future climate scenarios.¹⁵ By virtue of similarities in climate, it is likely that a similar outcome could occur in Hajar district in the coming years if the current trends persist without a proper response.

The increased incidence of pests and diseases has also been observed in livestock, with animals more vulnerable to heat stress and diseases. This has led to a decrease in milk production, as well as a reduction in meat quality. Moreover, the increased price of livestock feed, due to the damage caused by the floods to hay crops, has also contributed to the decrease in livestock production and export.

Local experts interviewed describe how the frequent flash floods cause significant disruptions to livestock herding. One expert explains: "People are afraid of grazing during times of torrential rain because the district of Hajar consists mainly of wadi streams. Hence, when the floods start descending from the mountains, you will either be stuck at home or swept away by the flood along with your livestock."¹⁶ This disruption to livestock grazing is costly for the many households in Hajar district that rely on livestock for their livelihoods, as it reduces their incomes and increases the price of meat.

Loss of livelihoods and agricultural production has led to an increase in food insecurity in a district that was already considered to be one of the poorest and most marginalized in the country. Most estimates provided by interviewees place the poverty rate in Hajar district between 60-80 per cent, of which the majority are farmers and members of the Muhamasheen community. The latter are an ethnic minority that have historically been discriminated against and excluded from economic opportunities. The damage to roads and bridges caused by the floods has further isolated the district, disrupting food supplies and exacerbating food insecurity. In a district largely known for its agricultural activities, rates of food insecurity are now estimated to be as high as 80 per cent.

¹⁵ Shabani, F., Kumar, L., and Hamdan Saif Al Shidi, R. (2018). Impacts of climate change on infestations of Dubas bug (*Ommatissus lybicus* Bergevin) on date palms in Oman. *PeerJ*, 6, e5545. <https://doi.org/10.7717/peerj.5545>.

¹⁶ Interview with Aswan Awadh, a climate specialist, works for the Rural Water Corporation and the FAO, Hadhramaut (August 2022).

Bad Water Management Aggravates the Water Crisis

Being a rural area in Yemen, Hajar contends with government neglect and a severe lack of investment in infrastructure. This situation is further complicated by the fact that the district does not have a centralized water authority responsible for managing water resources. Instead, residents must deal with a patchwork of different and often competing water management schemes, some private, some public, and some based on customary law. This lack of coordination has led to inefficiencies and a general deterioration of the water infrastructure over time.

Currently, around 70 per cent of the district's population is connected to local water networks constructed by the district's residents themselves, largely through funding from local associations and non-profit organizations. One such project was inaugurated in 2021 by the local NGO Human Access, which intends to drill a well with a depth of 65 meters and construct a small network to bring water to thousands of households in al-Sadara area in the district.¹⁷ According to research interviewees, households connected to these water networks receive water for a fee of around 6,000 Yemeni riyals per month, for 2-4 hours of water supply, twice a week. This fee is much less than what residents would have to pay if they were to purchase water from a commercial tanker for a price of 15,000 Yemeni riyals per truck.

Since these water networks rely on groundwater, they require fuel to power the pumps that extract water from the wells. The lack of an electrical grid in the district means that these diesel-powered generators must be run constantly, leading to high fuel costs. Also, due to the current fuel crisis in Yemen, many of these networks have been forced to ration water or shut down entirely. More affluent households can continue drilling their own wells, but this also has negative impacts on groundwater levels and leaves the poor without access to water. A recent project funded by UNICEF has provided around 170 solar panels to power some of these pumps, which has helped to some extent in covering water needs.¹⁸ However, without sound water management laws and enforcement mechanisms, even these solar-powered water-pumps are susceptible to misuse and over-extraction.

Households not connected to the water network must rely on other sources of water, mainly rainwater harvesting, surface water, and springs, with the responsibility of collecting and storing water falling to women and children. Given the large distances

¹⁷ Human Access (2021). "Clean water drops bring back life. Inauguration of Al-Sadara Water Project, Hajar district". <https://humanaccess.org/m/news/clean-water-drops-bring-back-life-inauguration-of-al-sadara-water-project-hajar-district>.

¹⁸ Office of the Ministry of Social Affairs and Labor – Hadhramaut, 2022. <http://sahel.had-insurance.info/view/4113.aspx>.

between water sources and households, which sometimes can be as far as 2km, the task of collecting water can be dangerous and often time-consuming. As a result, many women and children in the district are deprived of education and economic opportunities, with disproportionate effects on girls who are more likely to drop out of school to help with household duties.

Moreover, the water from these alternative water sources is often deemed unsafe for human consumption. Although some interviewees note the unusual purity of the water in this particular wadi, one study clarifies that it is usually the stream flow in the upper stream of the Wadi Hajar that is potable, as the water there is less exposed to artificial contamination from farming activities and other human waste.¹⁹

Water quality is further degraded because there is no wastewater treatment in the district. This means that all sewage and waste from households and farms is dumped directly into the environment in an untreated state. Open defecation is also practiced by a small portion of the population, notably in the more remote areas where Bedouin tribes set up their camps. With no treatment or proper disposal, this wastewater eventually finds its way into the water sources that serve the district, especially during the rainy season when flooding often carries this waste into water sources. All these factors have led to a deterioration in water quality and an increase in water-borne diseases, including cholera, dengue, malaria, and even schistosomiasis.

As Climate Change Impacts Worsen, So Does the Risk of Societal Tensions

Most interviewees note that the incidence of collective conflict is generally low in Hajar, attributing this to the homogeneity of most of its population. However, there are a number of fault lines that could potentially be exacerbated by climate change impacts, leading to tension and conflict. Also, given the current state of insecurity and lack of economic opportunity, there is a real risk that the district could become a breeding ground for radical groups.

One driver of societal tensions is the division between upstream and downstream communities in Wadi Hajar. As one local council member interviewed for this study explains: "In the summer, farmers from the upper parts of the wadi block the flow of water to irrigate their crops, depriving farmers downstream of water for their own crops. This often leads to tensions between the two groups." He added that this issue has now been largely resolved by the establishment of agricultural committees, known as Lijan, consisting of members elected by locals from outside these two

¹⁹ https://openjicareport.jica.go.jp/pdf/11282530_03.pdf.

communities, to mediate disputes and oversee the equitable allocation of water resources.²⁰

Another potential source of tension is the unequal distribution of land ownership in Hajar district. While most residents are poor small-scale farmers, there is a significant minority of large landholders. Amjad Saad, the General Director of Agriculture Research and Extension Authority (AREA) in the East Coast, highlights how this inequality can lead to tensions: "Sometimes landholders try to evade contributing to the repair of water barriers or soil erosion, which often occur due to climate-induced extreme weather events, causing disputes between farmers and landholders."²¹ What makes land-related disputes even more complex is the lack of official titling and well-defined land rights, which can lead to confusion and disagreement over who owns what. Land in Hajar is mostly inherited, without clear boundary demarcations or judicially recognized proprietary rights, which can cause major problems when there are competing claims over land.²²

Local mediation over access to resources is a key element for maintaining peace and stability in the district. The establishment of local Lijan, or water users associations, is an important example of how communities have developed their own mechanisms to resolve disputes related to access to resources. One of the district projects, funded by the European Union and the United Nations Food and Agriculture Organization (FAO) and implemented by the local organization al-Khair coalition, established four Lijan in four different villages, Jazol, Hassien, Sidarah, and Jol. Interviewees reported that these Lijan have been quite successful in managing water resources and resolving disputes between different water users, largely since they are composed of local community members who understand the dynamics of water use in the area and are therefore able to make decisions that are acceptable to all.

However, while local mediation mechanisms have been effective in managing the tensions and resolving some disputes in the district, some interviewees note that not everyone has access to these mechanisms. More specifically, they point to the fact that women are often excluded from decision-making processes at the community level and are not part of any agricultural committees or water users associations. They also lack access to local mediation mechanisms due to strict social customs prohibiting women from talking to male strangers. This exclusion means that women are less likely to have a voice in how natural resources are managed and are more vulnerable to the impacts of climate change. Interviewees report that tensions at the

²⁰ Interview with Mohammed Salem, Director of Administrative and Financial Affairs at the Local Council of Hajar District, Hadhramaut (August 2022).

²¹ Interview with Amjad Saad, the General Director of Agriculture Research and Extension Authority (AREA) in the East Coast, Hadhramaut (August 2022).

²² Interview with Hussien Saleh, Director of the Secretarial and Technical Follow-up Department in Hajar district, Hadhramaut (August 2022).

household level are also on the rise, usually over the collection of scarce resources such as water and firewood, which mainly fall on women's shoulders.

The two other social groups that are most vulnerable to the impacts of climate change and have the least access to local mediation mechanisms are Muhamasheen and Bedouin. In the case of the former, this is due to the social discrimination that they face due to their dark skin, as well as their lack of land ownership and resources. In the case of the latter, this is due to their semi-nomadic lifestyle, which makes it difficult for them to put down roots in one place and participate in community life. This is compounded by the fact that they are often seen as outsiders by sedentary residents. Yet, members of these two groups are more likely to live in tents or other flimsy structures in hazardous locations, such as on the edges of wadis, which makes them more susceptible to the impacts of extreme weather events.

In addition, most interviewees note that there is a lack of economic opportunity in Hajar, particularly for young people. This has led to high levels of migration out of the district, notably to Mukalla. This does not come without its own challenges, as interviewees report that migrants often are not able to find work or a place to live. This lack of economic opportunity is also leading to an increase in crime, as residents turn to illegal activities to make ends meet. Although not currently an issue, the persistence of these dire economic conditions could lead to social unrest in the future. The neighboring city of Mukalla has already seen protests over the lack of economic opportunity and government neglect and corruption in recent years. This is also happening at a time when different armed groups are emerging in the region and competing for control. While Hajar district has so far been spared the worst of the fighting, there is a legitimate concern that the large unemployed population of farmers could join the ranks of these groups if the situation deteriorates further, a trend that has been observed elsewhere in Yemen.

Already, Hajar district has been making news for fostering al-Qaeda affiliates. Their last reported presence in the district was in February 2018, when they clashed with Emirati-backed Hadhrami Elite Forces leading up to their withdrawal. Before this, Al-Qaeda in the Arabian Peninsula (AQAP) managed to seize control of the center of Hajar district, including public buildings, and established checkpoints near two villages in the district.²³ This is a worrying trend, especially when considering that extreme climate changes in Hajar have made it difficult for local communities to

²³ Morton, M., Cialone, P., Perez, T., "Gulf of Aden Security Review," *Critical Threats*, 2018.

<https://www.criticalthreats.org/briefs/gulf-of-aden-security-review/gulf-of-aden-security-review-february-23-2018>; Reports of AQAP activities in Hajar date back at least to 2014, when they launched an attack on a security compound in Hajar, killing one soldier and injuring four others. <https://www.reuters.com/article/cnews-us-yemen-houthis-idCAKBN0FA0BU20140705>.

maintain their livelihoods and sustain themselves, creating a desperate situation that is ripe for exploitation by extremist groups.

The above challenges are exacerbated by the fact that Hajar district is largely cut off from the outside world. This is due to its location, as it is situated in a remote and inaccessible part of the country. This isolation means that residents have limited access to information and services and are often unaware of the resources that are available to them. It also makes it difficult for residents to advocate for their rights, as they are not connected to the outside world and do not have the means to do so.

Hajar's Current Climate Response Is Far from Adequate

In the face of all these challenges in the district, the response from the government, and the nonprofit sector, pales in comparison to the scale of the problem. Most interviewees complain that the climate response in the district has been ad hoc and reactive, rather than coordinated and preventive. For example, after the devastating floods of 2020, the emergency response, mostly led by local associations and nonprofit organizations, was to provide tents and emergency supplies of food and drinking water for some of those affected. However, there was no attempt to address the root causes of the problem or to build resilience for the future.

In the same vein, the current government approach to climate change in the district is too focused on mitigation rather than adaptation. For example, a member of the local council notes some limited intervention from the governorate's authorities, such as the opening of some roads and the restoration of a few water networks, which are mainly funded by international NGOs (INGOs). However, he admits that these are temporary band-aid solutions that do not hold up in the long run. A different government official echoes this sentiment, adding: "Some areas [villages] in Hajar were left out of the emergency water response that was implemented after the 2020 floods. These areas still lack access to water after their water networks were destroyed two years ago. In other areas, water pipes were restored, but were made out of material not durable enough to withstand another flood."

Many of the people interviewed touched on the fact that the current interventions are not only inadequate but also not appropriate for the local context. This is mainly because they are not designed with the input of those who will be affected by them. For example, one interviewee highlights one such intervention: "An NGO funded the construction of a water dam/barrier near the water stream in one of the villages in Hajar. However, the dam was not built in the right place and was quickly swept away by the next flood." He further emphasizes that such interventions need to be designed with the input of locals in order to be effective: "The people of Mecca know more about its reefs, and so, it's vital to benefit from local knowledge, especially when civil

engineers are brought from outside of the area, lacking background knowledge about our agricultural lands and water resources."²⁴ The same problem was observed again as there were inadequate efforts to restore irrigation canals in some areas in the district, which were also swept away by the next floods.²⁵

Perhaps one of the biggest challenges in the climate change response in the district is the lack of coordination among different actors. This was a common theme that emerged in interviews, with interviewees citing examples of wasted efforts and corruption. Many of the interviewees place the blame on NGOs and INGOs, which they say tend to bypass local authorities and communities. For example, a local council member notes: "One of the NGOs, in collaboration with the FAO, brought its own project coordinators from outside of the district who were arrogant enough not to coordinate with local authorities. Instead, they relied on their own local connections and ended up selecting project beneficiaries based on cronyism, sometimes adding more than one family member to the list of beneficiaries."²⁶

Sometimes, this lack of coordination causes friction due to a lack of knowledge of local traditions. For example, one interviewee describes how an INGO wanted to take pictures of women receiving food aid to use as part of their project report, which stirred some anger among locals as this went against their social traditions.²⁷ Another interviewee also laments the lack of a well-trained female cadre in some health-related projects, which has led to some issues with delivery of services to women.²⁸

Furthermore, projects in Hajar district are often hampered by a lack of sustainability. This is because most of the funding for these projects comes from external sources, which are not always reliable. For example, a local council member laments the limited financial and technical capacity of the local council to respond effectively to the needs of the district, forcing them to seek help from the governorate, which is often slow in coming. This also means that the district is mainly relying on funding from NGOs and INGOs, who tend to pull out their support once their project ends, leaving the district in a precarious position. Many people interviewed referred to a project by the FAO as an example, which provided support to farmers in the district for a few months, but then abruptly pulled out, leaving them stranded after the 2020 floods swept away much of their crops.

²⁴ Interview with Ahmed Barajash, journalist and researcher of humanitarian work, Hadhramaut (August 2022).

²⁵ Interview with Abdullah Bahoaj, humanitarian worker and activist, Hadhramaut (August 2022).

²⁶ Interview with Saeed Badubais, Chairman of the Planning and Development Committee of the local council of Hajar, Hadhramaut (August 2022).

²⁷ Interview with Mohammed Salem, Director of Administrative and Financial Affairs at the Local Council of Hajar District, Hadhramaut (August 2022).

²⁸ Interview with Wijdan Al-Shatheli, Executive Director of Hajar Development Foundation, Hadhramaut (August 2022).

TAWAHI DISTRICT

As the world continues to grapple with the issue of climate change, the people of Yemen's Aden city could witness large parts of their city submerged under water due to rising sea levels. Aden was named the sixth most vulnerable city in the world to sea level rise and storm surges, according to a 2009 study.²⁹ Tawahi district is in the southeast of the city, overlooking the Gulf of Aden. This low-lying district is particularly at risk from future rising sea levels, water salinization, landslides, and flooding. Human communities and natural ecosystems in this coastal area are already feeling the effects of climate change. Communities face shortages and salinization of drinking water, as well as an increase in flash floods and landslides incidents. Natural ecosystems suffer from beach erosion, coral bleaching, and habitat loss. As the sea level continues to rise, the district's future looks increasingly uncertain.

Previously a small fishing village, Tawahi district is now a rapidly changing coastal area. It is a destination for rural-urban migrants, as well as war refugees fleeing from the ongoing conflict in the country. The name Tawahi is derived from the Arabic verb 'Tah', which means 'lost', as it is said that the people of Aden in the past were afraid to visit the village for fear of getting lost in its mountains.³⁰ Now, in its surrounding mountains unplanned settlements and infrastructure are expanding as a response to Aden's housing crisis. Yet, this upward expansion is a double-edged sword, as the same infrastructure that offers cheap housing to its inhabitants also makes them more vulnerable to the impacts of climate change. Landslides, water shortages, and stagnant floodwater accompanied by waterborne diseases are frequent occurrences in the area, a clear sign of what could be to come.

At the district's heart is a vibrant fish market, bustling with activities and life, as well as consumers from all over Aden city. Here, almost half of the population still relies on fishing as their primary source of livelihood. The coastal waters around the district are amongst the busiest fishing grounds in the Gulf of Aden, providing food and income to thousands of families. Yet, both the rising sea level and the coral bleaching due to rising water temperatures take their toll on the fish stocks and varieties, as well as local fishers, who must venture further out into the sea for their daily catch. Their troubles are multiplied by a host of human activities, from overfishing to pollution by wastewater discharge and regular oil spills from ships.

²⁹ Dasgupta, S., Laplante, B., Murray, S., and Wheeler, D. 2009. *Climate Change and the Future Impacts of Storm-Surge Disasters in Developing Countries*. Technical Report, Center for Global Development, Working Paper 182. 1800 Massachusetts Ave., NW, Washington, D.C.: https://www.cgdev.org/sites/default/files/1422836_file_Future_Storm_Surge_Disasters_FINAL.pdf.

³⁰ Tawahi City, Alamree net, 2010. <https://alamree.net/aden%20-tawahi.htm>.

The district is also endowed with beautiful sandy shores bound by igneous mountains, turning it into a popular tourist stop with many economic benefits to local communities. These shores include the Goldmoor, Elephant Bay, and al-Aroosa. Yet, the district's beauty is increasingly threatened by rapid and uncontrolled coastal urbanization, marine pollution, and changing climatic conditions. Coastal erosion has been a major issue for the area, and wetland inundation by the rising sea is becoming more frequent and extensive every year.

Tawahi district offers a unique glimpse into how climate change is already affecting the lives of people and ecosystems in the city. It is a reminder that, as the country continues to grapple with conflict and deepening economic and political crises, climate change is sweeping in, with its own set of challenges that must be addressed. In the face of this global threat, it is of utmost importance that the necessary actions are taken to mitigate its devastating impacts, while also providing support and adaptation measures to those at risk. Only then can the people of Aden, and Tawahi alike, look to a more hopeful future.

Aden's Coastal Areas Increasingly Threatened by Rising Sea Level and Flooding

Sea-level rise is a major concern for Aden City. With the latest models measuring sea level rise in Aden to be around 3.3mm/yr,³¹ this puts many coastal communities at risk from flooding and other damage due to extreme weather events such as storm surges. It is worth noting that this rate is well below the global extreme scenario of 60cm/yr (5.9 mm/yr) at the highest tide, put forth by the IPCC Fourth Assessment Report. However, according to a study published by Sanaa University, even this lower rate of sea level rise could lead to increased coastal erosion of about 48ha and an inundation of a 43km² area (5.7 per cent of the total area of Aden governorate) along Aden's shoreline. Under the 60cm scenario, these numbers are even higher, with a predicted coastal erosion of 86ha and inundation of 45km² (6 per cent of total area). The same study puts Tawahi district among the most affected areas in Aden for these hazards due to its low elevation and its proximity to the sea.³²

³¹ Woodworth, P., Foden, P., Pugh, J., Mathews, A., Aarup, T., Aman, A., Nkebi, E., Odametey, J., Facey, R., Esmail, M. Y. A. and Ashraf, M. 2009. Insight Into Long Term Sea Level Change Based on New Tide Gauge Installations at Takoradi, Aden and Karachi. *International Hydrographic Review*, 1(May), 18–23. <https://journals.lib.unb.ca/index.php/ihr/article/view/20831/23991>.

³² Al Saafari, M.A., Nagi, H.M., Alhababy, A. and Abubakr, M.M. 'Impact of sea level rise and climate change on the coastal zone of Aden Governorate, Republic of Yemen' in *Faculty of Science Bulletin, Sana'a University*, Vol. 27, pp. 15–32, 2015.

As sea level rises, fresh water will become scarcer due to saltwater intrusion into the groundwater supply, putting pressure on both local communities and the city's water infrastructure. This is particularly concerning in the context of Aden, which mostly relies on groundwater for water supply, and is already facing water scarcity due to over-abstraction. According to the study, in Tuban Delta, the contours of saltwater intrusion are approximately parallel to the coastline, about 10km inland, affecting Bir Nasser, which is the main source of water for Tawahi district. Future sea level rise could make this situation worse, as saltwater intrusion could reach farther inland, around 160m and 240m inland for the 33cm and 60cm scenarios respectively.³³

Beside storm surges, Tawahi district is exposed to flooding induced by heavy rainfall, which has become more frequent in recent years. According to Fawaz Bahamish, Assistant Professor of Applied Geomorphology at the University of Aden, torrential rains and subsequent flooding are becoming increasingly common in the area, specifically from 2017-2021.³⁴ This observation was confirmed by Nader Basnaid, Head of the Marine Environment Department at the Geological Survey and Mineral Resources Authority, who attributed the increase in flooding to the change of precipitation patterns in Aden due to climate change. He notes that although the average annual rainfall has not changed much, the intensity of rainfall itself has increased to the extent that "if an area received an average of 35-50mm rainfall a year, now it can receive up to 50mm in a single hour".³⁵ During the 2020 floods in Aden, particularly on 25 March and 21 April, Yemen Meteorological Services reported that over 75mm and 125mm of rain fell over 24 hours in the city, respectively.³⁶ This was an excessive amount of rainfall in an area that usually receives close to zero precipitation. Many experts interviewed also point out a shift in the timing of the rains, from the traditional winter season to early spring and summer.³⁷

It is this heavy rainfall combined with the increasingly impermeable surfaces due to urbanization that are causing flooding in Aden City. This is especially the case in

https://www.researchgate.net/publication/308920314_IMPACT_OF_SEA_LEVEL_RISE_AND_CLIMATE_CHANGE_ON_THE_COASTAL_ZONE_OF_ADEN_GVERNORATE_REPUBLIC_OF_YEMEN.

³³ Saafari, M.A., Nagi, H.M., Alhababy, A. and Abubakr, M.M. 'Impact of sea level rise and climate change on the coastal zone of Aden Governorate, Republic of Yemen' in Faculty of Science Bulletin, Sana'a University, Vol. 27, pp. 15-32, 2015.

https://www.researchgate.net/publication/308920314_IMPACT_OF_SEA_LEVEL_RISE_AND_CLIMATE_CHANGE_ON_THE_COASTAL_ZONE_OF_ADEN_GVERNORATE_REPUBLIC_OF_YEMEN.

³⁴ Al-Qadi, B. 'Will Sea Water Swallow the Southern City of Aden?', South 24, 2021.

<https://south24.net/news/newse.php?nid=2038>.

³⁵ Interview with Nader Basnaid, the Head of the Marine Environment Department at the Geological Survey and Mineral Resources Authority, Aden (July 2022).

³⁶ Floodlist News, 2020. 'Yemen – More Devastating Flash Floods in Aden After 125mm of Rain', <https://floodlist.com/asia/yemen-floods-aden-april-2020>.

³⁷ Interview with Mansoor Jaafar, a hydrogeology professor at the University of Aden, Aden (August 2022).

Tawahi district and the surrounding districts of Crater and Mualla, where the volcanic rocks in those areas are highly impermeable, thus reducing the ability of flood water to seep into the ground, as confirmed by Mansoor Jaafar, a hydrogeology professor at the University of Aden.³⁸ Furthermore, a lack of proper drainage and solid waste management makes the area more vulnerable to flooding and exacerbates the impacts, especially in relation to health risks due to water contamination.

Damage from such flooding is severe. During the 21 April 2020 tropical storm, the Internationally Recognized Government of Yemen declared Aden a disaster zone, with Tawahi district among the worst-hit areas.³⁹ By some accounts, at least 12 people died due to the floods, along with the destruction of more than 75 houses, including in Tawahi.⁴⁰ Overall, around 16,200 people were reportedly impacted in Aden, with infrastructure such as roads and bridges damaged, and residents displaced within and outside the city. Many livelihoods were also impacted as small businesses, shops, and other commercial activities were destroyed or forced to close by the floods.⁴¹

According to interviews, the floods in Tawahi were especially devastating due to unplanned residential construction on top of the surrounding mountains. As floodwater descended along the mountain slopes, it picked up large amounts of debris, soil, and rocks that caused damage to residential homes along the way. Inadequate drainage also played a role in exacerbating flooding. Many of the existing drainage systems were clogged due to rubbish and debris, forcing floodwater to spread out over the district and turn into stagnant puddles. With high temperatures, these pools of water can create breeding grounds for disease-carrying mosquitoes, including malaria risks. In fact, reports show that in the days following the floods, Aden City witnessed a significant spike in chikungunya fever cases, with more than 3,000, due to the swamps created by the floodwater.⁴²

Rising Sea Temperature Threatens Marine Life and Biodiversity

When it comes to the temperature, interviews with experts reveal that there has not been a significant increase in the average temperature in the area. One publication

³⁸ Ibid.

³⁹ ACAPS Briefing Note: Floods in Yemen, 2020.

https://www.acaps.org/sites/acaps/files/products/files/20200423_acaps_yemen_analysis_hub_heavy_rains_flash_floods_in_yemen_0.pdf.

⁴⁰ Uqba, S. 'Yemen in Focus: PM appeals for assistance after 'disastrous' Aden flooding,' The New Arab, 2020.

<https://www.newarab.com/analysis/yemen-focus-appeals-assistance-after-aden-flooding>.

⁴¹ Al-Akwa, K., Zumbärgel, T., 'The Disaster of Yemen's Flash Floods Impact of and Local Responses to the Torrential Rains and Flooding in 2020,' CARPO, 2021. https://carpo-bonn.org/wp-content/uploads/2021/12/carpo_brief_21_07-12-21_EN.pdf.

⁴² Al-Ahmadi, A., '50 die in Yemen from mosquito-borne disease,' Anadolu Agency, 2020.

<https://www.aa.com.tr/en/middle-east/50-die-in-yemen-from-mosquito-borne-disease/1835300>.

shows an increase of 0.5°C from 1979 to 2021 in Aden city,⁴³ but interviews suggest that this difference is scarcely noticeable. However, there are other indicators of climate change. Along the coast, for instance, some experts report an increase in sea-surface temperatures over the past few years, which has contributed to stormy weather.

According to studies, sea-surface temperatures of at least 26.5°C are required for tropical storms to form, and coastal areas in Yemen have already exceeded this temperature.⁴⁴ Jaafar also notes a shift in the timing of the rains induced by these storms from the traditional winter season to summer, which is consistent with climate change trends.⁴⁵ One of these storms was Cyclone Sagar in 2018, which took advantage of a low wind shear and water temperatures of up to 31°C to cause extensive rainfall and flash flooding in the city.⁴⁶ The changing climate means that there could be more storms of this kind in the future, further increasing the risks of flooding and other natural disasters.

The rise in sea temperature can also have an adverse effect on the marine ecosystem. While Aden's coastal area is already facing other problems such as pollution from oil spills and illegal fishing, the rising sea temperature also leads to coral bleaching and an increase in algae, which can deteriorate the quality of the water. According to experts interviewed for the research, the increase in atmospheric CO₂ has led to an increase in acidity levels (measured by pH) in the sea. This increased acidity makes it difficult for many marine organisms – including coral reefs – to form their skeletons and shells. As these organisms die off, entire ecosystems are at risk of collapse. “We are now seeing colorful coral turning not only white, which can be reversed, but to a greyish color which is an indication that it has died”, said one of the marine experts interviewed. This, in turn, can bring about a loss of marine biodiversity and fish stocks, given that coral reefs are the main habitats for a variety of marine species.⁴⁷ Similarly, the erosion and inundation of wetlands, mudflats, and salt pans caused by sea level

⁴³ Al-Sarari, L., ‘Yemen: Instability Hits the Climate Too,’ Assafir Arabi, 2022.

<https://assafirarabi.com/en/48629/2022/11/09/yemen-instability-hits-the-climate-too/>.

⁴⁴ NASA, 2003. “Recipe for a Hurricane”.

https://www.nasa.gov/vision/earth/environment/HURRICANE_RECIPE.html.

⁴⁵ Interview with Mansoor Jaafar, a hydrogeology professor at the University of Aden, Aden (August 2022).

⁴⁶ Henson, B., ‘One Dead as Tropical Cyclone Sagar Brings Life-Threatening Flood Threat to Somalia, Djibouti, Yemen,’ The Weather Channel, 2018. <https://weather.com/storms/hurricane/news/2018-05-17-tropical-cyclone-sagar-gulf-of-aden-yemen-somalia-djibouti>.

⁴⁷ Interview with Nader Basnaid, the Head of the Marine Environment Department at the Geological Survey and Mineral Resources Authority, Aden (July 2022).

rise can also reduce the diversity of habitats for marine creatures and migratory birds.⁴⁸

Water Resources Under Increasing Pressure from Climate Change and Over Extraction

In Tawahi district, the combined effects of climate change and human activities are placing an increasing strain on the district's water resources. In the absence of precise data, it remains unclear which of these two factors has the greater effect on water resources, but certainly they both play a role. The district's water resources can already be considered inadequate since 20-40 per cent of the population lack access to improved drinking water sources. This figure is much higher for the more than 4,000 IDPs that live in the district, over 80 per cent of whom lack access to improved drinking water sources.⁴⁹ With a fast population growth, around 53 per cent increase in the last two decades,⁵⁰ and a lack of proper management of water resources, it is likely that the district will increasingly face severe water shortages.

The water shortage has an even greater effect on the poorer communities in the district, who are often unable to buy water from commercial tankers and must rely on limited public water sources. Residents of unplanned houses on the mountain slopes are particularly vulnerable to water shortages. Interviews and reports confirm that these areas are not connected to the public water network, and mostly rely on charity water tanks and water from mosques. Sometimes, those residents carry water up the mountain slopes on the backs of donkeys, especially if they cannot afford fuel for pumping water to their houses. Water supplied through commercial tankers is also expensive, varying between 8,000 to 30,000 Yemeni riyals for 1,000 liters of water, depending on the highly fluctuating dollar exchange rate, fuel crisis, and the size of the family. These costs can be difficult for people to pay, especially because of the ongoing deep economic crisis in Yemen.

To make matters worse, the water quality is often poor and contaminated, especially water supplied by public charity tanks and mosques. Many interviewees for this research note that most mosques in the district rely on water from wells randomly dug without any treatment, as opposed to the water supplied by the local water and

⁴⁸ Al Saafari, M.A., Nagi, H.M., Alhababy, A. and Abubakr, M.M. 'Impact of sea level rise and climate change on the coastal zone of Aden Governorate, Republic of Yemen' in Faculty of Science Bulletin, Sana'a University, Vol. 27, pp. 15-32, 2015.

https://www.researchgate.net/publication/308920314_IMPACT_OF_SEA_LEVEL_RISE_AND_CLIMATE_CHANGE_ON_THE_COASTAL_ZONE_OF_ADEN_GOVERNORATE_REPUBLIC_OF_YEMEN.

⁴⁹ Aden City Profile (UN-Habitat, 2020) https://unhabitat.org/sites/default/files/2020/11/01_aden_city_profile.pdf.

⁵⁰ Ibid.

sanitation corporation (LWSC). In this regard, Jaafar warns that water from charity tanks and mosques usually have a high level of salinity, at more than 4,000 microsiemens per centimeter ($\mu\text{S}/\text{cm}$), which exceeds the World Health Organization's (WHO) desirable and maximum limits of 800 and 1,500 $\mu\text{S}/\text{cm}$, respectively.⁵¹ Dr. Iqbal Saeed, Director of the Health Office in Tawahi, adds that even water sources supplied by LWSC can be contaminated by wastewater since many parts of the district lack sewage systems. Flash floods can especially become problematic for breaking water tubes connecting the district to public water sources, as well as spreading sewage and garbage in the streets. These reports are further confirmed by a 2022 study that found that water pollution in the Bir Nasser water fields greatly exceeds the WHO's safe limits.⁵² It is not surprising, then, that water-related diseases such as cholera and malaria are common in these areas, as confirmed by the interviews.

The district's reliance on groundwater for its water supply also makes it particularly vulnerable not only to climate change but also to human activities, such as over-extraction of groundwater. According to some experts, salinization of existing groundwater resources is already occurring in some areas due to sea level rise, making the water unsuitable for drinking or irrigation. In this regard, Jaafar notes that the lower permeability of the district's volcanic soil means it is less affected by salinization despite sea level rise. Still, Tawahi district shares the same aquifers as other nearby districts, such as Dar Saad, which are already experiencing salinization due to sea level rise and impacting the water quality in the vicinity.⁵³

This coincides with an ever-increasing depletion of aquifers due to over pumping and lack of proper management. The main water resource for the district is Bir Nasser water field located in the Tuban Delta in Lahj governorate. According to a 2008 study conducted by Mansour Haidera and Abdullah Noaman from Sanaa University, two thirds of the water that is used for irrigation in Lahj comes from the Delta Tuban aquifer, which also supplies all water needs in Lahij City in addition to 75 per cent of water needs in Aden City.⁵⁴ Some projections suggest that, if nothing is done to correct current mismanagement, by 2025 the Tuban aquifer will be depleted. The depletion of Tuban aquifer is occurring at a much faster rate when compared with the Abyan

⁵¹ World Health Organization, 2008 Guidelines for Drinking Water Quality: Surveillance and Control of Community Supplies, 2nd edn. World Health Organization, Geneva.

⁵² Saleh, S., Al-Sallami, A., "Assessment of the Level of Physicochemical and Microbiological Contamination of Groundwater in Parts of Bir Nasser and Bir Ahmed Water Fields in Tuban Delta in Aden and Lahej Governorates-Yemen," *Electron. J. Univ. Aden Basic Appl. Sci.*, vol. 3, no. 2, pp. 101-116, June. 2022. DOI: <https://doi.org/10.47372/ejua-ba.2022.2.158> <https://www.ejua.net/index.php/EJUA-BA/article/view/158/203>.

⁵³ Interview with Mansoor Jaafar, a hydrogeology professor at the University of Aden, Aden (August 2022).

⁵⁴ Haidera, M., Noaman, A., 'Application of Decision Support Tools for Water Resources Management in Coastal Arid Areas (Case study: Aden, Yemen)', Sanaa University, 2008. <https://icwrae-psipw.org/papers/2008/Water/72.pdf>.

aquifer, which meets the water demands of Abyan governorate and the remaining 25 per cent of Aden.⁵⁵

Climate Change Threatens Food Security and Fishing Communities

When it comes to livelihoods, the most vulnerable population in the district is typically fishers. Although there have not been any scientific studies to measure climate change impacts on the availability of fish in the Gulf of Aden region, anecdotal evidence suggests that catch sizes have decreased considerably in recent years. Climate-related events, such as a rise in sea temperatures and the subsequent coral bleaching, are having an impact on the abundance and variety of fish locally. Local experts note that some of the small fish species that used to be abundant in the area are no longer found, while others have shifted their habitats further away from the shores, forcing fishers to go further out into deeper waters to catch them. For example, catching the small Indian Mackerel (Ar.: Bagha) used to be easier because it is usually found near the shores, but along with other small fish species their numbers have significantly decreased in recent years. Some experts interviewed point out that fishers now mostly rely on big fish catches, such as Yellowfin Tuna (Ar.: Thamad). However, the international demand for these types of fish have significantly increased local prices. Due to stronger currents that can be attributed to climate change,⁵⁶ fishing, especially in deep waters which fishers are forced to access due to the lower availability of fish, has also become more dangerous. Finally, with an increase in extreme weather events such as cyclones and floods, there is also an increased risk of damage to fishing equipment and boats, leading to further economic losses for fishers.

In addition to the direct economic impacts on fishers, food insecurity is also a major concern. This can be attributed to the fact that fish are a central part of the local diet. Therefore, with a decrease in catch sizes, the price of fish has multiplied, making it unaffordable for many families. For example, Indian Mackerel, which used to cost only 100 Yemeni riyals per kilo, now costs more than 1,000 riyals in Aden due to its scarcity. Similarly, Yellowfin Tuna now costs around 12,000 riyals, a sharp increase from the 1,000 riyals it cost a few years ago.⁵⁷ What's more peculiar is that these prices are reportedly lower in other parts of Yemen, such as Sanaa. According to some fishers, this disparity is because fish in Aden are exported to outside of the country, leading to

⁵⁵ Readiness and Preparatory Support Proposal: Yemen. Green Climate Fund, 2021.

<https://www.greenclimate.fund/sites/default/files/document/yemen-un-habitat-2021.pdf>.

⁵⁶ Studies further confirm that rising sea temperatures are speeding up ocean currents, although no particular study was found that measures this effect in the Gulf of Aden. <https://www.earth.com/news/rising-surface-temperatures-are-speeding-up-ocean-currents/>

⁵⁷ Interview with Mansoor Jaafar, a hydrogeology professor at the University of Aden, Aden (August 2022).

local shortages and increased prices. It can also be explained by the lack of regulation and oversight over fishers who sell fish to canning factories at exorbitant prices.⁵⁸ Therefore, these double hits to the local fishing industry are having a major impact on food insecurity in the district, at a time when Aden, and the entire country, is already facing a crippling economic crisis.

Political Complexities Stifle Climate Response and Further Weaken the Fishing Industry

These climate change impacts are also intertwined with a complex political environment that is making it difficult to address climate change adaptation and mitigation strategies. For example, along with corruption and mismanagement of resources, political and institutional divides at the national level are preventing the development of a coherent strategy to tackle climate change. In Aden, this divide is manifesting itself locally in the form of political rivalry between the Southern Transitional Council (STC), backed by the United Arab Emirates, and the Internationally Recognized Government of Yemen supported by Saudi Arabia. These divisions are making it particularly difficult to formulate a unified approach to address climate change and limit the capacity of the government or local authorities to develop and implement any meaningful adaptation strategies. Concern over this political division was expressed by locals interviewed during the research, who fear that even if a strategy is developed, it will have limited impact because of the lack of coordination and political will to act.

The lack of an effective response is further exacerbated by the situation in Tawahi district. As home to the STC leader, Aidrous Al-Zabidi, there is an increased focus on security concerns that has prevented or slowed down any meaningful adaptation projects in the district. According to one of the experts interviewed, the heavy security presence in the district, including security checkpoints, acts as a barrier to access the district and implement any projects. It has also resulted in a reduction of fishing grounds, and consequently, causing a decrease in the economic activity of fishers.

Furthermore, weak conservation and management of fisheries are also contributing to the strain on the local fishing industry. The lack of proper enforcement of laws and regulations to protect fish stocks has left the door open for overfishing, illegal fishing, and use of destructive fishing methods. In this context, local fishers are finding it hard to compete with foreign vessels, many of which are equipped with advanced

⁵⁸ Yemen Today, 2022. "Aden: Fish prices rose to a record level", available in AR at: <https://www.yementdy.tv/news22038.html>.

technology and fishing tools that have allowed them to expand their range in Yemeni waters, taking advantage of Yemen's lax enforcement.

Another notable issue in Tawahi waters is pollution from oil ships, which has become a common sight in recent years due to a lack of regulation and oversight. The last oil spill in the district was reported to have happened in July 2022, caused by the Pearl of Athena at the Bay of Tawahi where over 40 tons of oil were leaked into the sea.⁵⁹ Yet, the threat does not stop there, as reports of the General Authority for Maritime Affairs suggest that other major oil spills are imminent in the area near the Bay of Tawahi. This threat is posed by 12 dilapidated ships currently anchored in the port of Aden, owned by the oil tycoon Ahmed al-Essie, who enjoyed strong connections within the Hadi government until its replacement in early 2022. The ships have been abandoned since before the 2014 conflict and are in a state of serious disrepair, increasing the likelihood of an oil spill that would further contaminate the waters and impact the marine life and fishing grounds of Tawahi district.⁶⁰

THERE IS A WAY FORWARD TO BUILD A CLIMATE RESILIENT YEMEN

The deep-seated political and institutional divides across all levels of government, combined with inadequate enforcement of environmental regulations, lack of coordinated effort, and underfunded local administrations have inhibited any viable adaptation strategies from being implemented. Addressing the pressing issue of climate change in Yemen, as manifested in Tawahi and Hajar districts, requires a multi-level approach that combines policy reform, enforcement of regulations, and support for local government and communities.

The most immediate steps that government stakeholders should take include the formation of a multi-stakeholder platform to promote dialogue and coordinate efforts related to the implementation of adaptation measures. This should include representatives from national and local authorities, as well as local civil society and international organizations. Such a platform should also be complemented by the establishment of an inter-governmental framework that allows for the efficient sharing of information and resources between the various stakeholders. The success of such a platform will require in some instances bridging the political divide between political factions, such as the Internationally Recognized Government and STC, with respect to resources and decision-making authority.

⁵⁹ Pax for Peace, 2022. 'Leaking Ghost Tankers: Pollution in the Port of Aden', <https://paxforpeace.nl/news/overview/leaking-ghost-tankers-pollution-in-the-port-of-aden>.

⁶⁰ Alqadi, B., 'Gulf Dove, a Decayed Ship Threatening the Coast of Socotra South Yemen', American Center for South Yemen Studies, 2022. <https://www.americancentersy.org/2022/09/gulf-dove-decayed-ship-threatening.html>.

In addition to the above, it is important that international organizations and donors prioritize climate change adaptation when designing humanitarian assistance programs in Yemen. This includes providing the necessary funding to enable local communities and authorities to effectively implement adaptation measures, while also developing a long-term vision of sustainable development that considers the current humanitarian crisis and long-term climate change impacts.

At the local level, local authorities, including local councils and local branches of national ministries and environmental agencies, should be empowered to act and implement adaptation strategies on the ground, with appropriate technical and financial support from the national government and international donors. This could include encouraging local governments to develop early warning systems, with the participation of local communities in the design and implementation process; develop an emergency response plan that is tailored to the context of each affected district, such as planning for safe migration routes in areas of high risk; and develop climate plans to guide the design, construction, and maintenance of resilient infrastructure, with a special focus on vulnerable communities, like those who live in tents or in the way of flooding. It is important that in developing a holistic approach to disaster risk reduction and climate change adaptation, local communities' experiences, knowledge, and traditional coping strategies are taken into account.

The international community, including governments, international and supranational organizations, and private sector companies, must also take responsibility for providing the necessary financial and technical support to facilitate adaptation measures in Yemen. This includes both short-term support for risk mitigation, such as establishing emergency response funds to support rapid relief efforts in the event of a disaster, as well as long-term investment in the development of resilient infrastructure and creative solutions to adapt to climate change, such as mangrove and coral reef restoration, terracing, drought-resistant crop varieties, and the use of renewable energy. Particular attention should be paid to developing measures that are sensitive to cultural and gender dynamics in Yemen, with a focus on sustainable development and livelihood opportunities.

To ensure successful adaptation, it is essential that these measures are informed by both scientific research and the expertise of local communities. This requires strengthening the capacity of local and national research centres to collect data and conduct vulnerability assessments on larger scales, identifying characteristics of communities facing heightened climate risk, and equipping decision-makers with the information to pinpoint those populations in their community. In this regard, there is an urgent need to establish a data-driven, open, user-friendly, and integrated platform that holistically identifies communities vulnerable to climate change impacts, which would allow decision makers to determine which communities face increased vulnerability during natural disasters. In doing so, Yemen can establish an evidence-

based decision-making process to better inform adaptation strategies and ensure that initiatives are effective, cost-efficient, and culturally appropriate.

It is also of paramount importance to educate the public, especially young people, and build their capacity to identify signs of climate change and take action in their communities. This can be accomplished through public campaigns, media outreach, and educational workshops. In rural areas such as Hajar, information can be disseminated through factsheets and awareness sessions in schools and mosques, and over the radio, whereas in urban areas such as Tawahi, information can be shared through a mix of traditional and modern media, including radio, television, newspapers, and social media. Mobile-based applications can also be developed to provide information on climate change and adaptation measures, which can not only help to raise public awareness and promote knowledge sharing but also empower people to act in their own communities. Artistic content such as street art, poetry, story narration, theatre, and community-led dialogues can also be incorporated into public campaigns to further engage the population, especially targeting hard-to-reach communities like women, Muhamasheen, persons with disability, IDPs, and Bedouins.

Overall, Yemen must make it a priority to act on climate change adaptation now in order to reduce the impact, and costs, of extreme weather conditions in the future. However, without concrete and rapid mitigation efforts to reduce global greenhouse gas emissions, Yemen will continue to be increasingly vulnerable to climate change impacts with each passing year. It is thus essential that nation states fulfil their commitments to international frameworks such as the Paris Agreement, while acknowledging the unique situation of a country like Yemen that is currently experiencing multiple overlapping crises. Ultimately, a combination of targeted adaptation policies and ambitious mitigation efforts can pave the way for a more sustainable and resilient future in Yemen.

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About the Author

Hadil Al-Mowafak is a Research Analyst, having joined the Yemen Policy Center as a Research Fellow in 2020. Her research focuses on issues related to peacebuilding, security sector reform, and environmental security. More recently, she has authored a number of papers focused on civil society engagement in Yemen's UN-led peace process. She holds a B.A. in Political Science from Stanford University.

About the Report

In Yemen, the impacts of climate change and water scarcity are interlinked with conflict. Yet, these interlinkages are neither highlighted in analyses on the conflict today nor considered explicitly in peace-building programs. One reason for this is the lack of awareness amongst local CSOs and officials, a shift of priorities amongst international organisations, and a general lack of understanding of the interlinkages of climate change, water scarcity, and conflict. If organisations and local institutions continue to ignore these interlinkages, achieving sustainable peace will become ever more difficult. The report aims to detail these interlinkages; make information available to Yemeni and international stakeholders; and put climate change and water scarcity on the agenda of international organisations.



The Yemen Policy Center is an independent think tank established in 2020 by a group of Yemeni and German researchers associated with the Yemen Polling Center, a Yemeni NGO headquartered in Taiz, Yemen. Yemen Policy aims to impact local and international policymaking with the ultimate goal to improve the living conditions of the Yemeni people. With its research and advocacy activities, Yemen Policy works towards a closer integration of local perspectives into the policy-making process. While upholding the principles of the Human Rights Charter, Yemen Policy's strategy is to advocate for good governance reforms based on sound research and to support the creation of communication channels between citizens and state institutions. By seeking out and sharing positive stories and best practices, Yemen Policy does not only aspire to put local communities into the position to help themselves but also to put Yemeni civil society activities into the spotlight.