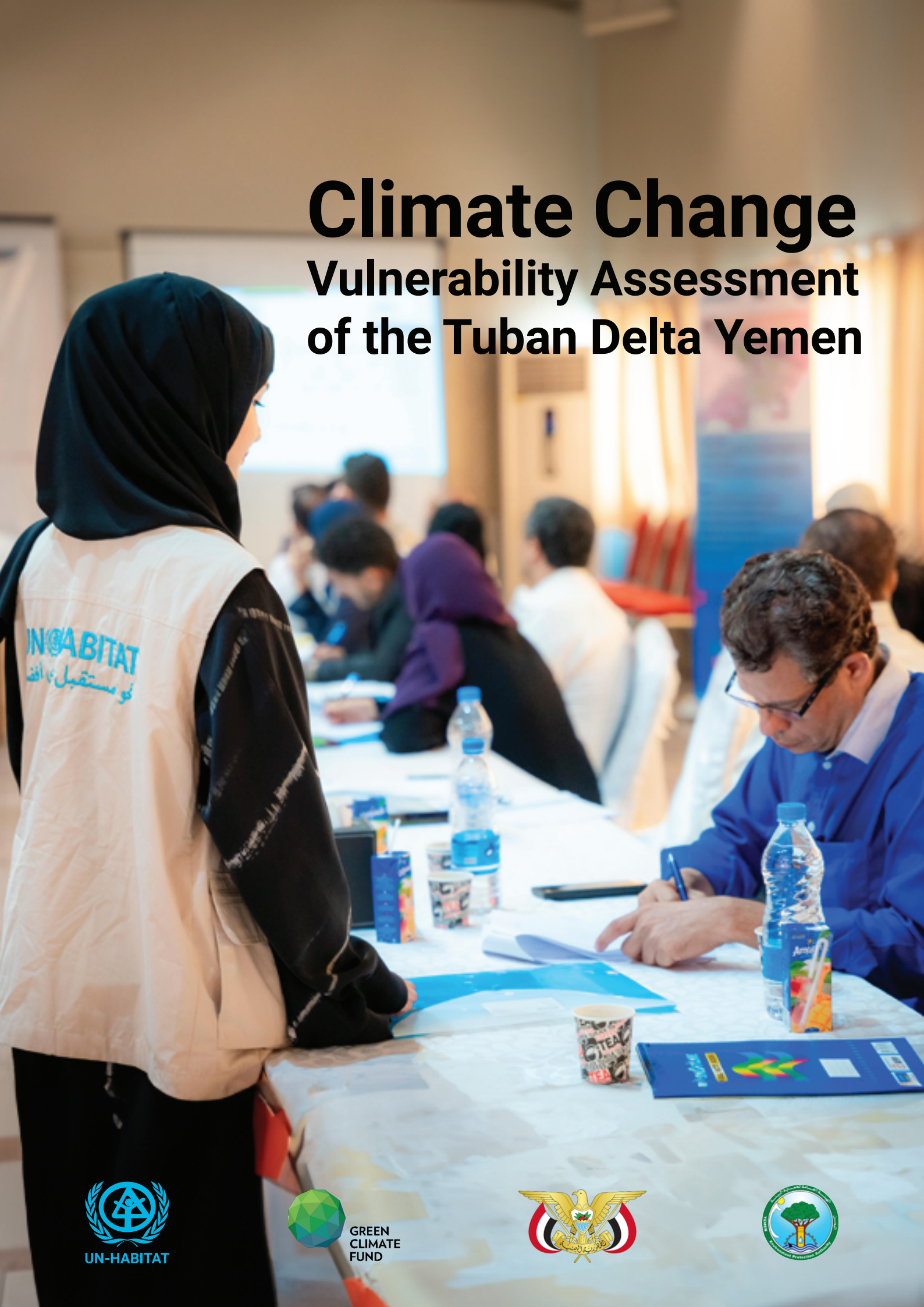
Climate Change
Vulnerability Assessment of the Tuban Delta Yemen



EXECUTIVE SUMMARY

This study is part of the Green Climate Fund (GCF) Readiness project 'Strengthen the capacities of sub-national authorities and key actors in the water sector to adapt to climate change in the Tuban delta'. The project is implemented by the United Nations Human Settlement Programme (UN-Habitat) in coordination with the Environmental Protection Authority (EPA) of Yemen, through Mr. Abdulwahid Arman and many national and international stakeholders including FAO.

The goal of the project is to enable the government of Yemen, and especially target sub-national authorities, to respond to climate change in the Tuban delta. This Climate Change Vulnerability Assessment (CCVA) alongside the hydrology study, also prepared for this project, are the basis for identifying adaptation options for the water sector. Further to this, the project will develop concept notes to access funding for the strategic investment priorities identified in this process.

An example of the destruction caused by flooding is from spring of 2020 when 30,000 people across all of the districts of Lahj and 11,000 people in Aden, many of whom were already displaced people, were affected by flooding as the result of a tropical storm. The situation in Aden City was declared a disaster zone by the government and seven people died as a result. There was also widespread damage to public and private property and basic services were affected. [1]

Yemen is also one of the most water scarce countries in the world and as a result millions of people do not have access to safe drinking water.

The following table summarizes the vulnerability for water security and flooding, the two hydrological climate change impacts assessed for the three regions. Flooding risk includes flash floods from rainfall and overtopping of the wadis as well as coastal flooding. Water Security includes both drought and chronic water stress.

	Upper Region	Middle Region	Lower Region
Water Security	Medium-High	High	High
Flooding	Medium	Medium-High	High

The Lower Region has high vulnerability to both water security and flooding which is largely due to the higher number of people and assets exposed and sensitive to these hazards as well as the added hazard of sea-level rise which affects flooding and water security but only in the Lower Region. The Middle Region has a high vulnerability to water security due in large part to the large agricultural production in the area and a medium-high vulnerability to flooding as it has less assets and people exposed to flooding yet there remain sensitivities and a lack of adaptive capacity. The Upper Region, due at least in part to less assets and people only has a medium level of vulnerability, however due to the reliance on agriculture for livelihoods, there is a medium-high vulnerability for water security.

[1]FRC Emergency Plan of Action, Yemen: Floods

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1. Project Introduction and Vulnerability Assessment Summary

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The CCVA was developed based on the inputs from workshops, field research, focus groups and interviews, the review of related studies and the hydrology study. The focus on the climate change impacts related to water security and flooding and the division of the Tuban Delta into three regions was the result of a workshop held in December 2022 to plan to work.

The climate change vulnerability assessment focuses on two key climate change impacts related to water for the Tuban Delta, Yemen: Water Security and Flooding. The table below shows the relationship between climate change drivers, hazards and these two key impacts .

Climate change driver / stressor	Climate change hazard	Impacts / issues
Reduced precipitation	Droughts	Water scarcity (including due to saltwater intrusion) leading to agriculture production issues, lack of clean drinking water, etc.
Increasing temperatures	Heat (wave)	
Increased precipitation	Floods (river and flash)	Flooding (flash, river, coastal) affecting people and critical infrastructure
Sea-level rise	Coastal flooding, erosion,and saltwater intrusion	

Vulnerability was assessed as a function of exposure, sensitivity and adaptive capacity to the hazards identified, utilizing qualitative and quantitative indicators. The vulnerability assessment focused on vulnerable assets (both economic and physical), vulnerable groups of people, and vulnerable ecosystems, in order to capture the social, economic and environmental aspects of vulnerability.

Exposure indicators measure the number of people and assets at risk to the impact, for flooding this includes infrastructure assets and ecosystems as well as people; whereas for water security it focuses on agricultural land and people. The sensitivity indicators are more qualitative and try to assess who or what is most vulnerable. For floods, this includes people living in IDP camps and informal settlements[2] as well as whether the infrastructure is critical at a regional or local level. For water security, the sensitivity indicators look at the types of crops being utilized and how drought resistant they are and the percentage of the population engaged in farming.

For adaptive capacity, there were two indicators which were the same across flooding and water security which was about existence of relevant management plans for water, climate change and/or land use and access to financial assistance for men and women. There was one adaptive capacity specifically for water security which was the use of modern irrigation methods and for flooding, the indicator was knowledge of climate change among local officials.

The following table summarizes the vulnerability for water security and flooding, the two hydrological climate change impacts assessed for the three regions.

	Upper Region	Middle Region	Lower Region
Water Security	Medium-High	High	High
Flooding	Medium	Medium-High	High

The Lower Region has high vulnerability to both water security and flooding which is largely due to the higher number of people and assets exposed and sensitive to these hazards as well as the added hazard of sea-level rise which affects flooding and water security but only in the Lower Region. The Middle Region has a high vulnerability to water security due in large part to the large agricultural production in the area and a medium-high vulnerability to flooding as it has less assets and people exposed to flooding yet there remain sensitivities and a lack of adaptive capacity. The Upper Region, due at least in part to less assets and people only has a medium level of vulnerability, however due to the reliance on agriculture for livelihoods, there is a medium-high vulnerability for water security.

[2]A term given to settlements or residential areas that by at least one criterion fall outside official rules and regulations. Most informal settlements have poor housing (with the widespread use of temporary materials) and are developed on land that is occupied illegally with high levels of overcrowding. In most such settlements, provision for safe water, sanitation, drainage, paved roads, and basic services is inadequate or lacking

2. Climate Change Vulnerability Assessment Methodology

The vulnerability and risk assessment focuses on two key climate change impacts related to water: Water Security and Flooding. The hazard assessment is based on the hydrology study completed as part of this project and the relationship of climate change indicators to hazards to impacts.

The methodology was developed based on the Climate Change Vulnerability and Risk guide by UN-Habitat which has been translated into Arabic as part of this project.

For water security the climate change indicators are temperature, precipitation and sea level rise which then correlate to the hazards of heat, drought and saltwater intrusion.

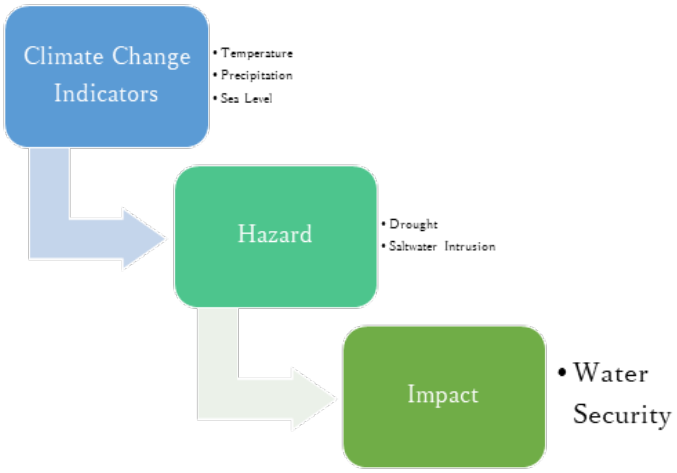

Figure 1. *Climate Change Indicators, Hazard and Impact for Water Security*

For flooding, the climate change indicators are precipitation and sea level rise which correlates to the hazards of both coastal and inland flooding.

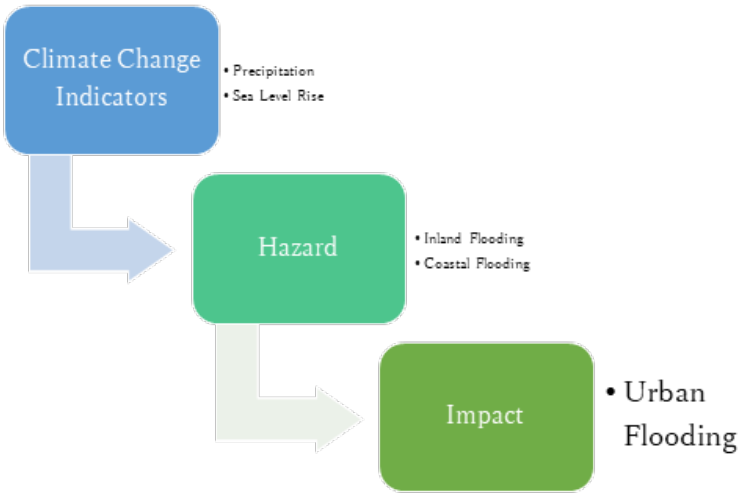

Figure 2. *Climate Change indicators, hazards, and impacts for flooding*

The hydrological study assessment provides a breakdown of two climate change scenarios RCP8.5 which is the highest emissions scenario and RCP 7 which is also higher emissions. The timeframes used are 2030-2040, 2041-2060, 2061-2080, 2081-2100.

For the flood risk assessment from rainfall, the high is ranked as 3, medium as 2, low as 1.

Years/regions	RCP 7			RCP 8.5		
	LR	MR	UR	LR	MR	UR
2023-2040	2	1	1	2	1	1
2041-2060	2	1	1	3	2	2
2061-2080	3	2	2	2	1	1
2081-2100	3	2	2	3	2	1

Table 2. *Adapted from Table 36 Urban Flood Risk Assessment for Tuban Delta from Hydrology Study*

This yields an average risk score for flooding as a result of rainfall as 2.5 for the Lower region, 1.5 for the Middle Region and 1.375 for the Upper Region. Only the Lower Region is potentially susceptible to flooding from sea level rise. It also should be noted that the flash flood risk assessment yields higher risk for all regions after 2061 in the high emission scenario and after 2081 in the medium-high emission scenario.

How Vulnerability was assessed

Vulnerability was assessed as a function of exposure, sensitivity and adaptive capacity to the hazards identified, utilizing qualitative and quantitative indicators, based on best practice from international guidance including UN-Habitat and IPCC. The vulnerability assessment focused on vulnerable assets

(both economic and physical), vulnerable groups of people, and vulnerable ecosystems, in order to capture the social, economic and environmental aspects of vulnerability.

The community profiles developed for the three regions for this project and the hydrology study provide the basis for the data for the indicators.

The following indicators were used to assess vulnerability to flooding. These were selected to incorporate quantitative and qualitative aspects as well as to cover the environmental, social and economic aspects. They were also selected based on the availability of data and information and use both historical and current data and context.

Exposure (Quantitative)	Sensitivity (Qualitative)	Adaptive Capacity
Number of Infrastructure & Economic Sectors Assets	Potential for Critical Assets - infrastructure and economic sectors - to be impacted	Local Knowledge of Climate Change
Population size	Potential Vulnerable and Marginalized populations affected	Access to Financial Assistance
Number of critical Ecosystems/ nature reserves	Level of Encroachment and Degradation of Critical Ecosystems	Relevant Plans (Climate Change, Land Use)

Each indicator was then rated on a scale of 1 to 3, using the following scoring for all of the regions.

	Exposure			Sensitivity			Adaptive Capacity		
Score	# of Infrastruc-ture Assets	# of People	# of critical Ecosystems	Infrastruture	People	Ecosystem-s	CC Knowl-edge	Plans	Financial Assistance
3	>10	>500,000	>5	Critical infrastruc-ture of regional importance at risk	People living in IDP camps; people living in informal settlements at risk; elderly; disabled; women and children	Endan-gered eco-systems or species	Limited	0	None
2	5 to 10	100,000 to 499,999	1 to 5	Critical infrastruc-ture of local importance at risk	People living in informal settlements at risk; elderly; disabled; women and children	Locally important ecosystem	Medium	1	Limited i.e. primar-ily for men or certain groups such as farmers
1	<5	>100,000	0	No critical infrastruc-ture at risk	Elderly; disabled; women and children		High	At least 2	Accessi-ble to all

After all indicators were scored, then the scores were compiled and vulnerability was assessed on the following scale:

Vulnerability Scoring

>20	High
15 to 20	Medium-High
10 to 15	Medium
5 to 10	Medium-Low
0 to 5	Low

The following vulnerability indicators were used for Water Security, based on similar parameters as outlined above for flooding.

Exposure (Quantitative)	Sensitivity (Qualitative)	Adaptive Capacity
Hectares of Agricultural Land	Types of crop	Irrigation Methods
Population size	Potential Vulnerable and Marginalized populations affected	Relevant Plans (Water Management, Climate Change)
Water Supply: Renewable Water Sources	Water differential (between supply and demand)	Access to Financial Assistance

Then the following scoring system was applied to the indicators.

	Exposure			Sensitivity			Adaptive Capacity		
Score	**# of Hectares of cultivated land**	**# of People**	**Water Supply: Renewable Water Sources**	**Crop Types**	**People**	**Water differential (between supply and demand)**	**Irrigation Methods**	**Plans**	**Financial Assistance**
3	>4000	>500,000	<25 MCM	Water Intensive Crops: Cotton, Vegetables	More than %33 of households not linked to water grid	Less than 0	Less than %10 Modern Irrigation	0	None
2	-2500 3999	100,000 to 499,999	25 to 50 MCM	Medium Water Intensive crops: Sesame, watermelon	Between %33-10 of households not linked to water grid	0 to 20 MCM	%25-10 Modern Irrigation	1	Limited i.e. primarily for men or certain groups such as farmers
1	<2500	>100,000	>50 MCM	Less water intensive crops: Sorghum, millet	Less than %10 of households not linked to water grid	>20 MCM	Over %25 modern irrigation	At least 2	Accessible to all

And the same scoring scale as with flooding was utilized.

Limitations of the extent to which other Impacts/Co-benefits were considered in the Vulnerability Assessment.

There are other impacts from climate change and hazards which may affect the Tuban Delta region, given the existing context especially Food Security, Health, marine and terrestrial ecosystem functioning, and how migration patterns may change. These were not extensively studied as this assessment focused primarily on the water sector, however positive outcomes for food security and health could be considered as important co-benefits in the selection of projects.

3. Community Profiles

3.1 Lower Region of the Tuban Delta

The Lower Region of the Tuban Delta includes both the Aden Governorate and the city of Aden as well as part of the Lahj Governorate south of Al Hawtah extending to where the two governorates meet. This area covers 1030 km2 with a population of 1,133,013. Of this, there are 524,106 females and 608,906 males and the majority of people 1,082,942 are in the Aden Governorate and the remaining 50,071 in Lahj Governorate. This region is the largest in terms of land area and population of the three regions.

Information about the community is based on data provided by the Aden and Lahj governorate, through field visits and focus group discussions, interviews with key officials, GIS analysis and the Aden city profile completed by UN-Habitat in 2020. Where information is not available at the local level, estimates from the national level and/or international studies have been utilized. In some cases, the information is only available for Aden city and/or Aden Governorate.

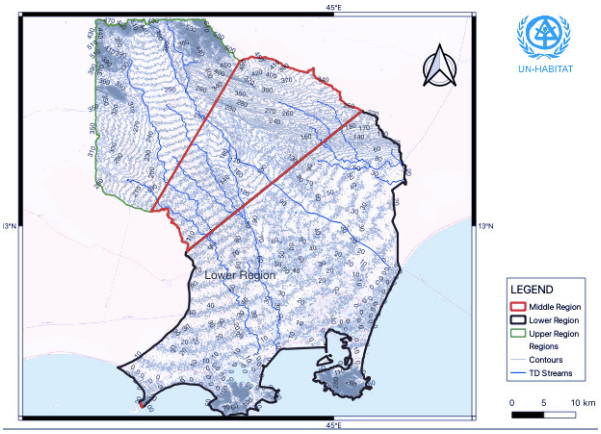

Figure 3. *The three regions of the Tuban Delta and major streams and elevation. UN-Habitat, 2023.*

The focus group discussions were divided into three groups: men, women and farmers. In addition, local government officials and representatives of the water user associations were interview in February 2023. They highlighted some key challenges of the population including: lack of jobs, high food prices, and health and water pollution. The farmers' group also highlighted the change in food security for farmers in the sense that they are no longer getting food from their farms to feed their families.

Population

The Lower Region has a total population of 1,133,013, of which 46.3% are females and 53.7% are males, as with elsewhere in the country, there are more men and boys than women and girls. The Aden Governorate portion of the Lower Region is 1,082,942 as it includes the second largest city in Yemen, Aden which is also the capital of the governorate.
The Lahj Governorate in the Lower Region has just over 50,000 people living in over 50 villages ranging in size from less than 100 people to a few larger ones of around 7,000 people.

According to figures provided by the Aden Governorate, the population has grown from 589,419 in 2004 to an estimated 1,051,000 in 2021. This is almost a doubling of the population in 17 years.

Yemen is a very young country although the rural areas and smaller cities skew slightly older than the larger cities. Aden Governorate estimated that there were 485,767 youth under the age of 15 in 2021 which is about 46% of the population, unfortunately gender disaggregated figures are not available. The elderly population (people over the age of 65) of Aden Governorate was estimated at 34,892 in 2001.

There are varying figures estimating the number of disabled people in Yemen from 3% of the population according to the 2013 National Health and Demographic Survey to 14.5% or 4.8 million people according to WHO and Handicap International. Based on this, there may be almost 75,000 handicapped females and over 88,000 handicapped males, in the Lower Region. However, if we take the more conservative estimate then this would be around 15,000 and 18,000 handicapped females and males, respectively.

In terms of diseases, Aden has been affected by cholera outbreaks in 2016 and 2017 and cases of diphtheria in 2017. It was reported that there has also been an increase of malaria and diarrhea in Aden as well. Children are particularly susceptible to diarrhea and also suffering from malnutrition, respiratory tract infections and measles and dengue fever in addition to cholera. Children living in poor housing conditions, lacking water and sanitation and access to health services, such as children in displaced and refugee populations are especially vulnerable. A Nutrition and Mortality Survey in 2015 carried out in Aden governorate in August 2015 found 19.2% of children were acutely malnourished and 23.4% were underweight.[3]

Women and girls face challenges including underrepresentation in education; participation in formal labor markets; lack of legal frameworks setting the minimum age for marriage, divorce, inheritance and child custody; and lack of maternal healthcare.[4] The women's focus group for this project also highlighted that women are marginalized because they are not involved in decision-making.

In terms of ethnic minorities or marginalized groups, the Muhamasheen community who suffer from caste-based, socio-economic and political discrimination. There are no official statistics of the community but in 2014, UNICEF estimated that the population is about 10 percent of the population in the country.

[3]UN-Habitat (2020) Aden City Profile
[4]UN-Habitat (2020) Aden City Profile

According to the UN-Habitat Aden city profile, the Muhamasheen face less discrimination in Aden than other places however they still struggle to access employment, housing and basic services.

There is an on-going humanitarian crisis in Yemen which exacerbate existing social, economic and environmental inequalities and fragilities. According to UNHCR, there is a total of 95,224 IDPs in the Aden Governorate and 28,345 refugees and asylum seekers, the second largest community in the country.

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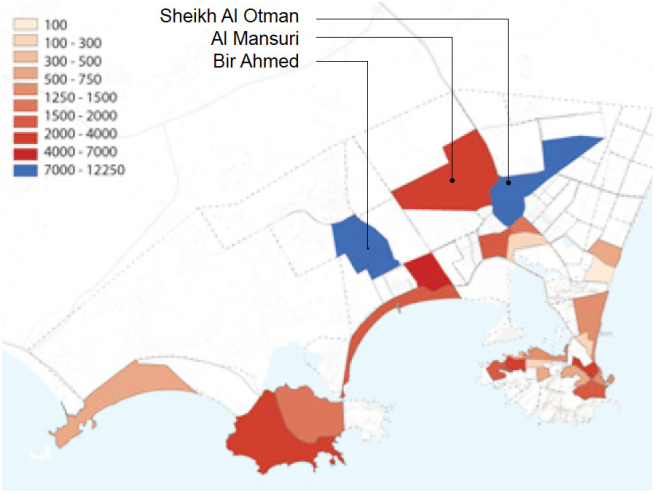

Figure 4. *IDPs residing in regular accommodation in Aden, Yemen. UN-Habitat, 2019.*

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[5]According to the Central Statistical Office of Yemen (CSO) projected numbers for 2018, the age and gender breakdown of IDPs are as follows: 21% are men, 23% are women, 28% are boys and 27% are girls. In the city of Aden, IDPs are in higher density in some neighborhoods than others, as illustrated in the map in Figure 4. According to the UN-Habitat city profile, 70% of IDPs have settled in one of the city cores and only 30% in new expansion areas. In addition, there are 71 IDP camps in 2023 in the Lower Region, according to UNHCR. The water users and government officials interviewed for this project highlighted that IDPs are marginalized in this region.

Land Use

Aden is the largest city in southern Yemen and host to a major seaport in one of the world's largest natural harbors. Historically, the city has been an important node in trading networks and had strategic significance in the British colonial period when it was one of the busiest refueling stations in the world and was a global transit point for trading between Europe, East Africa, the Arabian Peninsula and East Asia.

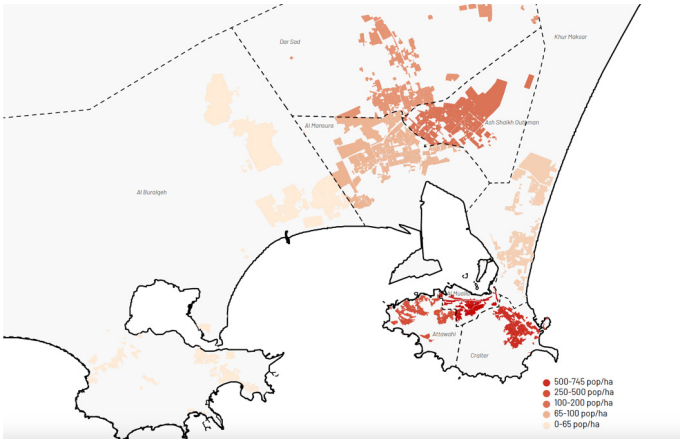

Figure 5. *Urban densities in districts in Aden. UN-Habitat, 2019.*

[5]https://data.unhcr.org/en/country/yem#_ga=2.51079209.1447391314.1679905938-1498650503.1679905938

Historically, Aden has consisted of urban centres or clusters of similar size. The UN-Habitat city profile found that the recent growth in the past 15 years has been low density urban development, some of it planned development such as residential compounds with villas or small multi-family condos as well as single houses on empty land in the urban periphery. Due to geographic constraints such as the sea, there have been distinct development patterns in different urban centers. In most districts, the density increased, however some districts such as Al Buraiqeh and Al Mansaurah, the density decreased due to urban sprawl.

Demand for housing due to urbanization, demographic pressure and high inflation has resulted in overcrowding in many households in Aden.

In 2005, the World Bank supported a second master plan for Aden for the period of 2005-2025 that estimated USD 30 million was needed to improve public services and infrastructure for a growing population projected to reach 1.5 million by 2025.

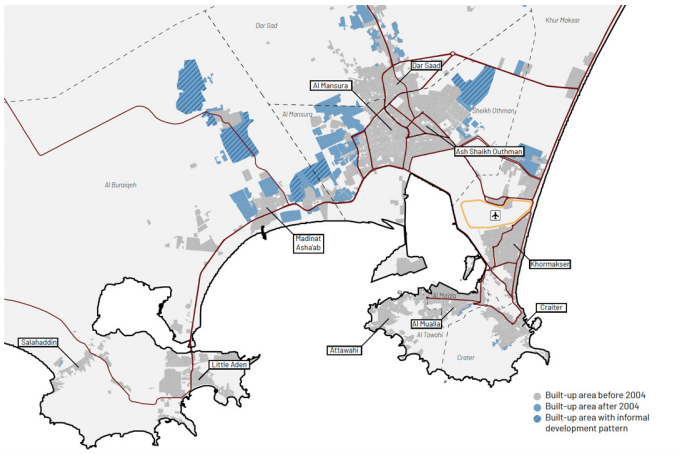

Figure 6. *Population, density, and built-up area per district in Aden. UN-Habitat, 2019.*

Despite all that has happened which was note predicted in this plan, as noted above the population of Aden has grown steadily and is over 1 million and could reach this mark by 2025. The Master Plan recommended the construction of 15 new neighborhoods and expansion of the existing industrial zones with planned expansion in areas north and east. The map in figure 6 shows the growth after 2004 and that much of it has been north and east and the urban centers but there has been a lot of built up area with informal development patterns since this time.

All of the focus groups noted that there has been land use change in the lower region in the past few decades, especially with the loss of agricultural land. However there were different causes of this attributed by the various groups with the men's group citing desertification and flooding of agricultural lands due to dam construction and the women's group and local authorities attributing it to urbanization. Farmers noted that around 10 years ago there was a change with less agricultural land. The men's group also noted this timeframe and loss of agricultural land and cited the issue as desertification.

The main industrial areas in Aden are the oil refinery in Al-Buriqah district, the light industry Al Durain and the Aden Free Zone (AFZ) and there are eleven saltworks in Aden which until recently processed, refined, and
packed 150,000 metric tons of salt a year. Figure 7 shows Aden production zones as mapped by UN-Habitat.

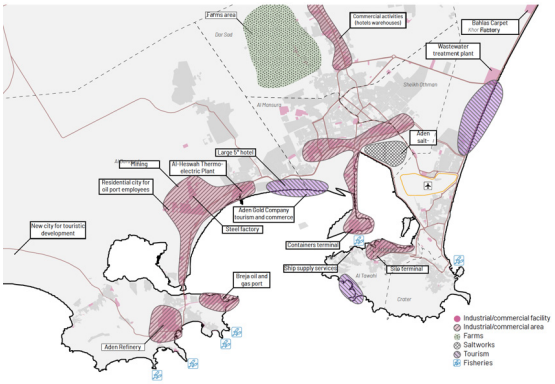

Figure 7. *Aden production zones. UN-Habitat, 2019.*

In the focus groups and interviews when asked about key infrastructure, the water users noted that in the past there was a cotton factory and tomato paste factory. Now there is the Nasser Well Station with generators. The government officials also noted the water station and the Bir Nasser Power Station as well as the brick factory.

Most of the cultural and religious heritage sites are located in the areas of Attawahi, Al Mualla and Craiter, UN-Habitat (2019). According to UNESCO field surveys, over 95% of heritage sites in the city have sustained significant damages from conflict related causes.

Ecosystems/Natural Resources

The Lower Region of the Tuban Delta includes ranges from more arid lands in the northern part to wetlands, coastal ecosystems and the natural harbor in Aden as well as a dormant volcano which is now a major residential area. The wetlands in Aden include lagoons, salt plains, mud-flats, marshes and beaches and are habitats for many bird species.[7]

There are many pressures on wetland ecosystems, including development encroachment, withdrawal of water for irrigation and contamination from oil pipelines and untreated wastewater. The marine ecosystems are also affected by the untreated wastewater which affects marine life and has resulted in a decline in fishing stocks.

There have been two reserves established in the Aden Governorate: Al-Heswah Wetlands Reserve and a Nature Reserve for Swans.

Communities surrounding the Al-Heswah Wetlands Reserve are active in supporting ecosystem restoration and biodiversity management. They worked on an initiative to redirect wastewater from the Aden sewage plant to restore the wetland water table and in order to ensure the water is properly treated, they planted a four-hectare buffer zone with doum palm which purifies the wastewater, removing toxins before the water reaches the wetland ecosystem. [8]The communities have also established an ecotourism site that provides bird-watching sites and recreational sites for a small fee.

In the focus group discussions for this project, participants were asked about critical biodiversity and the following flora were noted: Aloe vera, pomegranate, lemon, henna, sesbania and tamarind. The fauna noted were fox, rabbit, ferret and monkey although all of these were said to be in decline.

Economy

Aden has a long history has an economic hub in the region, connecting the interior of the country with an active international port. Although the Lower Region still has a lot of agricultural activity, the local economy of Aden is different from much of Yemen. Business and commerce have been a major portion of the economy and contributed to the emergence of a substantial middle class and has a large share of three major economic activities: mining and quarrying, transportation and storage and real estate.[9]

In terms of the economics of the port, prior to the conflict, the majority of cargo consisted of oil and oil represented 75% of the government revenue and 90% of export revenue.[10]However, oil and gas production has slowed due to the conflict.

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[6]*https://www.equatorinitiative.org/wp-content/uploads/2017/05/Al-Heswa-Yemen.pdf*
[7]*UN-Habitat (2020) Aden City Profile*
[8]*https://www.equatorinitiative.org/wp-content/uploads/2017/05/Al-Heswa-Yemen.pdf*
[9]*UN-Habitat (2020) Aden City Profile*
[10]*USAID, Property Rights and Resource Governance: Yemen, USAID Country Profile, 2010, https://www.land-links.org/wp-content/uploads/2016/09/USAID_Land_Tenure_Yemen_Profile-1.pdf*

National policy has encouraged investments in the fisheries sector, which is dominated by small-scale enterprises. Fisheries was the largest export earner after oil and gas and employs 1.5% of the national labor force and is also critical to meet food needs in the area. Unfortunately fishing, like agricultural production, has decreased from pre-conflict levels resulting in the displacement of many fishermen.[11]

For the Tuban District of the Lahj Governorate in the Lower Region, the government reports that 70% of the population works in agriculture but this only represents 75% of their income and the remaining 25% is supplemented by informal and irregular daily work. In Aden, around 7% of population work in agriculture, but this is only 50% of their income source, while the remaining 50% comes from irregular, informal daily work.
The focus group discussions also said many people have government jobs or are employed by the private sector however the women's group noted that women are primarily housewives.

Infrastructure and Services

In Aden, the water supply grid is approximately 1,111 km long and consists of 34 reservoirs and water towers, 3 water sterilization facilities, 8 water pumping stations and 116 water wells.[12]The main source for obtaining water is groundwells, however water supply is limited, at least in part due to electricity. The UN-Habitat profile for Aden found that in half of the city's districts (Al Buraiqeh, Al Mansura, Attawahi and Craiter), the water is only available on average from 0-4 hours. In five districts (Dar Sad, Craiter, Khur Maksar, Al Mualla and Attawahi) lack of water for cooking, bathing, laundry and personal hygiene were reported as a top priority in need of attention.[13]The hydrology study for this project found that 25% of households in the Lower Region are not linked to the public water delivery.

According to the hydrology study for this project, domestic water use is 110 litres per day per capita. Almost half (44%) of the households in Aden have reported reducing water consumption either because of unavailability or because of high prices. As of April 2020, Aden local council provided 30 million m3 of water per year, while the estimated demand was 39 million m3. The majority of households in Aden rely on piped water as the primary source for drinking and other household functions. Other sources of water supply include trucking, boreholes, and storage tanks. The most persistent issues in the community are lack of water points, long waiting times at water point queues, non-functionality of water points, and perceived poor quality of water

The women's focus group noted that women and children are responsible for water collection and it costs about 1,000 Yemeni riyals in a month. They are also concerned about the water quality. The farmers' group also estimated 1,000 Yemeni riyals per month and that 50 years ago people got water from the well by bucket but now its so deep that they need pumps which require electricity and when this goes out, it is an issue for water collection.

[11]*UN-Habitat (2020) Aden City Profile*
[12]*Dorsch International Consultants GmbH, Yemen Water Sector Damage Assessment Report of Twelve Water Supply and Sanitation Local Corporations (LCs) and their Affiliated Branch Offices and Utilities, Annex 2 – Technical Assessment Report for LC Aden; (Bonn and Eschborn: GIZ, September 2018).*
[13]*UN-Habitat (2020) Aden City Profile*

The men's group said it was 2,000 Yemeni riyals per month for water from government and private wells. The local authorities said that water is provided by public water network and ground water wells. They cited that the cost is 1,000 litres for 3,000 RY and that some of the farmers sell water from their wells. The water users said the price of water was 3,000 litres for 1 USD and that farmers provide water to other farms in exchange for 25% of their crops

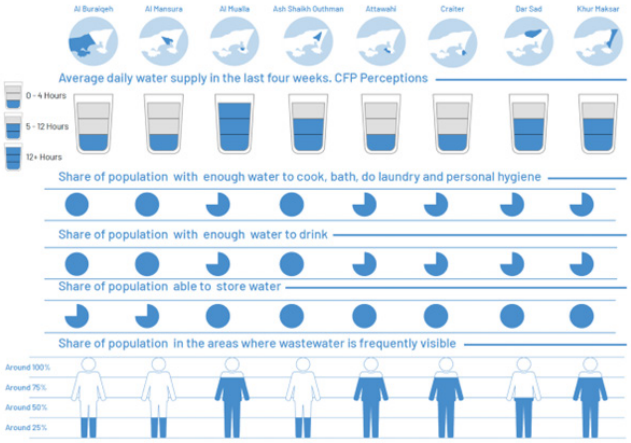

Figure 5. *Availability of WASH Services in Aden City. UN-Habitat, 2019.*

There was an agreement that farmers get their water from groundwater floods and that farmers stop farming when there is a lack of water and they use drip irrigation and that the water is drinkable.

In Aden, about 86% of the city's population is connected to the public water supply system and 69% is connected to the sanitation system. The sanitation system has about 391 km piping collection network and three wastewater treatment plants with a total capacity of 100,000 m3 per day. In three districts located in southern and eastern Aden (Al Mualla, Attawahi, and Crater), insufficient and inadequate sanitation facilities were reported, or too crowded if available. In five districts out of eight (all except for Ash Shaikh Outhman, Al Mansura, and Crater) there is no drainage system. There are major problems with sewage systems reported in five districts (all except Al Buraiqeh, Al Mansura and Ash Shaikh Outhman) as most areas have constant sewage problems. Furthermore, 75% of people living in Al Mualla, Attawahi, Crater and Khur Maksar reported that wastewater is frequently visible; due to non-functioning pumps and intermittent electricity. [14]

There are issues with energy and electricity supply in Aden, exacerbated by the damage that the grid has suffered as a result of the conflict. The figure below shows that many neighborhoods in Aden have electricity for less than half of the day and that all neighborhoods have suffered damage to the grid.

The decrease of electricity supply led residents to increasingly rely on solar energy which they install themselves, however access to solar energy remains limited due to high costs for installation. Many households therefore rely on small generators or invertor batteries to supply some power when the electricity is out.

[14] *UN-Habitat (2020) Aden City Profile*

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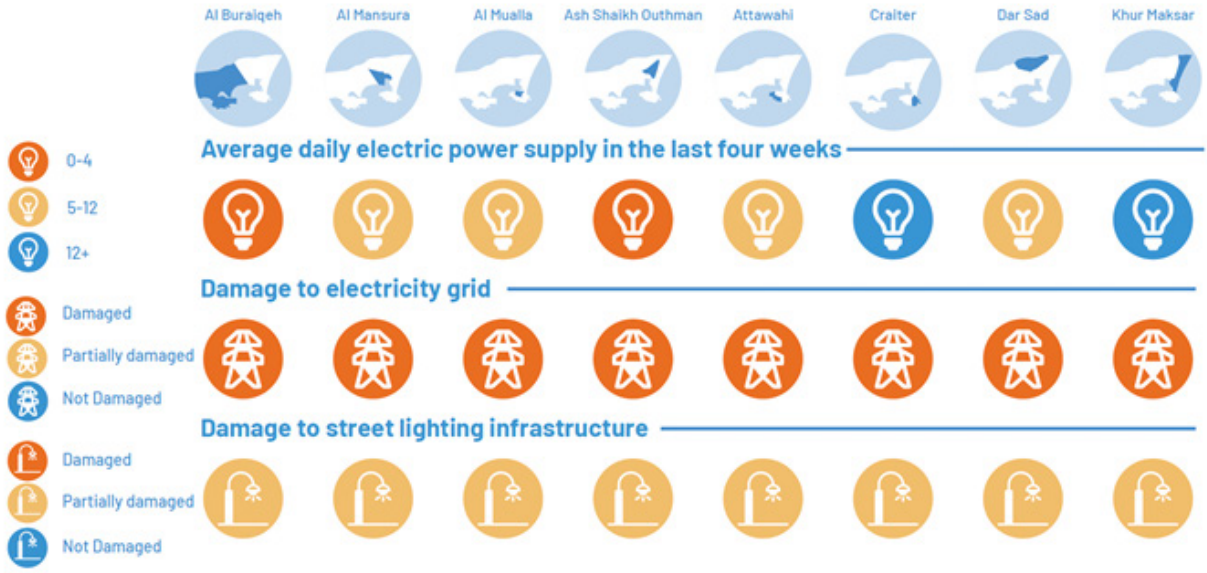

Figure 9. *Energy and Electricity Supply in Aden. UN-Habitat, 2019.*

Solid waste disposal is another issue in Aden. While garbage is collected once or multiple times per week in most districts, visible piles of garbage are still seen in all districts. The number of waste collection vehicles has significantly decreased since 2015, with many vehicles damaged, inaccessible or stolen. There was also a drastic reduction in numbers of available personnel.[15]

Overall, the condition of roads is poor throughout the city. The road network is completely damaged in four districts (Al Buraiqeh, Al Mualla, Ash Shaikh Outhamn and Dar Sad) which limits the mobility within the city and contributes to traffic congestion across the city. Regional connectivity is also affected by damaged roads, notably the road connecting Aden and Taizz. Due to high fuel prices, many people are increasingly relying on public transportation.[16]

Internet and mobile network services are available in all districts of Aden, however it can be limited and network coverage is poor in most districts, with the exception of Al Mualla and Crailer. In the interviews with local authorities for this project, they noted that almost everyone has a telephone and most men and women utilize social media.

[15] *UN-Habitat (2020) Aden City Profile*
[16] *UN-Habitat (2020) Aden City Profile*

In terms of health services, there is a lack of health facilities, as well as medical personnel throughout the city and certain services, including emergency and major surgery, are not available in most districts.
Furthermore, already prior to the conflict, the quality of healthcare services, especially specialized ones, was poor, with those that could afford it, travelling abroad to receive treatment. The figure below shows the location of the main health facilities in Aden.

According to the Humanitarian Needs Overview (HNO), almost half the population of Aden are in need of healthcare assistance and an estimated 245,661 people in Aden governorate are in need of nutrition assistance, with 156,127 people in acute need.

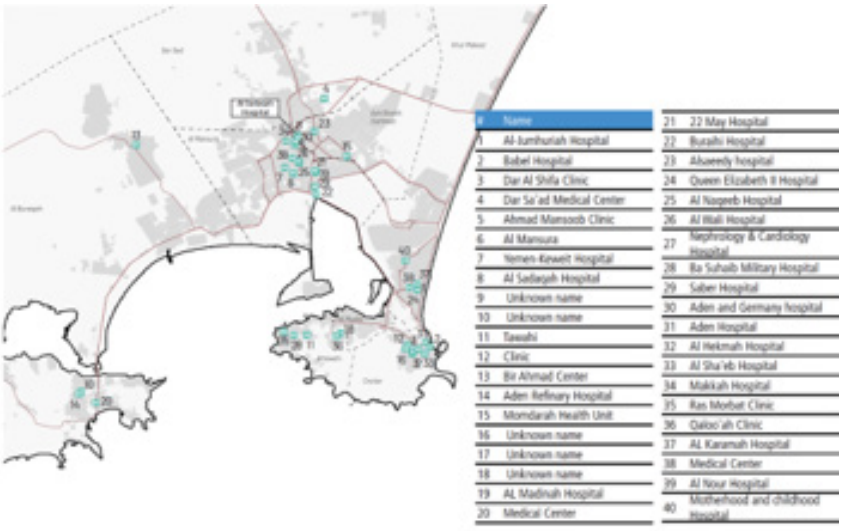

Figure 10. *Main health facilities in Aden. UN-Habitat, 2019.*

Over 80% of Community Focal Points interviewed for the Aden City Profile selected provision of healthcare services, including health facilities, health personnel and health services, as a critical need for the population in Aden.

In 2013, the total enrollment for basic education in Aden was 80%, and the following year, the enrollment rate was estimated to be 77%. [17]

According to the Joint Education Needs Assessment, an estimated 20 percent of children were out of school in Aden in 2016. Currently, attendance varies from one district to another, with the lowest rates observed in Khur Maskar. Female students aged 3-5 and 13-17 are disproportionately affected in Al Mualla where an estimated two-thirds of the respective age group populations are out of school. The following figure shows school attendance by district, broken down by age and gender.[18]

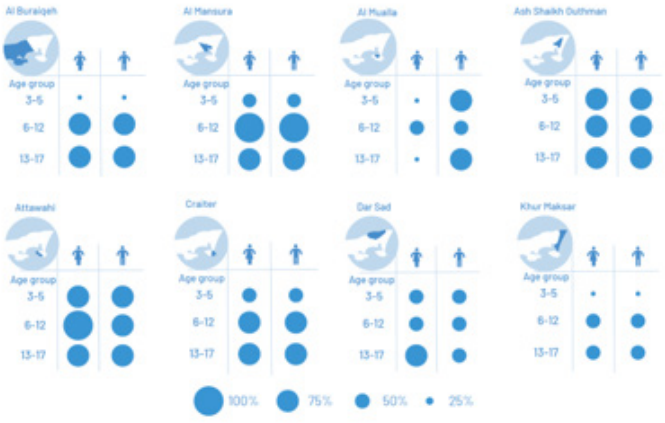

Figure 11. *School Attendance rates in Aden. UN-Habitat, 2019.*

[17] *Save the Children, Yemen Education Cluster, Joint Education Needs Assessment Report, Aden – Yemen, (2016).*
[18] *UN-Habitat (2020) Aden City Profile*

Most of the schools that sustained damage were rehabilitated by the end of 2016 and during the rehabilitation, many students were able to attend lessons at nearby schools. However teacher absenteeism and lack of studying materials have contributed to quality of education issues. A map of education facilities is below.

Figure 12. *Education Facilities in Aden. UN-Habitat, 2019.*

Governance

Aden is the interim capital of the Internationally Recognized Government of Yemen. Daily administration of the city and its eight districts is undertaken by the Local Councils (LCs).

According to an analysis for the UN-Habitat Aden City Profile, the main sources of revenue for the city are building permits and rehabilitation fees, municipal taxes and levies, fines for building violations, direct investments and parking fees. Revenue has declined since 2015 due to the decline of the oil industry. LCs lack the authority to set a budget to cover their operations and rely on financial support from the central government.

Decentralized authority actually varies by district with some districts able to select contractors and define recovery and development projects without needing permission from the central government and others requiring permission. In general however, districts cannot borrow funds without permission from the central government, however all the districts in Aden, except Dar Sad, can deal with international aid or stabilization programmes without needing to get permission from the central government. About half of the districts can also sign agreements with private sector, however only three can set user charges for services.[19]

A full breakdown is portrayed in the figure below.

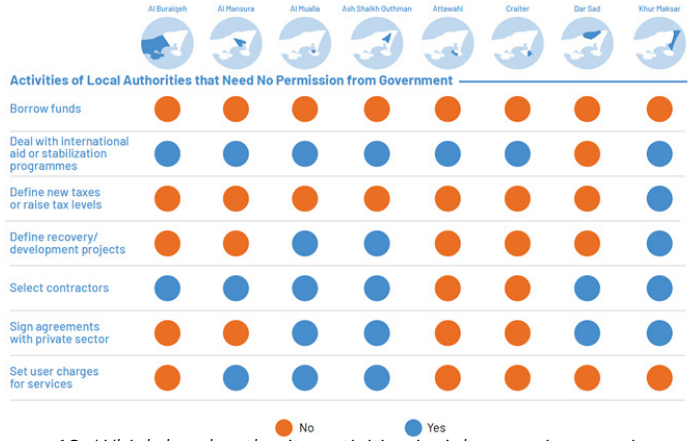

Figure 13. *Which local authority activities in Aden require permission from the central government. UN-Habitat, 2019.*

[19] *UN-Habitat (2020) Aden City Profile*

The LCs are very important public institutions in Yemen because are responsible for providing basic public services to their electorate in education, health, water and sewage, waste collection, electricity, road repairs, and infrastructure. However, legal ambiguities, bureaucracy, lack of trained personnel, and
disruptions by years of conflict hinder effectiveness. In Aden, the complex governance structures shared between the various political interests complicates local administration. Collaboration tends to work better in non-sensitive areas, such as delivery of basic services like water and electricity.

3.2 Middle Region of the Tuban Delta

Introduction

The Middle Region of the Tuban Delta is located in the Lahj Governorate. The area covers 570 km2 and has a population of 85,954, of which 41,371 are females and 44,583 are males. Al-Hawtah, the capital of the Lahj Governorate, is located here accounting for almost half of the population.

Information about the community is based on data provided by the Lahj governorate, through field visits and focus group discussions, interviews with key officials, GIS analysis and the Al-Hawtah city profile completed by UN-Habitat in 2020. Where information is not available at the local level, estimates from the national level and/or international studies have been utilized.

Figure 11.*Map of the three regions and Lahj Governorate. UN-Habitat, 2023.*

The focus group discussions and interview officials which took place in February of 2023 highlighted some key challenges of the population including lack of jobs, food, solid waste management, water, and insufficient salaries. The women's group particularly emphasized the high price and low quality of food as well as the lack of jobs for women.

Population/Demographics

As noted above, there are 85,954 people in the Middle Region, of which 48.1% are females and 51.9% are males, as with elsewhere in the country, there are more men and boys than women and girls. Al-Hawtah, the largest city in the region and the capital of Lahj Governorate, has a population of 40,632.

[20] *UN-Habitat (2020) Aden City Profile*

In addition, there are 34 villages, the largest is approximately 4,500 people and the smallest less than 100 people. There are 15,114 families, with average family size at 5-6 people. The Al-Hawtah city profile found that there are approximately 300 female-headed households in that city.

The city of Al-Hawtah has been growing at a yearly rate of about 2.52 percent since 2004 with the population projected to reach over 50,000 people by 2030.

Yemen is a very young country although the rural areas and smaller cities skew slightly older than the larger cities. Al-Hawtah city was estimated by the UN-Habitat State of Yemeni cities report to have 44% of population between 0-14 years of age and 4% over 65. If we apply these percentages to the rest of the Middle Region, there would be approximately 18,000 females and 19,000 males under the age of 14. The elderly population would be estimated at 1,600 females and 1,800 males.

There are varying figures estimating the number of disabled people in Yemen from 3% of the population according to the 2013 National Health and Demographic Survey to 14.5% or 4.8 million people according to WHO and Handicap International. Based on this, there may be as many as 6,000 handicapped females and almost 6,500 handicapped males, if we take the more conservative estimate then this would be 1,200 and 1,300 respectively.

According to a survey of Community Focal Points (CFP) conducted as part of the UN-Habitat city profile, there are approximately 180 people with disabilities living in Al Hawtah city and an approximate 520 individuals who are in serious medical conditions, either life threatening (requiring immediate treatment) or chronic (requiring long-term treatment).

According to the CSO Yearbook from 2017, the most widespread diseases in Lahj Governorate were diarrhea and gastroenteritis followed by lower respiratory infections. There were also some upper respiratory infections, typhoid and influenza cases reported.

In terms of ethnic minorities or marginalized groups, the Al-Hawtah city profile identified the Muhamasheen community (locally referred to as 'Akhdam') who suffer from caste-based, socio-economic and political discrimination. There are no official statistics of the community but in 2014, UNICEF estimated that the population is about 10 percent of the population in the country although Lahj governorate is one place with a large Muhamasheen community. Historically, they have lived in poor conditions in segregated slums on urban peripheries including Al Hawtah City and have limited access to employment opportunities.

According to UNHCR, there is a total of 79,163 IDPs in the Lahj Governorate, however this is not broken down by the three regions[21]. The Humanitarian Needs Overview (HNO) conducted in 2019 found that there are 7,356 IDPs in Al Hawtah, out of which 4,620 are from the district. The HNO study estimated 21.1% of the total estimated population whereas the CFP survey by UN-Habitat estimated it to be 25% of the population. The Yemen Shelter Cluster report from 2017 found that 32% of IDPs are women aged 18-60 years, the next largest group was men in the same age group and boys 0-17 years old, both at 28%, girls aged 0-17 were only 12% of the IDP population.

According to UNHCR, there are twenty IDP camps in the Middle Region: Al-Sardah, Al Mikhshabah, Al Habeel, Al Khuddad, Al-Hasky, Al Jaroubah, Sad Falej, Al Ziady, Al Hussaini, Al Kudaam, Qaryart An Nouba, Sofyan, Al-Hawtah Al-Harat, Al Amal, Al Hamra'a, Housing/Facilty of Agriculture, Al Maghafa, Internal Housing of the Faculty of Agriculture, Abrlasloum, and Qaryat Ash Shadheif.

[21] *https://data.unhcr.org/en/country/yem#_ga=2.51079209.1447391314.1679905938-1498650503.1679905938*

Land Use

The hydrology study conducted for this project found that the middle region has a land use breakdown of 86.6% pastureland, 11.1% Agricultural Land and 2.3% populated land. The following map was produced for the Al Hawtah city profile and shows the populated areas in the district, including industry and commerce as well as the wadi and surrounding agricultural land. Al Hawtah district is in the delta of the Wadi Tuban, with the main populated area between the two branches of the wadi as illustrated below with the main roads and markets connecting Al Hawtah with Aden.

In the focus group discussions, there was general consensus that the agricultural land in the area has been decreasing in recent decades and there are more buildings and ad-hoc constructions. The local government officials interviewed emphasized the urban expansion of Al Hawtah, especially in the past ten years. The men's group cited that agricultural land began decreasing in the last 5 to ten years and the buildings increased. Women said that changes started 20 years ago with less agricultural and more buildings from "random" construction.

Yemeni law divides state land into to six categories for land administration purposes, with different rules applicable to them. However, there is no specific data on the amounts of land within each of these categories

- Allocated Land: Lands that have been planned and plotted prior to distribution;
- White Land: Lands that are not allocated lands but fall within urban planning areas;
- Agricultural Land: Land cultivated or well suited for cultivation;
- Fallow Land: Agricultural land that has been abandoned or neglected;
- Public Utility Land: Mountains, hills and slopes that receive rainwater, including the major structures through which flood waters are collected from tributaries;
- Desert Land: Lands that are covered by sand or sandy lands

Most structures are built using mud brick with thick walls and are used because they tend to lock cool air inside the building which helps in an area with high temperatures. Mud is also widely abundant and cheaper than concrete and wood. However, these homes are extremely vulnerable to heavy rains and floods. In addition, an estimated 60% of Al Hawtah's building exhibit signs of structural damage much of a direct result of the war.

Figure 15. *Agricultural Land and Industrial and Commercial Activities in Al Hawtah. UN-Habitat, 2019.*

There is a lack of housing in the city, a result of the destruction of many buildings combined with the rapid influx of IDPs, especially a limited number of rental units. The Yemen Shelter Cluster report found that, as of 2018, 75.1% of prospective tenants are IDPs.

Informal settlements, known locally as “Ashwaiyat” are found throughout the city, although many of them are quite small and not exceeding a few meters. Some of them are home to many IDPs who lost their homes in the district or were displaced from other cities.

The World Bank estimates that 44% of the urban population lives in slums based on the international definition which would amount to almost 18,000 people in Al Hawtah living in informal settlements.

Al Hawtah is also home to many cultural heritage sites including palaces, shrines, and ancient water wells. A map of the main heritage sites from the UN-Habitat profile is below. Unfortunately, cultural heritage sites have also suffered damage because of the conflict and due to their fragile status, many are in need of regular maintenance, preservation and protection. Given the housing situation, the Sultan’s Palace, Al Abdali is being used by IDP families as shelters and in exchange they are providing maintenance to the building and grounds.

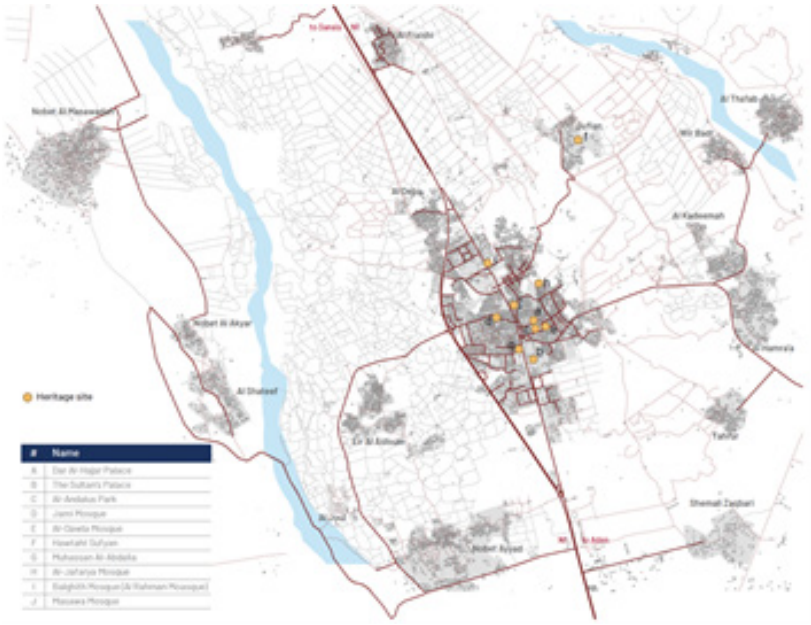

Figure 16. *Main Heritage Sites in Al Hawtah. UN-Habitat, 2020.*

Ecosystems/Natural Resources

As highlighted above, the Middle Region of the Tuban Delta is predominately agricultural lands and pastureland. The climate is semi-tropical and arid and the elevation varies from 100 meters above sea level to 490 meters above sea level. The region has several streams and the wadi splits into two branches in this area.

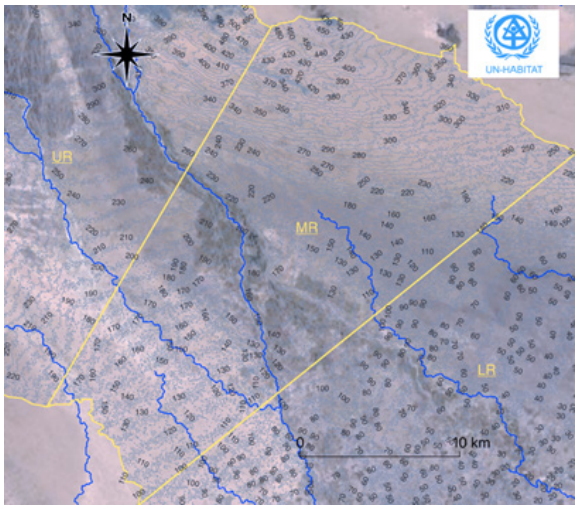

Figure 17. *Map of the Tuban Delta with main streams and elevations. UN-Habitat, 2023.*

Lahj has two livelihood zones: The Western Coastal Plain millet, considered a sorghum and livestock zone (highlands), and the Western and Central Wadi which is regarded as the sorghum, millet, vegetable, fruit and livestock zone (lowlands).

The Tuban Delta used to be known for the purity of its water and gardens of jasmine trees and roses.[22] However the focus group discussions conducted for this project noted poor water quality and that water used to be more plentiful but now wells needed to be dug deeper and still sometimes there is no water. It was also noted that some wells have become polluted by sewage water. Water availability was estimated in the hydrology study as 84 mm from rainfall for the Middle Region in 2022 and 25.5 MCM (Million Cubic Meters) was calculated as available runoff water for the Middle Region.

Irrigation systems have been built around floodplains to take advantage of seasonal rainwater from the north, however sometimes seasonal rainwater washes away parts of agricultural lands.[23] The irrigation methods used in the Middle region are predominately check basin irrigation (55%) and spate irrigation (40%) with modern irrigation only accounting for 5%.

The region is also well known for an abundance of clay minerals which have been used manufacturing cement and bricks.

The focus group discussions highlighted the following plants as critical biodiversity: aloe vera, mashmoom, ziziphus, spina-christi, morimerah and sisaban “prosopis” trees.

Honey production is also an important ecosystem service in the region.

Issues around food – availability, price, quality – were raised in the focus groups discussions. There are not disaggregated figures about food security and nutrition for the Middle Region however the HNO analysis in 2019 found that 71.8% of households in the Lahj Governorate were food insecure, with more than half of those people (416,500) categorized as in acute need of food security.

Economy/Production

Al Hawtah city is located along the main trading route which links Aden, Sana’a and other cities in the region.

Employment figures from before the conflict from ILO showed an unemployment rate of 13.5%, relatively evenly split between men and women however labor force participation rates are much higher for men at 65.4% and only 6% for women.

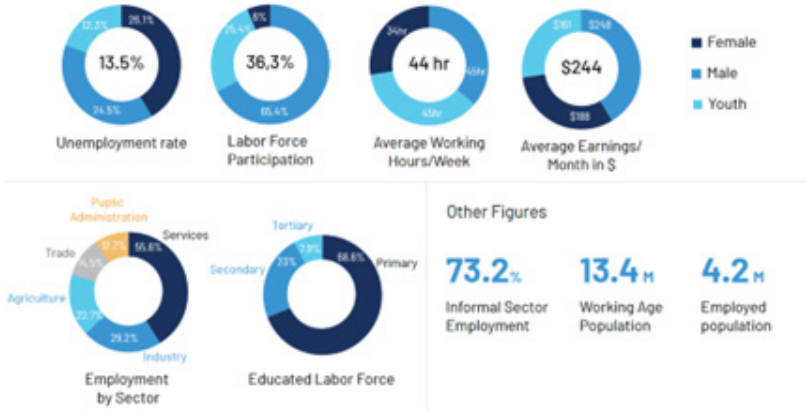

Figure 18. *National Employment Figures for Yemen from 2013-2014, prior to conflict. Original Source ILO. Figure by UN-Habitat, 2020.*

[22] *UN-Habitat (2020) Al Hawtah City Profile*
[23] *UN-Habitat (2020) Al Hawtah City Profile*

In terms of employment by sector, services was the leading sector with over 50% followed by industry (29.2%) and Agriculture (22.7%).According to World Bank data for the national level, agricultural employment has declined steadily since the early 1990s from 47% to 27% of male employment and from 85% to 42% for female employment.[24] It is important to note that while women make up a smaller portion of the labor force participation, agriculture and services employ almost equal percentages of women. The figure above shows these pre-conflict figures, including the very high rate of employment in the informal sector.

The survey of Community Focal Points for Al Hawtah confirmed the importance of informal employment for income with 54% of the primary source of income coming from Informal employment income generating activities, the next largest share was 24.3% and formal employment was the same percentage as loans from the bank, government or microfinance at 8.1%. Interestingly the highest percentage of the reported secondary source of income was from formal employment (29.7%) followed by safety nets (24.3%).

Although not the highest share of employment, agriculture is the lead economic activity in terms of economic productivity, with the main crops in the Middle Region by hectares as sorghum, millet, cotton and vegetables.

In the focus group discussions, the farmers explained that farm production is for daily subsistence as well as crops for sale and that farms were abundant in the small wadi until 1994 and there used to be agriculture cooperatives but the land was redistributed. They explained the historical changes in what was planted from the Sultans Era to the socialist era where there was more investment in agriculture, but they noted that the weather changed, and rice became an alternative food source which was gotten from the market.

Women noted for agriculture that there is a lack of some crops such as cotton, sesame, Djar[25] and lack of grain cultivation. Men also noted that before there was cotton and grain and now more vegetables, fodder, tomato, and onion. The local government made similar observations to the men on how crops changed.

One of the main challenges in the region is poverty. Again disaggregated data for the Middle Region and Al Hawtah city is limited however Lahj Governorate is the second poorest governorate in Yemen based on CSO data from 2014 which estimate the poverty rate as 69.1%.[26] Further, data from 2005-2006 showed that the rural poverty rate was higher in the Lahj Governorate at 49.5% compared to urban poverty at a rate of 22.9% however both were higher than the national averages.[27] Given the large youth population in the region, youth unemployment is a major concern and estimates from 2016 showed a youth unemployment rate around 30% in urban areas.

The CFP survey found that for women specifically, it is difficult to secure and maintain a job in Al Hawtah due to the need to focus on raising children and domestic work. A lack of jobs and skills, which are similar obstacles for men, were also cited.

[25] *A type of edible bean, smaller than soya bean*
[26] *UN-Habitat (2020) Al Hawtah City Profile*
[27] *UN-Habitat (2020) Al Hawtah City Profile*

Infrastructure and Services

The focus groups for the Middle Region discussed water use and water availability describing that many households get tap water from government wells and networks, but there are also private wells even in Al Hawtah but as some wells are polluted, they are not suitable for drinking. They noted that some people are also purchase treated water by purification companies.

They noted that some people are also purchase treated water by purification companies. The women's discussion group said that women are responsible for the collection of water and noted concern about the low quality of water and need for it to be filtered. The concern about the quality of water coming from wells was reiterated by the group of farmers.

The Al Hawtah city profile noted that the water supply infrastructure sustained extensive damage from the conflict, including reservoirs, pumping stations, and wells. In the CFP survey, almost all respondents said that water for drinking purposes is not readily available, and most households have trouble getting enough water to drink.

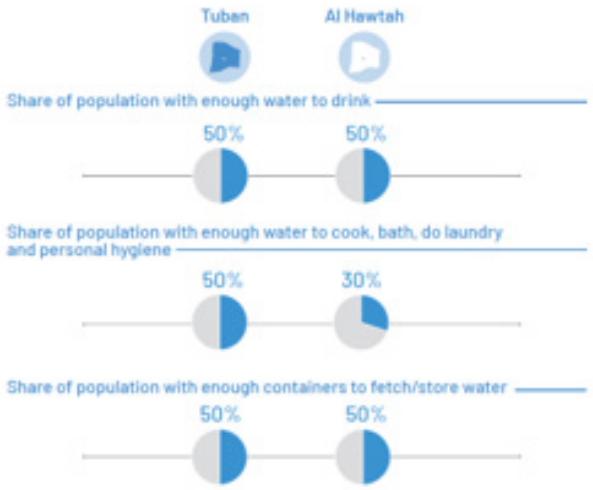

Figure 19. *Perceptions of WASH in Tuban District and Al Hawtah. UN-Habitat, 2020.*

They also reported on affordability issues which was also reported in the focus groups for this project. The hydrology study for this project found per capita consumption in the Middle Region to be 103 litres per capita per day and that 40% of the households in the Middle Region are not linked to the public water supply system.

Sewage and wastewater management issues were also reported as a key issue throughout the Tuban region.

Local Water and Sanitation Corporation - Lahj (LWSC) is the body responsible for managing the water services in Al Hawtah and Tuban districts as well as the rest of the Lahj Governorate.[28] The LWSC water infrastructure includes 20 water reservoirs and water towers, with a capacity of 28,800 m3, one water sterilization facility and 89 km of the supply network. The LWSC has seven fuel generators for the water supply system but there are no operation and maintenance vehicles, and as they have been damaged or stolen during the conflict.

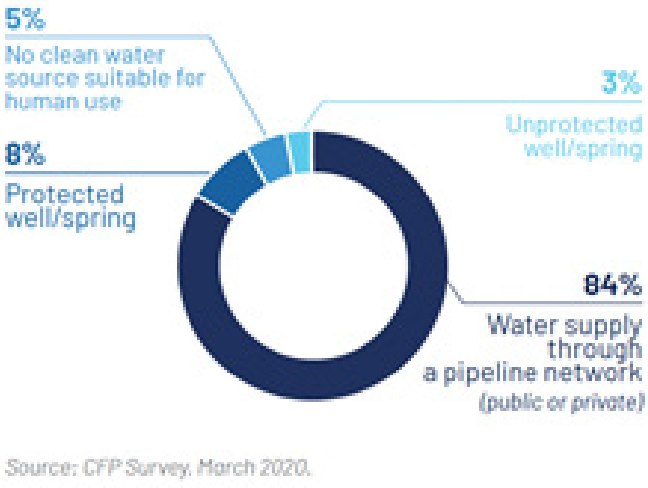

Figure 20. *Main Source of Water in Al Hawtah city based on Community Focal Point survey. UN-Habitat, 2020.*

[28] *GIZ (2018), Damage Assessment Report of Twelve Water Supply and Sanitation Local Corporations (LCs), (Bonn and Eschborn, Germany: GIZ, 2018).*

In terms of healthcare facilities, there are a total of 39 public and private facilities operating in Al Hawtah. Ibn Khaldoun is the main public hospital in Lahj Governorate and has a bed capacity of 250. The majority of IDPs from surrounding areas are also frequently transferred to it for treatment.

Education serves have been disrupted in recent years due to the conflict and influx of IDPs.
While there was an increase of children due to the arrival of IDPs, the number of facilities in the Tuban district has not increased. The figure below shows a breakdown of schools in Tuban district and Al Hawtah specifically.

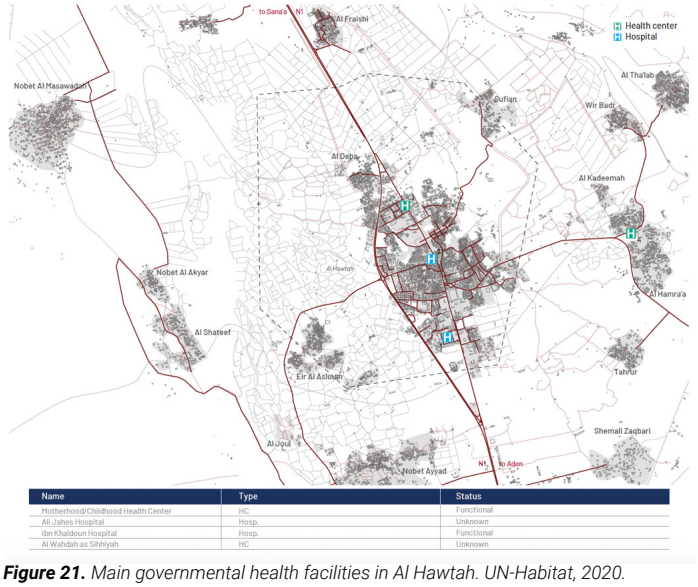

Figure 21. *Main governmental health facilities in Al Hawtah. UN-Habitat, 2020.*

On Information and Communication Technologies (ICT), the focus groups noted that mostly every household has a mobile phone and people use WhatsApp and social media to communicate however the internet is weak and mostly only available in Al Hawtah. In the CFP survey for the Al Hawtah city profile, about 15% of respondents said that communication services are not readily available and there is only one mobile tower that is partially functioning.[29]

IDPs face particular challenges in accessing services from WASH to health and infrastructure. Most IDPs in Al Hawtah have problems accessing water. Surveys from the United Nations High Commissioner for Refugees (UNHCR) suggested that approximately two-thirds of IDP children were not enrolled in school in 2015.[30]

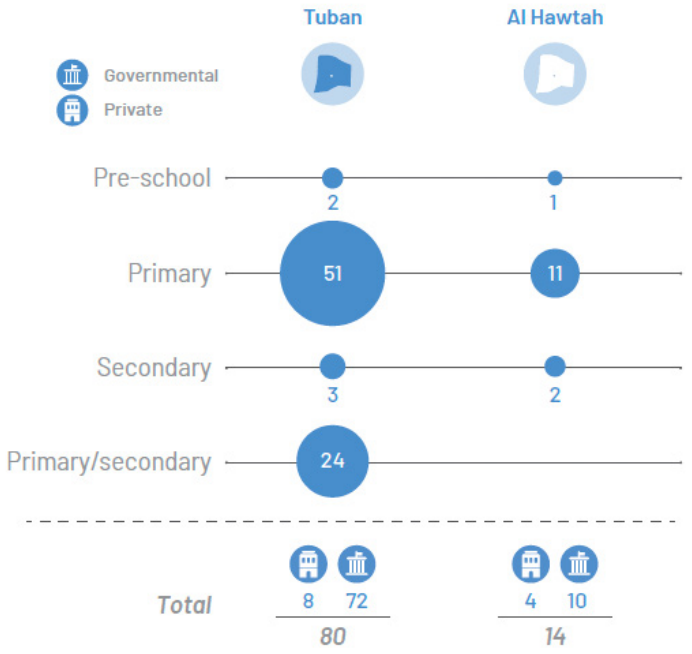

Figure 22. *Number of schools in service from 2017-2018 in Al Hawtah and Tuban Districts*

Governance

Even prior to the conflict, Al Hawtah Local Council (LC) had lower operational functioning than the national average, including human resources, sufficient capacity, office space equipment and fiduciary responsibility.

[29] *UN-Habitat (2020) Al Hawtah City Profile*
[30] *UN-Habitat (2020) Al Hawtah City Profile*

Despite the capacity gaps, the LC staff was responsible for both preparing and implementing the annual plan and budget, and unlike in other LCs, the governorates level did not seem to be involved in the district plans and budgets. The figure to the side shows the governance framework from national to governorate and district levels.

Disputes over land are an on-going issue in the region and land dispute resolution mechanisms are not functioning well. Property rights and tenure security is undermined by adequate dispute resolution.
In tribal areas in Lahj, Tribal Sheikhs are occupying a prominent role in dispute resolution and conflict mediation within their local communities. While Governmental Executive Units and LCs also operate collectively or sometimes in parallel with the Tribal Sheikhs.

There are a few women's groups active in Al Hawtah. Al Hawtah's Women and Children Department, Local Leadership Program of the STC, Al Hawtah Women Development Association, Al Hawtah District Union of Southern Women, Department of Women and Children.

On the environment, the Environmental Protection and Development Organization (EPSDO), initially known as the Association of Bees for Environmental Protection has obtained recognition from the
United Nations Convention to Combat Desertification (UNCCD).

A youth focused organization, Youth Without Borders Foundation, engages youth to achieve sustainable development capacity, encouraging youth to participate in Yemen's development process and communicating youth voices to decision makers.

Figure 23. *Al Hawtah Strategic priorities for City Recovery based on UN-Habitat City Profile Analysis. UN-Habitat, 2020.*

3.3 Upper Region of the Tuban Delta

Introduction

The Upper Region of the Tuban Delta is located in the Tuban District in the Lahj Governorate. The area covers 450 km2 and has a population of 36,921. There are an estimated 6,538 families in the region and 19,125 males and 17,796 females. The region has predominately small to medium sized villages with the largest a little over 5,000 people but the majority with a few thousand or several hundred.

Information about the community is based on data provided by the Lahj governorate, through field visits and focus group discussions, interviews with key officials and GIS analysis, and national. Where information is not available at the local level, estimates from the national level and/or international studies have been utilized.

[31] *UN-Habitat (2020) Al Hawtah City Profile*

The focus group discussions and interview officials which took place in February of 2023 highlighted some key challenges of the population including: lack of jobs, food, and insufficient salaries. The women's group also emphasized poor food quality as well as lack of drinking water due to increased population and high cost of water and the group of farmers emphasized all of these as well as lack of agricultural activities and that the majority of changes occurred in the past two years.

Population/Demographics

As noted above, there are 36,921 people in the Upper region, of which 51.8% are males and 48.2% are females. There are 27 villages, the largest is 5,890 people and the smallest less than 100 people. There are 6,358 families, with average family size at 5-6 people.

The population data is not further broken down by age, poverty level, etc so the following estimates are based on national averages and data from international studies.

Yemen is a very young country and the rural areas and smaller cities skew slightly older than the larger cities. Al Hawtah city was estimated by the UN-Habitat State of Yemeni cities report to have 44% of population between 0-14 years of age and 4% over 65. If we apply these percentages to the Upper Region, there would be an estimated 7,830 females and 8,415 males under the age of 14. The elderly population would be estimated at 712 females and 765 males.

There are varying figures estimating the number of disabled people in Yemen from 3% of the population according to the 2013 National Health and Demographic Survey to 14.5% or 4.8 million people according to WHO and Handicap International. Based on this, there may be around 2,500 handicapped females and about 2,750 handicapped males in the Upper Region, if we take the more conservative estimate then this would be about 500 and 570 respectively.

According to UNHCR, in 023, there are four IDP camps in the Upper Region; Al Shaqa'a, Al And, Ash Shaqa'h and Al Zaydah.

In the focus group discussions and interviews, the women's group noted that women are marginalized from decision-making and the farmers noted that there are homeless in Wadi Kahl, however there are not statistics about the number of homeless in the region.

Land Use

The Upper Region is predominately rural with small and medium-sized towns and a lot of agricultural and pastureland. The hydrology study conducted for this project found that the Upper Region has a land use breakdown of 91.4% pastureland, 7.1% Agricultural Land and 1.6% populated land. The study also found that there is 3,180 hectares of agricultural land and 2,830 hectares of cultivated land. The main crops as per number of hectares dedicated to the crops are Fodder and Sorghum followed by Millet and to a lesser extent Sesame, Vegetables and melons.

The focus groups said there have been some decreases in agricultural land and this is the result of urbanization, although one group also said it was the result of desertification. They also noted that there has been in a chance of the crops planted, away from cotton and cereals to cash crops.

Yemeni law divides state land into to six categories for land administration purposes, with different rules applicable to them.

However, there is no specific data on the amounts of land within each of these categories.

- Allocated Land: Lands that have been planned and plotted prior to distribution;
- White Land: Lands that are not allocated lands but fall within urban planning areas;
- Agricultural Land: Land cultivated or well suited for cultivation;
- Fallow Land: Agricultural land that has been abandoned or neglected;
- Public Utility Land: Mountains, hills and slopes that receive rainwater, including the major structures through which flood waters are collected from tributaries;
- Desert Land: Lands that are covered by sand or sandy lands

Ecosystems/Natural Resources

The climate is semi-tropical and arid and the elevation varies from 200 meters above sea level to 500 meters above sea level (see map). The region has several streams.

In the focus group discussions, the follow species were highlighted: Sesbania, Sada'a, Allabina, Allwa, Dom, Palm, Coconut (currently not available), lemon, acacia, saber, tamarind, madras thorn fruit, grapes, mango, aloe vera, Ziziphus spina-christi, basil and cloves.

The women and farmers groups noted a decline in species.

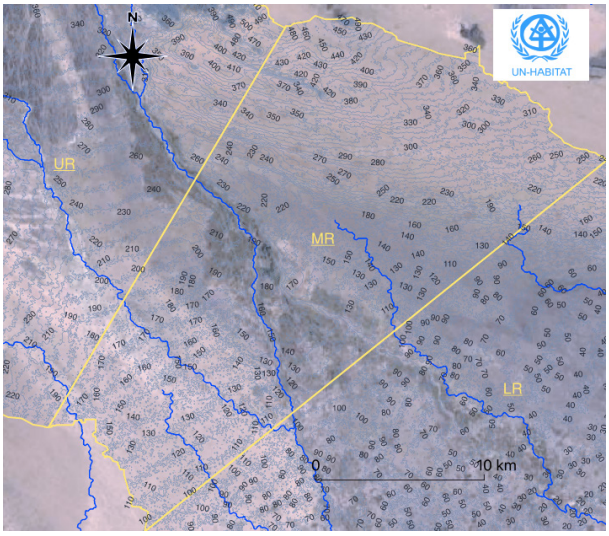

Figure 24. *Elevations and streams in the Upper Region of the Tuban Delta. UN-Habitat, 2023.*

Economy/Production

Employment figures from before the conflict from ILO showed an unemployment rate of 13.5%, relatively evenly split between men and women however labor force participation rates are much higher for men at 65.4% and only 6% for women. In terms of employment by sector, services was the leading sector with over 50% followed by industry (29.2%) and Agriculture (22.7%).

According to World Bank data for the national level, agricultural employment has declined steadily since the early 1990s from 47% to 27% of male employment and from 85% to 42% for female employment.[32]It is important to note that while women make up a smaller portion of the labor force participation, agriculture and services employ almost equal percentages of women. The figure below shows these pre-conflict figures, including the very high rate of employment in the informal sector.

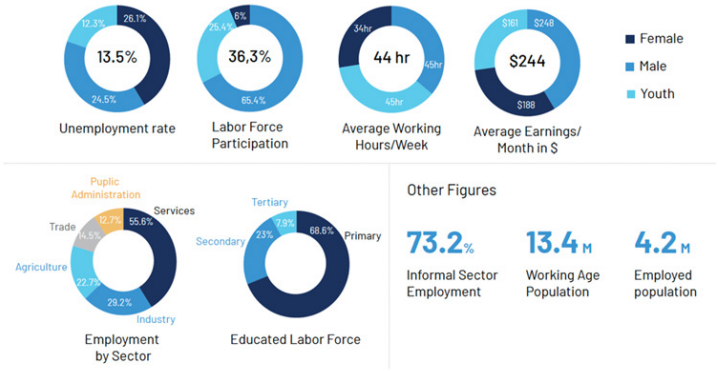

Figure 24. *Elevations and streams in the Upper Region of the Tuban Delta. UN-Habitat, 2023.*

[32]*https://data.worldbank.org/country/yemen-rep*

In the focus group discussions, the main forms of employment highlighted were farming, government and private businesses and specifically for men, the military and day laboring, whereas specifically for women, the handicraft industries and harvesting.

Infrastructure and Services

The focus group discussions identified an asphalt plant, cement plant, and Coca-Cola plant as key infrastructure in the region. The Al-anad Water Supply Station and the Dar Al-Araes Palace are the two key infrastructure assets identified in the hydrology study.

On water services, the Al-Hawtah City Profile found that for the Tuban District as a whole, only 50% of the population has enough water for drinking, cooking, bathing and to do laundry, as illustrated in the figure below. In the focus group discussions, the women's group explained that women are responsible for collecting water and household water is obtained from the market as water access from wells is far away from households.
The groups also reported that the water quality is not good because they are "artesian" wells that don't have desalination and because of pollution due to the lack of sanitation and sewage leaks into the wells.

It was explained that some people have their own private wells and others buy from carts that sell water for household use.

The hydrology study for this project found per capita consumption in the Upper Region to be 100 litres per capita per day and that 40% of the households in the Upper Region are not linked to the public water supply system.

In terms of other services in the area, there are a number of schools in the Tuban District, however this is not broken down by the different regions. In total, there are 80 schools in the entire district, however given the lower population in this region, it is likely that there are less schools here.

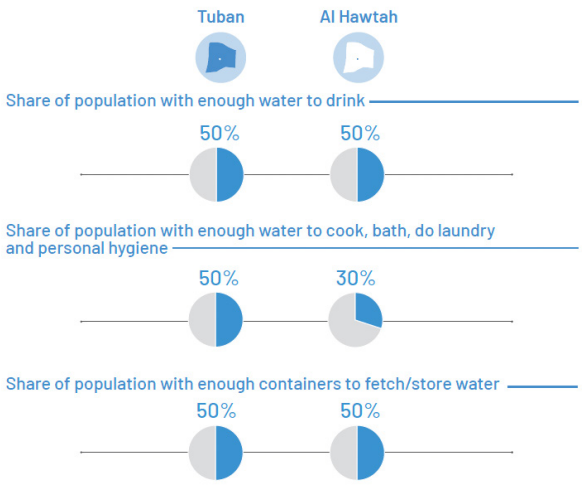

Figure 26. *Perceptions of WASH in Tuban District and Al Hawtah UN-Habitat, 2020.*

In terms of ICT access, in the interviews, they said that most households have at least one mobile phone but that internet is weak. However a lot of people get news from social media.

Economy/Production

The Upper Region is within the Tuban District of the Lahj Governorate.

The figure below shows the local governance framework that shows the relationship between the district, governorate and national levels.

Also of note in tribal areas in Lahj, Tribal Sheikhs are occupying a prominent role in dispute resolution and conflict mediation within their local communities. While Governmental Executive Units and LCs also operate collectively or sometimes in parallel with the Tribal Sheikhs. [33]

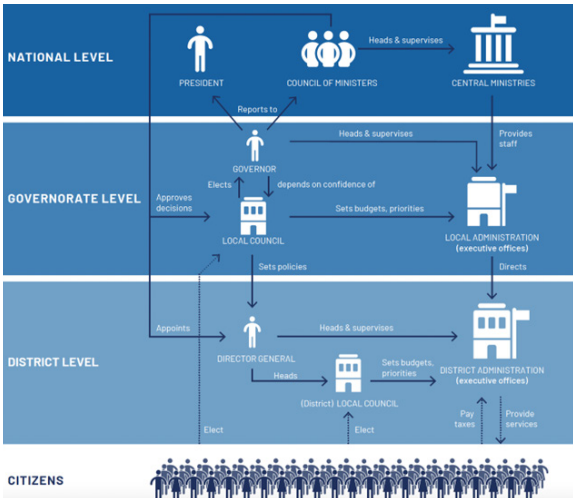

Figure 27. *Local Governance Framework in Yemen. UN-Habitat, 2020.*

4. CCVA Outcomes for the three regions

The CCVA utilizes the methodology developed and highlighted above and the data and information which was collected for the community profiles (in the previous section) and the hydrology study for this project.

The vulnerability is assessed on exposure, sensitivity and adaptive capacity for the two main hydrological risks from climate change: flooding and water security. All of the exposure and sensitivity indicators were ascertained from the hydrology study and/or data provided by the government. The Adaptive capacity indicators are all based on the responses from the focus group discussions.

For flooding, the lower region is the only one susceptible to coastal flooding which is exacerbated by sea level rise and all three regions are at risk from flooding as the result of precipitation.

As demonstrated in the map below, the larger watershed of the Tuban Delta contributes to the potential of flash flooding in the three regions.

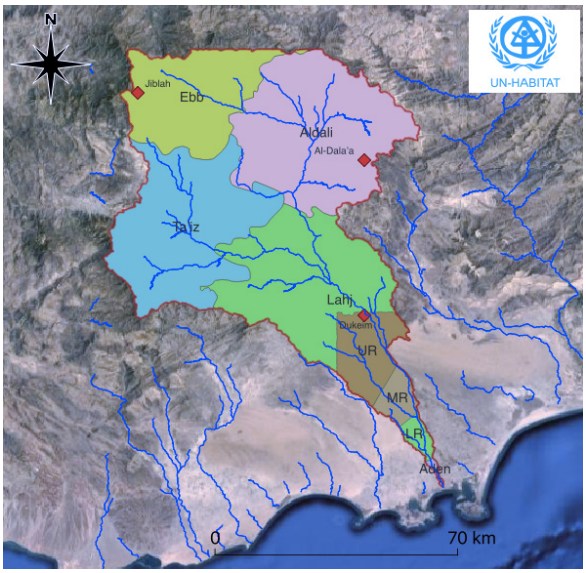

Figure 28. *The boundaries of the watershed that contributes to flash flooding risk in the Tuban Delta*

[33] *UN-Habitat (2020) Al Hawtah City Profile*

The hydrology study also mapped the assets throughout the Tuban Delta alongsie the major streams to understand which assets are at highest risk to flash flooding.

The water security of the three regions is affected by the occurrence of drought combined with an imbalance of water resources. In addition, saltwater intrusion into groundwater has an adverse impact on water supply in the lower region and thus affects water security of that region as well.

The hydrology study assessed the drought index by region, as shown in the map below, it is clear that the lower region has an extremely dry rating over the majority of the region.

Figure 29. *Major assets and streams in the Tuban Delta*

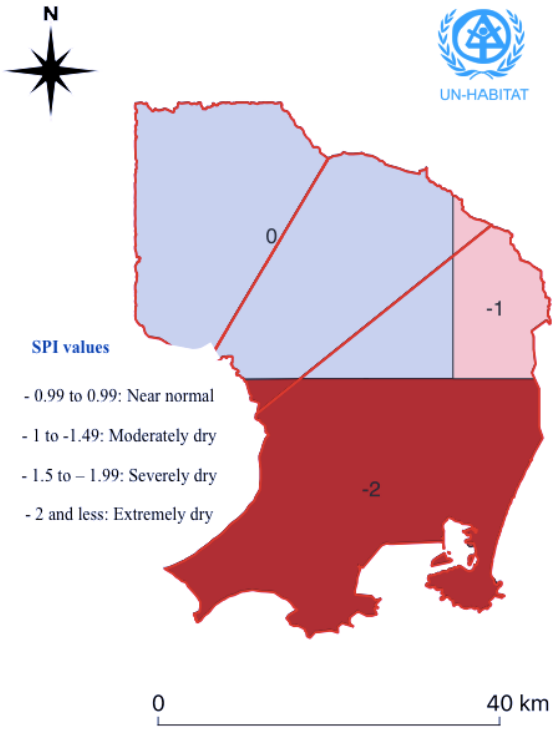

Figure 30. *SPI drought index by region*

4.1 Lower Region Risks and Vulnerabilities

The Lower Region of the Tuban Delta includes the Aden Governorate and the city of Aden as well as a portion of the Tuban District of the Lahj Governorate. It is the largest in terms of population of the three regions and it is the only one which includes a coastal area.

There are 71 total IDP camps, of which 10 have high flood risk.

Governorates	District Name	Site Name (English)	Site Name (Arabic)	Regions	Flood risk
Aden	Al Burayqah	Al Burayqah	رأس عباس	LR	High risk
Aden	Dar Sad	Dar Sad	حوش درهم	LR	High risk
Aden	Dar Sad	Dar Sad	موقع عمار بن ياسر	LR	High risk
Aden	Dar Sad	Dar Sad	حوش عثمان	LR	High risk
Aden	Dar Sad	Dar Sad	المعهد السعودي	LR	High risk
Lahj	Tuban	Al Hawtah - Tuban	سد فالج	LR	High risk
Lahj	Tuban	Al Hawtah - Tuban	مخيم عطيرة	LR	High risk
Lahj	Radfan	al Habilin	المحوى الأعلى	LR	High risk
Lahj	Radfan	al Habilin	محوى الكهرباء	UR	High risk
Lahj	Al Malah	Al Malah	سيلة بله	LR	High risk
Lahj	Radfan	al Habilin	المحوى الاسفل	LR	High risk

Based on the hydrology assessment for this project, the assets with high flood risks are the airport, two main roads, one wastewater treatment plant and the nature reserve for swans. At medium flood risk are wetlands, two hospitals, one power station, one water supply station, one wastewater treatment plant and two landfills. The remainder of the assets assessed have low flood risk.

Name	Region	Climate risks
Aden Airport	LR	High flood risks
Biodiversity		
Nature reserve of the Swans	LR	High sea-level rise risk
Al-Heswah Wetlands	LR	Medium Sea-level rise risk
Hospitals		
Al-Waht Hospital	LR	Medium flood risk
Aden Hospital	LR	Medium flood risk
Al-Gamhoria Hospital	LR	Low risk
Al-Sadakh Hospital	LR	Low risk
Refinary Hospital	LR	Low risk
22 May Hospital	LR	Low risk
Power stations		
Al-Haswah Thermoelectric Plant	LR	Low risk
Al-Mansorah Power station	LR	Low risk
Khormksr Power station	LR	Low risk
Hugaif Power station	LR	Low risk
Chihnaz Power station	LR	Medium flood risk

Water Supply and WWTps		
Bir Naser Water Supply station	LR	Low flood risk
Al-Barzakh water supply station	LR	Medium flood risk
Bir Ahmed Water Supply station	LR	Low flood risk
Saber Wastewater treatment plant	LR	Low flood risk
Al-Mansorah Wastewater treatment plant	LR	Low flood risk
Al-Areesh Wastewater treatment plant	LR	Low flood risk
Salah Addin Wastewater treatment plant	LR	High flood risk
Landfills (waste management)		
Al-Fashlah waste landfills	LR	Low flood risk
Al-Haswah waste landfills	LR	Medium sea-level rise risk
Roads		
Al-What Al-Rugaa Road	LR	High flood risk
Al-What Al-Rugaa Road	LR	High flood risk

Given its location, the Lower Region is the only region which has a risk of coastal flooding from sea level rise. The following figure shows the potential extent of sea level rise in Aden in 2040 and 2100 under a high emission scenario (SSP5/RCP 8.5).

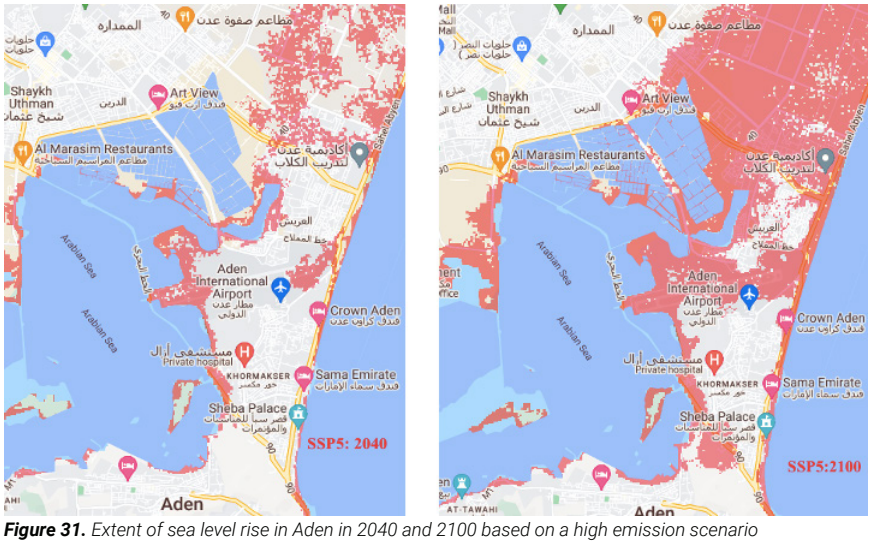

Figure 31. *Extent of sea level rise in Aden in 2040 and 2100 based on a high emission scenario*

Outlined below is the data for the flooding indicators for the Lower Region.

Exposure	Sensitivity	Adaptive Capacity
Infrastructure Assets: 24	Airport, hospitals, power stations, water supply stations, wastewater treatment plant, waste landfills, roads, museum	Local Knowledge of CC: Medium-Low
Population size Females: 524,106 Males: 608,906 Total: 1,133,013	IDP camps: 71 People living in Informal Settlements/Floodplains	Water Distribution Plan: 1 Agriculture plan (previously): 1
Ecosystems: 2	Wetlands Reserve Nature Reserve Encroachment and Degradation	Access to Financial Assistance: Cooperative Agricultural Credit Bank

Utilizing the scoring system, the Lower Region has a high vulnerability to flooding with a score of 23.

	Exposure	Sensitivity	Adaptive Capacity	
Infrastructure	3	3	3	Knowledge
People	3	3	1	Plans
Ecosystems	2	3	2	Financial Assistance
Total	8	9	6	23

For Water Security in the Lower Region, the data for the indicators is below:

Exposure (Quantitative)	Sensitivity (Qualitative)	Adaptive Capacity
Hectares of Agricultural Land 2948 ha	Types of crop Mix of high and low Water Intensive Crops: Sorghum, Cotton, Vegetables	Irrigation Methods %5 Modern Irrigation
Population size Females: 524,106 Males: 608,906 Total: 1,133,013	%25 of households not linked to water grid	Relevant Plans (Water Management, Climate Change) Water Distribution Plan: 1 Agriculture plan (previously): 1
Water Supply: 25.5 MCM Renewable Water	Water differential (between supply and demand) 2022 84.3- (MCM)	Access to Financial Assistance Cooperative Agricultural Credit Bank

Utilizing the scoring system, the Lower Region has a high vulnerability of water security with a score of 20.

	Exposure	Sensitivity	Adaptive Capacity	
Agriculture	2	2	3	Irrigation Method
People	3	2	1	Plans
Water	2	3	2	Financial Assistance
Total	7	7	6	20

4.2 Middle Region Risks and Vulnerabilities

The Middle Region of the Tuban Delta is located in the Lahj Governorate and includes the city of Al Hawtah, capital of Lahj Governorate.

There are two IDP camps in the Middle Region with high flood risk:

Governorates	District Name	Site Name (English)	Site Name (Arabic)	Regions	Flood risk
Lahj	Tuban	Al Hawtah - Tuban	المخشابة سد فالح	MR	High risk
Lahj	Tuban	Al Hawtah - Tuban		MR	High risk

In terms of infrastructure and heritage sites, there are several with low flood risk and the natural channel is the only asset with medium flood risk.

Name	Region	Climate risks
Biodiversity		
The natural channel from Byzag Weir to Al-Hadarm Weir	MR	Medium flood risk
Heritage		
Al-Rawda Palace	MR	Low flood risk
Al-Qomondan Palace	MR	Low risk
Hospitals		
Ibn Khldoon Hospital	MR	Low risk
Power stations		
Abass Power Station	MR	Low flood risk
Water Supply and WWTps		
Al-Hawtah Water supply station	MR	Low flood risk
Al-Hawtah Wastewater treatment plant	MR	Low flood risk

Outlined below are the Flooding indicators:

Exposure	Sensitivity	Adaptive Capacity
Infrastructure Assets: 7	Hospital, Power Station, water supply station, wastewater treatment plant, palaces	Local Knowledge of CC: Medium-Low
Population size Females: 41,371 Males: 44,583 Total: 85,954	IDP camps: 20 People living in Informal Settlements/Floodplains	Rainwater Management and irrigation plan: 1
Ecosystems: 1	IDP camps: 20 People living in Informal Settlements/Floodplains	Access to Financial Assistance: International organizations for farmers, banks Less assistance for women reported

The UN-Habitat City profile for Al Hawtah also noted the extreme vulnerability of the city to heavy rains and flooding, especially on buildings made of mud brick.

Utilizing the scoring system, the Middle Region has a medium-high vulnerability to flooding with a score of 19.

	Exposure	Sensitivity	Adaptive Capacity	
Infrastructure	2	2	3	Knowledge
People	1	3	2	Plans
Ecosystems	2	2	2	Financial Assistance
Total	5	7	7	19

For Water Security in the Middle Region, the data for the indicators is below:

Exposure (Quantitative)	Sensitivity (Qualitative)	Adaptive Capacity
Hectares of Agricultural Land 4398 ha	Types of crop Mix of High and Low Water Intensive Crops: Sorghum, Cotton, Vegetables	Irrigation Methods %5 Modern Irrigation
Population size Females: 41,371 Males: 44,583 Total: 85,954	%40 of households not linked to water grid	Rainwater Management and Irrigation Plan: 1
Water Supply: 22 MCM Renewable Water	Water differential (between supply and demand) in 2022 8.8 MCM	Access to Financial Assistance Cooperative Agricultural Credit Bank

Utilizing the scoring system, the Middle Region has a high vulnerability for water security with a score of 21.

	Exposure	Sensitivity	Adaptive Capacity	
Agriculture	3	2	3	Irrigation Method
People	1	3	2	Plans
Water	3	2	2	Financial Assistance
Total	7	8	7	21

4.3 Upper Region Risks and Vulnerabilities

The Upper Region of the Tuban Delta is the least densely populated and most rural of the three regions and at the highest altitude.
There is only one IDP camp with high flood risk in the Upper Region:

Governorates	District Name	Site Name (English)	Site Name (Arabic)	Regions	Flood risk
Lahj	Radfan	al Habilin	محوى الكهرباء	UR	High risk

In terms of heritage sites and infrastructure in the region, there is one palace and one water supply station with high flood risk.

Name	Region	Climate risks
Heritage		
Dar Al-Araes Palace	UR	High flood risk
Water Supply and WWTps		
Al-Anad Water Supply station	UR	High flood risk

Outlined below is the data for the indicators for flooding vulnerability.

Exposure	Sensitivity	Adaptive Capacity
Infrastructure Assets: 2	Water Supply Station, palace	Local Knowledge of CC: Medium-Low
Population size Females: 17,796 Males: 19,125 Total: 36,921	IDP camps: 4 People living in Informal Settlements/Floodplains	Water Management Plan: 1 Land Use Plan: 1
Critical Ecosystems: 0	N/A	Access to Financial Assistance for men and women: Cooperative and Agricultural Credit (CAC) Bank

For Water Security in the Upper Region, the data is below:

Exposure (Quantitative)	Sensitivity (Qualitative)	Adaptive Capacity
Hectares of Agricultural Land 2830 ha	Types of crop Low Water Intensive Crops: Sorghum and Millet	Irrigation Methods %10 Modern Irrigation
Population size Females: 17,796 Males: 19,125 Total: 36,921	%40 of households not linked to water grid	Water Management Plan: 1 Land Use Plan: 1
Water Supply: 24 MCM Renewable Water	Water differential (between supply and demand) in 2022 38.6+ MCM	Access to Financial Assistance Cooperative Agricultural Credit Bank

Based on the scoring system, the vulnerability of the Upper Region for Water Security is Medium-High with a score of 18.

	Exposure	Sensitivity	Adaptive Capacity	
Agriculture	2	1	2	Irrigation Method
People	1	3	2	Plans
Water	3	2	2	Financial Assistance
Total	6	6	6	18

5. Conclusions: From Vulnerability Assessment to Adaptation Options for the Tuban Delta

The following table summarizes the vulnerability for water security and flooding, the two hydrological climate change impacts assessed for the three regions of the Tuban Delta based on the indicators.

	Upper Region	Middle Region	Lower Region
Water Security	Medium-High	High	High
Flooding	Medium	Medium-High	High

The Lower Region has high vulnerability to both water security and flooding which is largely due to the higher number of people and assets exposed and sensitive to these hazards as well as the added hazard of sea-level rise which affects flooding and water security but only in the Lower Region.

The Middle Region has a high vulnerability to water security due in large part to the large agricultural production in the area and a medium-high vulnerability to flooding as it has less assets and people exposed to flooding yet there remain sensitivities and a lack of adaptive capacity.

The Upper Region, due at least in part to less assets and people only has a medium level of vulnerability, however due to the reliance on agriculture for livelihoods, there is a medium-high vulnerability for water security.

The CCVA yields some overall key points for consideration in the development of adaptation options for the Tuban Delta:

- ✓ The Upper and Middle Region have higher vulnerability to water insecurity than flood
- ✓ The Lower Region has the highest vulnerability of the three regions to water insecurity and flooding, largely due to the higher number of people and assets
- ✓ Adaptive Capacity is low across regions due to lack of management plans and lack of widespread knowledge on climate change
- ✓ Sensitivity is high for all regions for water insecurity and for the Middle and Lower Region for flooding
- ✓ Exposure is highest in the Lower Region for flooding due to the size of population in Aden but exposure is high across all three regions for water insecurity because of the importance of agriculture across the regions
- ✓ Impacts are likely to be exacerbated for many vulnerable groups such as women, youth/children, elderly, and IDPs

The hydrology study further recommended that to cope with climate change and water scarcity challenges in the Tuban Delta, the following measures are needed:

1. The Lower region needs additional water resources, which can be provided by a solar-powered desalination plant.

2. Wastewater treatment plants need rehabilitation, monitoring, and appropriate plan to reuse the treated water for irrigation or for groundwater recharge.

3. Irrigation channels should be maintained, and modern irrigation method should be applied.

4. Disaster management plan should be developed coupled with an early warning system to cope with flooding and drought.

5. Groundwater discharge should be monitored to control groundwater depletion and saltwater intrusion in the Lower Region.

6. Continuous capacity building programs are needed addressing hydrological modeling, water use efficiency, water allocation and climate change adaptation.

7. The above-mentioned measures can be fostered by developing an Integrated Water Resource Management (IWRM) plan/strategy for the Tuban Delta.

The outcomes of the CCVA and hydrology study were reviewed by stakeholders in the Tuban Delta who then carried out an exercise to brainstorm possible adaptation measures for each of the regions, over different time periods and considering both urban and rural solutions. The following table shows the outcomes of the possible adaptation measures:

Regions	Short-term options (3-1 years)	Medium-term options (6-4 years)	Long-term options (+6 years)
Upper Tuban region	**Urban:** Flood protection measures; Early Warning System. **Rural:** Raising awareness; Improve irrigation efficiency.	**Urban:** Disaster risk management plan; Early Warning system. **Rural:** Water Harvesting; Irrigation technologies; Greywater reuse .	**Urban:** Sustainable water use management; Flood risk management; Tree Planting. **Rural:** Water barriers; Irrigation Technologies.
Middle Tuban region	**Urban:** Flood protection measures; awareness-raising in water usage rationalization. **Rural:** Raising awareness; Improve irrigation efficiency.	**Urban:** Greywater reuse; Water harvesting/ storage; wastewater treatment and reuse. **Rural:** Drought-tolerant crops; Salt-tolerant crops.	**Urban:** Sustainable water use management. **Rural:** Sustainable water use management.
Lower Tuban region	**Urban:** Awareness-raising in water usage rationalization. **Rural:** Raising awareness; Improve irrigation efficiency.	**Urban:** Greywater reuse; Water harvesting/ storage; wastewater treatment and reuse. **Rural:** Drought-tolerant crops; salt-tolerant crops.	**Urban:** Seawater desalination; sustainable water use management: Rehabilitation of Al-Tawelah Tanks. **Rural:** Sustainable water use management; Tree Planting; Mangrove cultivation .

Based on this brainstorm and the team's analysis of priorities and the data and information, the following adaption measures are proposed:

1. New desalination plant to cover the increasing drinking water demands in Aden.
2. Greywater reuse from Mosques and schools in agriculture/creation areas.
3. Rehabilitate the existed wastewater treatment plants and reusing the treated wastewater in agriculture/creation areas.
4. Early warning Systems & Risk Management plans.
5. Re-utilization of desalinated water from Al-Hswah Thermal Power Plant by a) Creating artificial ponds/lake for ground water recharge OR b) sending the water to the national water company
6. Rehabilitation and protection of irrigation system of Tuban Delta for effective water delivery and to reduce floods risks.

UN-HABITAT

Climate Change Vulnerability Assessment Report

UN-Habitat Yemen Programme

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