REQUEST FOR PROJECT/PROGRAMME FUNDING FROM THE ADAPTATION FUND

The annexed form should be completed and transmitted to the Adaptation Fund Board Secretariat by email or fax.

Please type in the responses using the template provided. The instructions attached to the form provide guidance to filling out the template.

Please note that a project/programme must be fully prepared (i.e., fully appraised for feasibility) when the request is submitted. The final project/programme document resulting from the appraisal process should be attached to this request for funding.

Complete documentation should be sent to:

The Adaptation Fund Board Secretariat

1818 H Street NW

MSN P4-400

Washington, D.C., 20433

U.S.A

Fax: +1 (202) 522-3240/5

Email: afbsec@adaptation-fund.org

ADAPTATION FUND

PROJECT/PROGRAMME PROPOSAL TO THE ADAPTATION FUND

PART I: PROJECT/PROGRAMME INFORMATION

Project/Programme Category:	Regular
Country:	Yemen
Title of Project/Programme:	Increase the climate change resilience to water scarcity and flooding in the Tuban Delta
Type of Implementing Entity:	Multilateral Implementing Entity
Implementing Entity:	United Nations Human Settlements Programme (UN-Habitat)
Executing Entity:	Ministry of Water and Environment. Tentatively: Ministry of Agriculture and Irrigation; Cooperative and Agricultural Credit Bank; NGO as part of procurement process
Amount of Financing Requested:	USD 9,998,560

Project Summary

The proposed project "Increase climate change resilience to water scarcity and flooding in the Tuban Delta" has the overall objective to 'increase the resilience of people and water resource systems in the Tuban Delta. The intended impact is 'increased resilience of people and the water sector in the Tuban delta to cope with climate variability and change. This will be achieved through four interconnected components with related outcomes:

1. **Integrated and inclusive natural resource management for climate-resilient water systems**
   Outcome 1: Enhanced capacities of national and sub-national government institutions, communities and vulnerable groups to manage natural resources (focused on water and land) and respond to climate change risks in the Tuban Delta efficiently, sustainably and in a climate change resilient way.
2. **Increased adaptive capacity of the water sector (focused on irrigation and flood protection)**
   Outcome 2: Increased adaptive capacity of the water sector through the rehabilitation and protection of irrigation systems in the Tuban Delta
3. **Increased innovative adaptation practices for water supply systems (focused on innovative practices)**
   Outcome 3: Increased innovative, efficient, sustainable and climate change-resilient practices to improve the water supply systems for urban and agricultural purposes.
4. **Improved ownership and capacities at the local level to respond to climate change.**
   Outcome 4: Improved ownership and capacities at a local level to respond to climate change, including operating, maintaining, and replicating resilient water and irrigation systems.

1.1. PROJECT / PROGRAMME BACKGROUND AND CONTEXT

Country Context: Main Issues and Needs

Yemen faces serious risks from climate change that further threaten the already fragile state of the country.[1] Climate change, rapid population growth, damaged infrastructure and lack of natural resource management put more and more pressure on critical resources, especially water, and leave communities vulnerable to water insecurity, drought and flooding.

Yemen is highly vulnerable to climate change-related risks and impacts such as drought, extreme flooding, disease outbreaks, changes of rainfall patterns, increased storm frequency/severity and sea level rise. The population of the city of Aden, located in the Tuban Delta, 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 for the second largest city in Yemen. Despite this large-scale urban growth, agriculture remains the sector with the highest demand for water. As a result, Yemen experiences extreme water scarcity due to its climate and overexploitation of groundwater.

These are serious concerns as Yemen's economy largely depends on its rural natural resources (esp water in rural areas). Moreover, more than 75 percent of the population is rural based engaged in farming and pastoralism and hence highly reliant on favourable climatic conditions for their livelihoods.

Due to the armed conflict, which started in 2014, Yemen is increasingly suffering from severe food insecurity and water scarcity, worsening gender inequality, widespread poverty (more than half of Yemen's population live below the poverty line) and a lack of economic growth.

[1] USAID (2016)Climate Change Risk Profile: Yemen. Available at: https://www.climatelinks.org/resources/climate-change-risk-profile-yemen

Geography and Current Climate

Yemen is a Middle Eastern country at the southern end of the Arabian Peninsula. It is bordered to the north by Saudi Arabia, to the East by Oman, and to the South and West by a 2,200 km coastline along the Gulf of Aden, Arabian Sea and the Red Sea.

Yemen has a semi-arid-to-arid tropical climate with significant variations due to topographical differences (see Figure 1). It features five agri-ecological zones (see Figure 2), of which the two sea areas are considered one zone. Temperatures vary by location and season. The coastal regions are hot and dry. Rain is rare in all but the highest regions, where the monsoon winds from the Indian Ocean bring rainfalls of 5-10 cm per month in June and July. Rainfall in the drier regions is rare but can be very heavy.

The t**emperature** in Yemen is generally high, with an annual average of 21 degree C. Temperatures vary by location and season. The coastal regions are hot and dry. The southern coastal areas are characterized by limited rainfall (50 mm per year). **Rainfall** in the temperate highlands varies from 400 mm to 800 mm per year. Northern regions and Wadi Hadhramawt are hot and dry throughout the year. In the highlands there is more seasonal variety: winter can be cold, with temperatures below 0 degree C, while the summers are temperate and rainy.

Figure 1. Yemen Geography

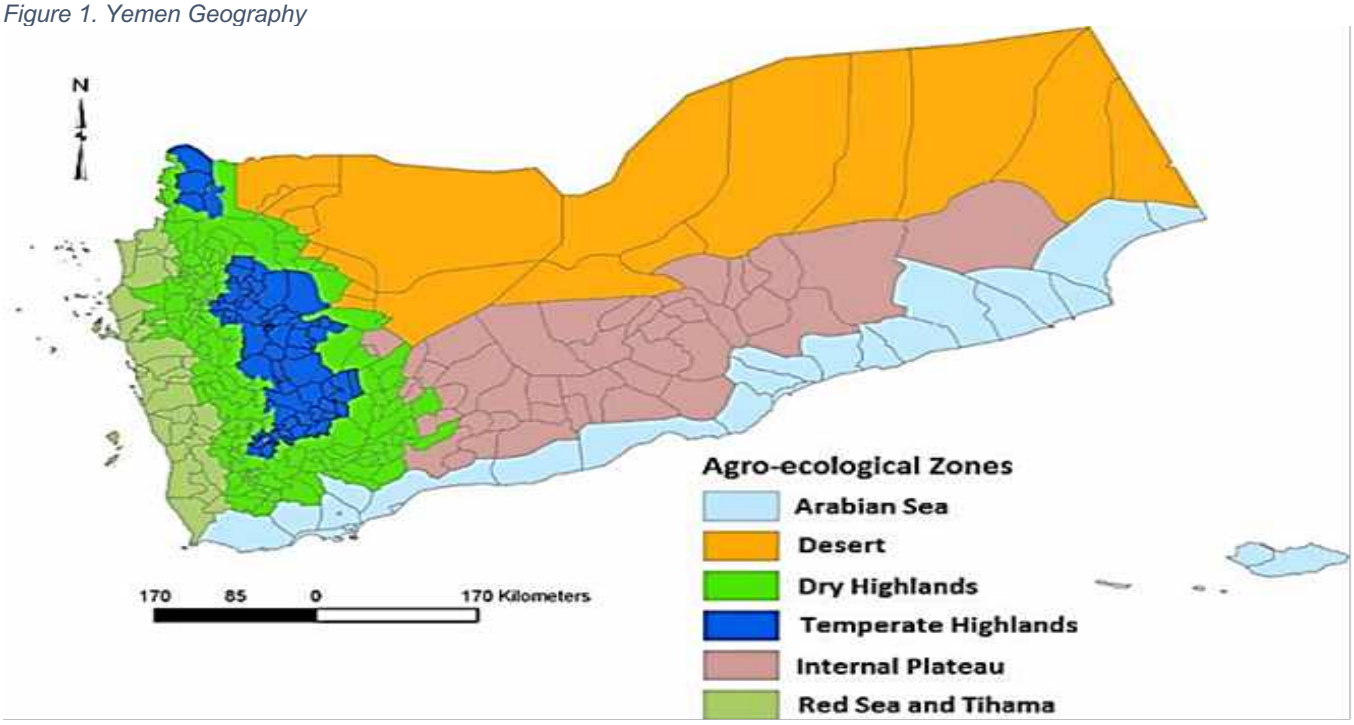


Figure 2. Yemen's Agro-ecological zones

Environmental Context

Yemen has a total land area of 527,970 km2, of which 410,842 km2 (79.3%) is classified as desert with an estimated desertification rate of 3-5% annually.

Yemen experiences extreme water scarcity due to its climate and overexploitation of groundwater. In coastal zones this leads to saltwater intrusion, especially in combination with sea level rise. Climate change is expected to increase temperatures, variability of rainfall and heavy precipitation events. This may shorten growing seasons, especially in the north. Water scarcity, saltwater intrusion and shorter growing seasons threaten food security, and competition for dwindling natural resources could further fuel conflict. On-going conflict, a lack of adequate natural resources management, weak governance as well as other factors seriously hinder Yemen's ability to address the current and future impact of climate change.

It is widely acknowledged by government and citizens that Yemen's major environmental resource problem is water scarcity, a situation being exacerbated by climate change. The water sector in Yemen faces formidable challenges, including decreased agriculture productivity and related reduced food security, increased conflict over resources and accelerated land degradation, and increased livelihood vulnerability. With the current, weak adaptive and institutional capacity, climate change associated risks and impacts will push livelihood vulnerability of the poor into further declines, leading to further environmental resource degradation, increased ecological scarcities, and hardship, and hence increased poverty.[2]

Between 1981 and 2022, 56 weather related hazards have been reported in Yemen, of which 43 hazards are related to floods (77%), 8 to storms (14%) and 5 to landslides (9%). Overall, the number of weather-related hazards has increased over time. While 15 hazards have been observed between 1981 and 2000, a total of 36 hazards have been reported between 2001 and 2020. The number of casualties and people affected by these hazards has decreased over time, from 1.17 million to 0.51 million, especially when comparing the 1981-2000 and 2001-2020 periods.

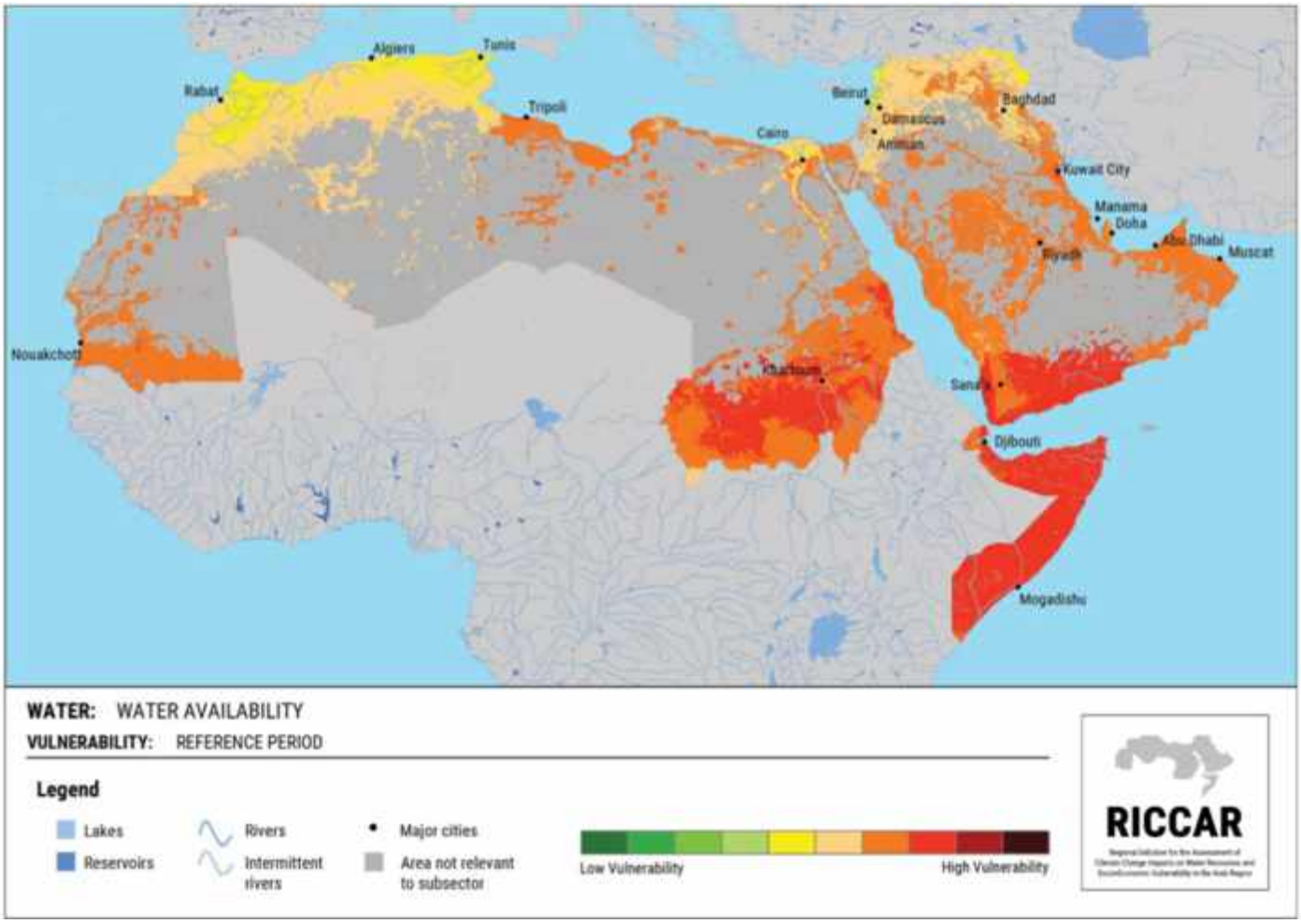


Figure 3. Regional Water Availability Vulnerability, RICCAR, 2019.

[2] http://www.undp.org/content/dam/yemen/E&E/Docs/UNDP-YEM-Governance%20of%20Climate%20Change%20in%20Yemen.pdf

Yemen's **water availability** per capita is currently the lowest in the world[3] and mid-century water availability vulnerability is expected to be very high (see Figure 4). Groundwater extraction has exceeded the level of replenishment capacity, causing water depletion. Since Yemen over-extracts an estimated 0.9 billion cubic meter of water each year from its deep aquifers, groundwater aquifers are declining one to seven meters each year.[4] It is anticipated that climate change combined with high population growth, inadequate agricultural development and policies, qat growth, and a lack of law enforcement to regulate water will put continuing pressure on Yemen's water resources and contribute to its water crisis.[5]

The main water authorities in Yemen are the Ministry of Water and Environment, the Ministry of the Agriculture and Irrigation, the National Water Resources Authority (NWRA), the National Authority for Rural water Projects, National water and Sanitation Authority the Local Water and Sanitation Local Corporations, and the Water User Associations (WUAs). The NWRA is a decentralized government agency with the power to allocate water rights and implement as well as enforce relevant regulations. The work of the NWRA is complemented by the LWCs which are supervising water management at basin level.

Socio-economic context

Yemen currently ranks as the most Fragile State in the world.[6] Prior to the current conflict Yemen was the poorest country in the Middle East. It was estimated that up to 43 percent of its people were living in chronic poverty with 32 percent of the population being food insecure.[7] Notwithstanding the current conflict, given the country's historically high levels of food import dependency, food insecurity, and poverty, both global and local climate change impacts are likely to significantly influence its prospects. Currently, according to the UN, Yemen is suffering the worst humanitarian crisis in the world. In 2020, the UN estimated 24.3 million people—80 percent of the population—were "at risk" of hunger and disease, of whom roughly 14.4 million were in acute need of assistance.[8]

Key facts:

☐ GDP (PPP) per capita (2022):[9]	USD 650
☐ Population (November 2022):[10]	33,696,614 (2.28% growth rate)
☐ Population Aden (2023):[11]	1,082,942
☐ Projected population (2050):[12]	48 304,000
☐ Human Development Index (2020):[13]	177 out of 188 countries
☐ Gender Inequality Index (2020):[14]	0.834
☐ Fragile States Index (2023):[15]	2 out of 178 countries
☐ Groundwater depletion:[16]	1.5 billion m3 (170%) per year; 2-7 meters annually
☐ Per capita water availability	120 m^3 per year in 2016
☐ *Wastewater treatment / access[17]:*	28% of the total population (2022)
☐ Share agriculture employment:[18]	33.1%

National employment figures from before the conflict from ILO showed an unemployment rate of 1%, 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.[19] 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.

Yemen is also a very young country although the rural areas and smaller cities skew slightly older than the larger cities. 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

[3] Glass, N. (2010): *The Water Crisis in Yemen: Causes, Consequences and Solutions, Global Majority E-Journal 1(1)*
[4] USAID (2016)
[5] Glass, N. (2010): *The Water Crisis in Yemen: Causes, Consequences and Solutions, Global Majority E-Journal 1(1)*
[6] https://fragilestatesindex.org/data/
[7] Wiebelt et al. (2011)
[8] World Bank (2020) http://www.worldbank.org/en/country/yemen
[9] World Bank Data – GDP per capita, PPP. http://data.worldbank.org/ indicator/NY.GDP.PCAP.PP.CD
[10] World Population Review – Yemen, http://worldpopulationreview.com/countries/yemen-population/
[11] Statistics provided by the government
[12] UNDESA (2017): *World Population Prospects: The 2017 Revision, Key Findings and Advance Tables.* Working Paper No. ESA/P/WP/248. https://esa.un.org/unpd/wpp/Publications/Files/WPP2017_KeyFindings.pdf
[13] http://hdr.undp.org/
[14] Ibid
[15] https://fragilestatesindex.org/data/
[16] CSO, 2010 World Bank 2016
[17] https://www.sdg6data.org/en/country-or-area/Yemen
[18] National Agriculture sector strategy (2012)
[19] https://data.worldbank.org/country/yemen-rep

healthcare.[20] The women's focus group for this project also highlighted that women are marginalized because they are not involved in decision-making.

There are also many internally displaced persons (IDPs) in the country due to the years of conflict, many of whom are settled in cities and small towns although some camps exist as well.

Historically, Yemen was heavily dependent on imported food. Prior to the conflict, it imported 70-90 percent of its cereals and was a net importer of many other food items as well. Maize, millet, sorghum, and wheat are cultivated in Yemen, yet mainly for household or village level consumption. There is concern that the ancient terraces designed to be flood-irrigated will become high risk with changes in climate as seed can germinates and then die due to lack of water.[21] Wheat is considered the most vulnerable crop, followed by maize. Losses are mainly incurred in the Desert zone, where grain production is limited to wheat. Red Sea/Tihama is expected to benefit from climate change. This is because sorghum and millet experience high yield increase and at the same time account for a larger share of agricultural value-addition than in any other zone, whereas the grains with declining yields (maize and wheat) are hardly produced.

Climate Change projections, impacts and vulnerabilities at the national level

Climate change risks are projected to not only impede the national capacity to achieve sustainable development but also to reverse the economic development that occurred prior to the conflict.

Future climate projections show a potential **temperature increases** of as high as +3.5 to +4.0ºC along the Red Sea and Arabian Sea coastline by the end-century (2070-2099) and further modelling shows that an increase of 30 additional hot days (>40ºC) per year by mid-century under a medium emission scenario (RCP 7).[22] This will **increase evapotranspiration**, thereby decreasing water supply for households and agriculture while also potentially simultaneously increasing water demand as a coping mechanism.

In addition, the number of dry days per year is expected to increase along the western Arabian Sea coastline as well as towards the Highlands by approximately 2 to 6 additional days/yr. under the low-emission scenario (RCP 2.6) and by 8 to 14 days/yr. under the high emission scenario (RCP 8.5.).[23] Further the lower Tuban Delta region, which includes Aden, is likely to have more **drought periods** than the rest of the Tuban Delta.

Precipitation projections vary by emission scenario and by region, although most models show an annual precipitation reduction of -20 to -40mm under RCP 8.5 along the Red Sea coastline and Highlands. Days with **heavy rainfall** are likely to increase in most regions**. With serious and severe flooding** in all regions of the Tuban Delta is likely to increase from 2040 under both medium and high emission scenarios due to increased heavy precipitation.[24]

Sea-level rise (30 cm by mid-century and up to 77 cm by the late 21st century) will continue to exacerbate shoreline erosion, as well as accelerate **saltwater intrusion** into groundwater which is already being observed because of increased water demand and drought years.

In the future, major climatic hazards include (i) higher intensity and frequency of floods (ii) prolonged droughts due to increasingly erratic rainfall and temperature rise droughts which may contribute to further desertification, land degradation and barren land, (iii) increasing water stresses due to higher evapotranspiration rates and increasing pressure on water resources. Lastly, sea level rise (from storm surges and global warming) is becoming a major climate threat in coastal areas that must be addressed to avoid large-scale casualties in the future.

Vulnerability is defined by the adaptive capacity and sensitivity of a system to a climate hazard(s). The impact of climate change on the most vulnerable groups (rural poor, women) include increased exposure to extreme weather events in combination with decreased financial resources available for reconstruction and preparedness due to lower (agricultural) incomes. Yemen's population growth is currently 2.28 percent, which increases the vulnerable position of the country by raising the demand for food, water, and other natural resources.

The climate hazards cited above can have severe implications for key ecosystems and sectors (water, crop production, livestock rearing, fisheries, public health) as well as livelihoods (rural, costal, and urban). In general, key national sectors such as water, agriculture and health as well as dependent livelihoods are exposed and vulnerable to climate change across Yemen.

Prior to the current conflict, over 90 percent of water consumption was used for irrigation. Climate change may decrease the frequency and amount of rainfall, thereby reducing the country's agricultural production. This would not only result in a water crisis, but also in food and economic crises. The severity of the crisis is expressed in the projection that Sana'a is the only capital city in the world that may run out of fresh water within the next decade.[25]

[20] UN-Habitat (2020) Aden City Profile
[21] World Bank; UN; EU; Islamic Development Bank (IDB), 2012: Joint Social and Economic Assessment for the Republic of Yemen, https://openknowledge.worldbank.org/bitstream/handle/10986/11920/693880ESW0P1300sment0pub08031012web.pdf?sequence=1
[22] GCF Country Programme Yemen 2023 (in draft)
[23] Ibid
[24] UN-Habitat (2023) Hydrology Study of the Tuban Delta
[25] Glass, N. (2010): *The Water Crisis in Yemen: Causes, Consequences and Solutions, Global Majority E-Journal 1(1)*

The following provides a summary[26] of major impacts of climate change in Yemen which represents priority areas of interventions for building resilience:

- ☐ Increased water scarcity and reduced water quality – leading to increased hardship on rural livelihoods;
- ☐ Increased drought frequency, increased temperatures, and changes in precipitation patterns – leading to degradation of agricultural lands, soils and terraces;
- ☐ Deterioration of habitats and biodiversity – leading to expansion of desertification;
- ☐ Reduced agricultural productivity – leading to increased food insecurity and reduced income generating activities;
- ☐ Increased sea levels – leading to deterioration of wetlands, coastal mangrove migration, erosion, infrastructure damage, and seawater groundwater intrusion;
- ☐ Increased climatic variability – leading to the possibility of spread and growth of vector borne and water borne diseases; and
- ☐ Impacts on coastal zones – leading to a loss of tourism activity due to sea level rise including loss of beaches.

Project Target Area: The Tuban Delta – Aden and Lahj Governorate

Geography

The Tuban Delta is the downstream area of Wadi Tuban basin. The Wadi Tuban has a total area of 7360 Km^2 and consists of seven sub-basins (Saleh et al., 2012). The Tuban Delta is located between 44.65º - 45.1º E and 12.7º -13.3º N, its topography ranges from 10 below sea level to about 800 above sea level. Based on consultations in country, the Delta was divided into three regions: the Upper Region, the Middle Region, and the Lower Region, represented in Figure X. The division was chosen because of different physical characteristics, pressures and issues being faced by each region.

The project target area is particularly vulnerable to:

- ☐ Aquifer depletion, affecting agricultural yields and water availability for human consumption, settlements and industry
- ☐ Aquifer pollution, and salty water intrusion in coastal areas.
- ☐ Loss of agricultural land diminished yield.
- ☐ Extreme weather events

This area has been selected because of:

- ☐ High vulnerability to climate change as established through a vulnerability assessment conducted for the Aden Coastal Area, also presented in the Second National Communication
- ☐ Challenges that need urgent response
- ☐ Government priority
- ☐ Relative stability and accessibility

Environmental Context

In the Tuban Delta, surface water and groundwater are experiencing several challenges, including overuse, increased evapotranspiration, and a lack of a sustainable water management strategy. These issues have an impact on the growing population, land use, water quality, water quantity, and agricultural systems. Furthermore, the development of several dams and other rainwater harvesting techniques in the upper section of the Tuban watershed (upstream) has decreased the availability of surface water in the Tuban Delta (downstream). As a result, limited water reaches the lower region and no water reaches the ocean, which forces people and farmers to depend mainly on groundwater. The demand for water in the region is due to both domestic and agricultural uses, with total demand in 2022 estimated at 136.4 MCM (million cubic meters) in demand (comprised of 45.5 and 91.9 MCM, for domestic and agriculture, respectively). The estimated water supply is however only 53 MCM, resulting in a

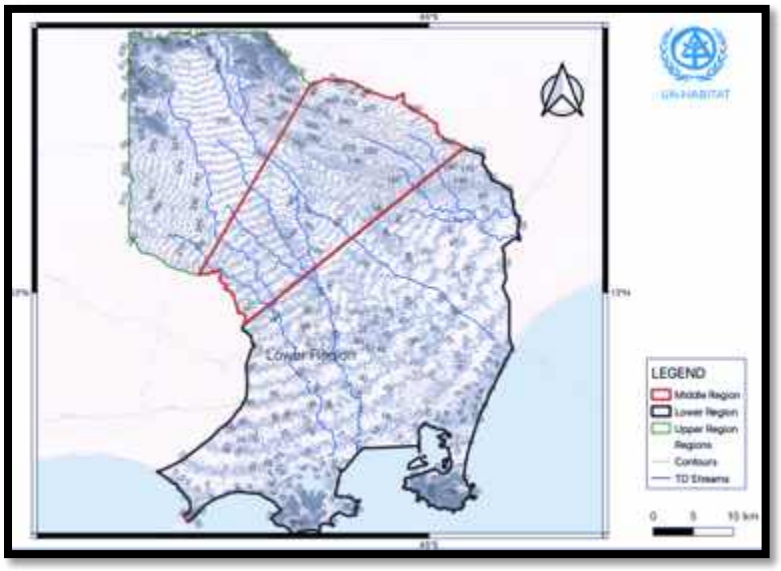


Figure 4 Tuban Delta regions with contours and streams delineated, UN-Habitat (2023) Hydrology report for the Tuban Delta

[26] INDC (2015)

total current water deficit of 84.4 MCM. This deficit will accelerate in the future due to climate change impacts and population growth to be about 90MCM in 2025 and 147 MCM in 2050.[27]

The sensitivity to water insecurity is high not only due to this water shortage but also due to water intensive crops being cultivates such as sorghum, cotton and vegetables and that some households in the region are not linked to the water grid – up to 25% in Aden and 40% in Al-Hawtah.

There is also an impact on natural ecosystems with the water withdrawal level so high, the environmental demand is unmet and no water flows to the ocean, disrupting the natural hydrological cycle.

This project aims to respond to the water scarcity-related challenges in the Tuban Delta, which includes Aden, the second largest city in Yemen, and its coastal climate change risks, including saltwater intrusion.

Lower Region of the Tuban Delta: Aden and surrounding area

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 km^2 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. 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. 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.

Figure 5. Cities, towns and villages of the Tuban Delta, UN-Habitat (2023) Hydrology report for the Tuban Delta

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.[28] 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.

Aden is the largest city in southern Yemen in terms of population and host to a major seaport in one of the world's largest natural harbors. Aden has a long history as 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.[29]

In terms of the economics of the port, prior to the conflict, most of the cargo consisted of oil and oil represented 75 percent of the government revenue and 90% of export revenue.[30] However, oil and gas production has slowed due to the conflict.

[27] UN-habitat (to be published) Hydrology study of the Tuban delta

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

[29] UN-Habitat (2020) Aden City Profile

[30] 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 percent 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.[31]

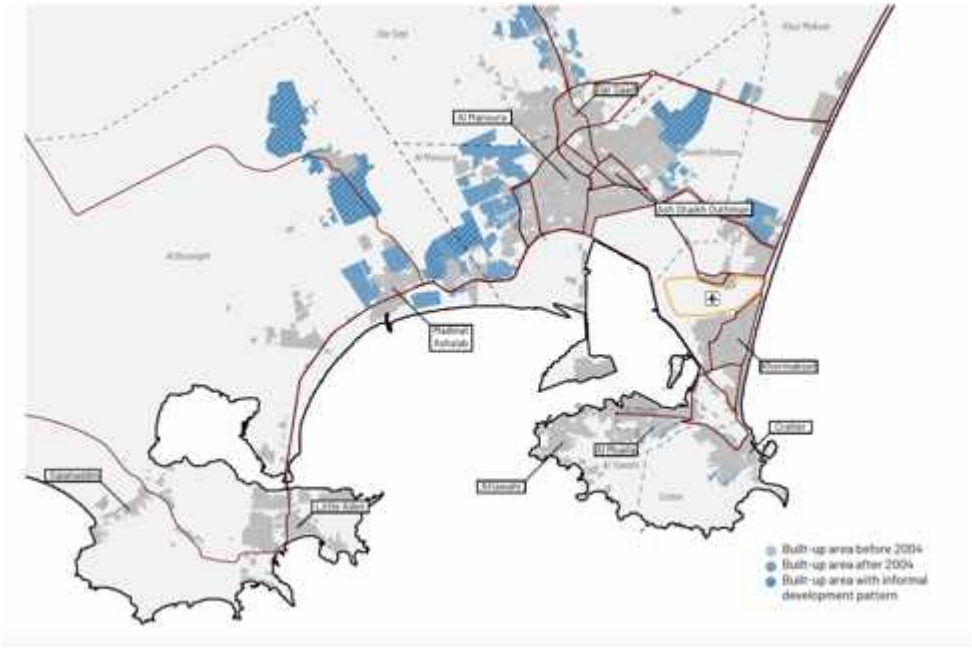


Figure 6. Urban expansion in Aden, UN-Habitat (2020) Aden City Profile

For the Tuban District of the Lahj Governorate in the Lower Region, 70 percent of the population works in agriculture but this only represents 75 percent of their income and the remaining 25 percent is supplemented by informal and irregular daily work. In Aden, around 7% of population work in agriculture, but this is only 50 percent of their income source, while the remaining 50 percent comes from irregular, informal daily work.

Historically, Aden has consisted of urban centers or clusters of similar size. The urban growth in the past 15 years has mostly been low density urban development some of which has been planned and some is unplanned.[32] Demand for housing due to urbanization, demographic pressure and high inflation has resulted in overcrowding in many households in Aden.

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.[33] The main source for obtaining water is ground wells, 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 Crater), the water is only available on average from 0-4 hours. In five districts (Dar Sad, Crater, 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.[34]

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. 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.[35]

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 Crater. 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. In 2013, the total enrollment for basic education in Aden was 80%, of which 66% attended public and 14% private institutions. The following year, the enrollment rate was estimated to be 77% (79% male and 75% female), of which 63% attended public and 14% private institutions. A 3% decrease was observed for male students in public schools. [36] According to the Joint Education Needs Assessment, an estimated 20 percent of children were out of school in Aden in 2016. 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.

[31] UN-Habitat (2020) Aden City Profile
[32] Ibid
[33] *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).*
[34] UN-Habitat (2020) Aden City Profile
[35] Ibid
[36] *Save the Children, Yemen Education Cluster, Joint Education Needs Assessment Report, Aden – Yemen, (2016).*

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, mudflats, marshes and beaches and are habitats for many bird species.[37]

There are many pressures on wetland ecosystems in the Aden area, 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.[38] There have been two reserves established in the Aden Governorate: Al-Heswah Wetlands Reserve and a Nature Reserve for Swans.

Wetland degradation has been observed across the country, in part because of climate change and limited water resources, but also due to repurposing of land without policies and law enforcement to protect the areas, which has led to uncontrolled construction and the establishment of illegal dumping sites. In particular the wetlands in Aden have shrunk significantly over the past years. The loss of wetlands is a concern both to the biodiversity, as well as the wetlands' ability to absorb pollution and floods, as well as recharge aquifers.[39]

To address this, conservation efforts have focused on the establishment of protection areas. For example, the Aden Wetlands protection initiative was officially declared in 2006 by the "Prime Minister's decree" No. 304. In addition to protecting the habitat for migratory birds, the protection sites were important to maintaining several plant and aquatic animal species.

In Aden, sand beaches forming large and scattered areas along the coastline, are considered to be of great ecological importance for different marine organisms. For instance, some of the beaches are nesting sites for sea turtles. The Aziz Island west of Aden is considered the main important site for nesting Hawksbill turtles along the coastline of the Gulf of Aden.

Middle Region of Tuban Delta: Al Hawtah, Lahj and surrounding area

The Middle Region of the Tuban Delta is located in the Lahj Governorate. The area covers 570 km^2 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. 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.

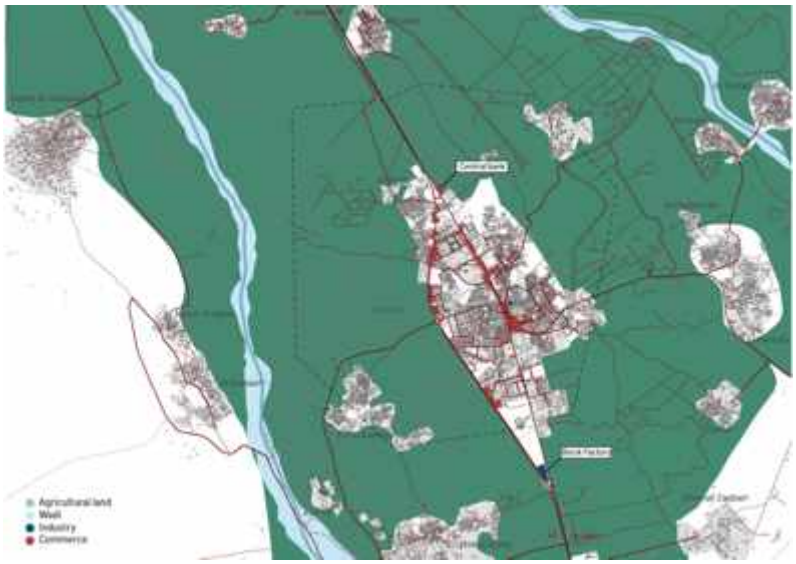


Figure 7. Al-Hawtah city and surrounding land uses, UN-Habitat (2020) Al-Hawtah city profile

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[40]. 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.

The hydrology study conducted for this project (for more details see annex 1 on page 94) 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.

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

[37] https://www.equatorinitiative.org/wp-content/uploads/2017/05/Al-Heswa-Yemen.pdf
[38] UN-Habitat (2020) Aden City Profile
[39] Afrah Saad Al-mahfadi and Mohamed Dakki, "Causes and Effects of Coastal Wetlands Degradation in Yemen," *Iioab Journal*, no. October, 2016.
[40] https://data.unhcr.org/en/country/yem#_ga=2.51079209.1447391314.1679905938-1498650503.1679905938

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.

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.

The water supply infrastructure in Al Hawtah sustained extensive damage from the conflict, including reservoirs, pumping stations, and wells. Water for drinking purposes is not readily available, and most households have trouble getting enough water to drink. Affordability of water is also an issue.

Sewage and wastewater management issues were also reported as a key issue throughout the Tuban region. Lahj Water and Sanitation Corporation (LWSC) is the body responsible for managing the water services in Al Hawtah and Tuban districts.[41] 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 LWCS 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.

The Tuban Delta used to be known for the purity of its water and gardens of jasmine trees and roses.[42] 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.[43] 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.

One of the main challenges in the region is poverty as Lahj Governorate is the second poorest governorate in Yemen based on CSO data from 2014 which estimates the poverty rate as 69.1%.[44] 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.[45] 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 UN-Habitat Al Hawtah City Profile showed 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 leading economic activity in terms of economic productivity, with the main crops in the Middle Region by hectares as sorghum, millet, cotton, and vegetables.

Education services 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. IDPs face particular challenges in accessing services from WASH to health and infrastructure. Most IDPs in Al Hawtah have

[41] GIZ (2018), Damage Assessment Report of Twelve Water Supply and Sanitation Local Corporations (LCs), (Bonn and Eschborn, Germany: GIZ, 2018).
[42] UN-Habitat (2020) Al Hawtah City Profile
[43] Ibid
[44] Ibid
[45] Ibid

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.[46]

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.[47]

Upper Region of Tuban Delta: Upstream highlands area in Lahj

The Upper Region of the Tuban Delta is located in the Lahj Governorate. The area covers 450 km2 and has a population of 36,921. 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. There are not any IDP camps in the Upper Region however there are likely to be some IDPs living in the area and renting homes.

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 climate is semi-tropical and arid, and the elevation varies from 200 meters above sea level to 500 meters above sea level and the region has several streams.

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 Palance 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.

Climate Change and the Tuban Delta

Climate Change Hazards: Increased Temperatures, Variable Precipitation, Sea Level Rise

The mean annual temperature is expected to increase by 1.2-3.3 degree C by 2060 and by 1.6-5.1 degree C for the end of this century. Models predict a strong increase in the duration of heat waves, as well as a strong reduction in duration of cold spells. The rate of warming is more rapid in the interior regions than in areas close to the coast. This increase of temperature will increase evapotranspiration rates and water scarcity in the Tuban Delta, thus reduce agriculture production (food security) and domestic water supply. Desertification and reduction of the water table pose severe risks to people's access to drinking water, agricultural production, and livelihoods. In the cities (see Table 1), temperature rise is further exacerbated by heat resources emitted from buildings (and air conditioning), asphalt roads, and limited vegetation, building up urban heat islands which in turn cause damage to asphalt roads and other infrastructure and impact human well-being.

Table 1. Average temperature increase in Yemen cities[48]

Average temperature increase	2016-2035		2046-2065		2081-2100	
City	**RCP45**	**RCP85**	**RCP45**	**RCP85**	**RCP45**	**RCP85**
Al Hawtah	0.8	0.9	1.6	2.3	2.1	4.3
Sa'ada	0.8	1.0	1.6	2.3	2.0	4.2
Ibb	0.8	0.9	1.5	2.1	2.0	4.1
Aden	0.8	0.9	1.6	2.2	2.0	4.0
Al Hodeidah	0.8	0.9	1.5	2.1	2.0	4.0
Sana'a	0.7	0.9	1.5	2.1	1.9	3.9
Mareb	0.7	0.8	1.4	2.0	1.8	3.7
Ta'iz	0.8	0.8	1.4	2.0	1.8	3.7

[46] Ibid
[47] UN-Habitat (2020) Al Hawtah City Profile
[48] Change in Annual Temperature (RCM Ensemble for near-,mid-,end-century, extracted from data www.riccar.org. Ensemble of 3 bias-corrected RCM projections using daily data from 3 different GCMs (CNRM-CM5, EC-EARTH, and GDFL-ESM2M). Data over the 20-year period is averaged to obtain the ensemble.

Projections for precipitation are more variable across different scenarios with some scenarios showing an increase in average rainfall in the region and some models showing a decrease in average rainfall. There is however concurrence that there will be an increase in one-day precipitation with more extreme rainfall events which are a major contributing factor to flooding.

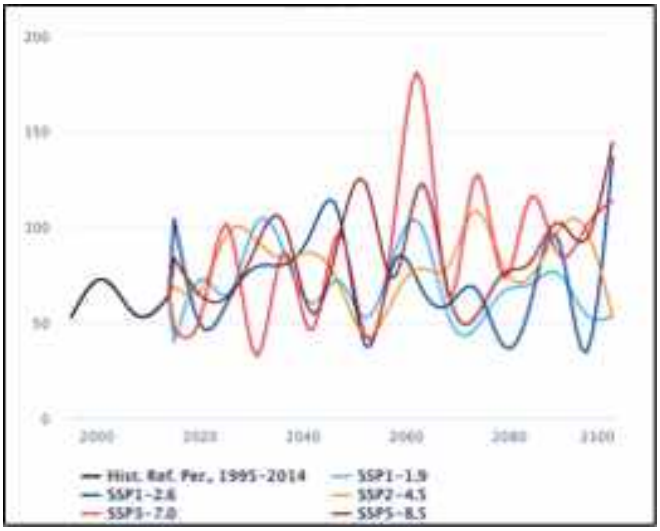


Figure 9. Projected Annual Precipitation in Aden (mm)

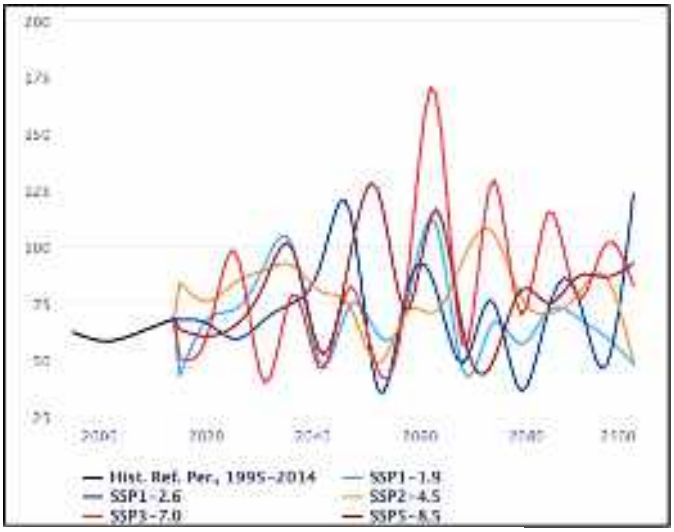


Figure 8 Projected annual precipitation in Lahj (mm)

Table 2. Average Annual Rainfall Projections (mm) under SSP3 and SSP 5. Source: UN-Habitat (2023)

Years	SSP3 /RCP 7	SSP5/RCP 8.5	SSP3 /RCP 7	SSP5/RCP 8.5	SSP3 /RCP 7	SSP5/RCP 8.5
	Lower Region		Middle Region		Upper Region	
Baseline (2022)	51		84		118	
2023-2040	69.8	82.3	69.4	79.9	76.3	87.8
2041-2060	76.4	89.6	68.3	90.0	75.1	99.0
2061-2080	110.4	77.7	106.2	74.8	116.8	82.3
2081-2100	100.5	97.2	94.9	84.3	104.4	92.7

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

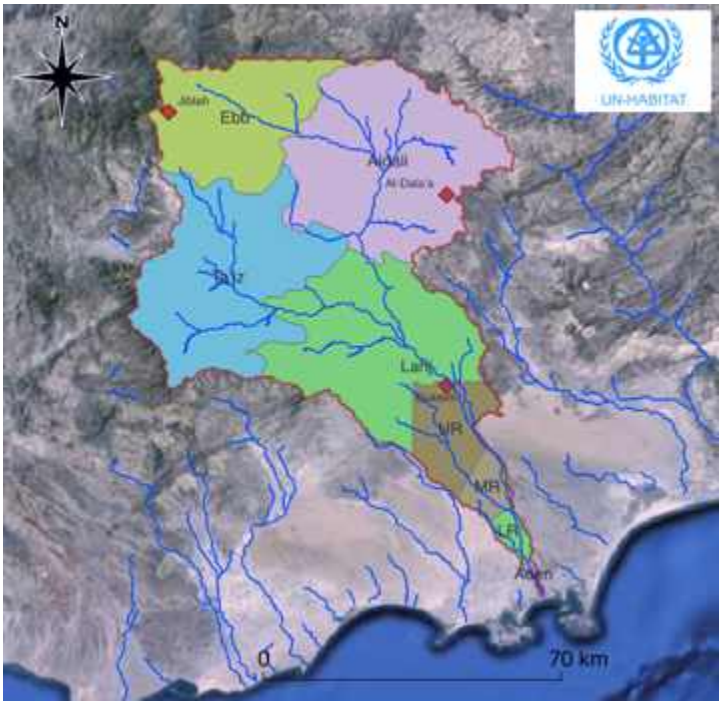


Figure 10 The boundaries of the Tuban Delta Watershed that Contributes to Flash Flood in Tuban Delta, Source: UN-Habitat (2023)

Figure 11 Main streams and infrastructure assets in the Tuban Delta

The hydrology study also mapped the assets throughout the Tuban Delta alongside 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.

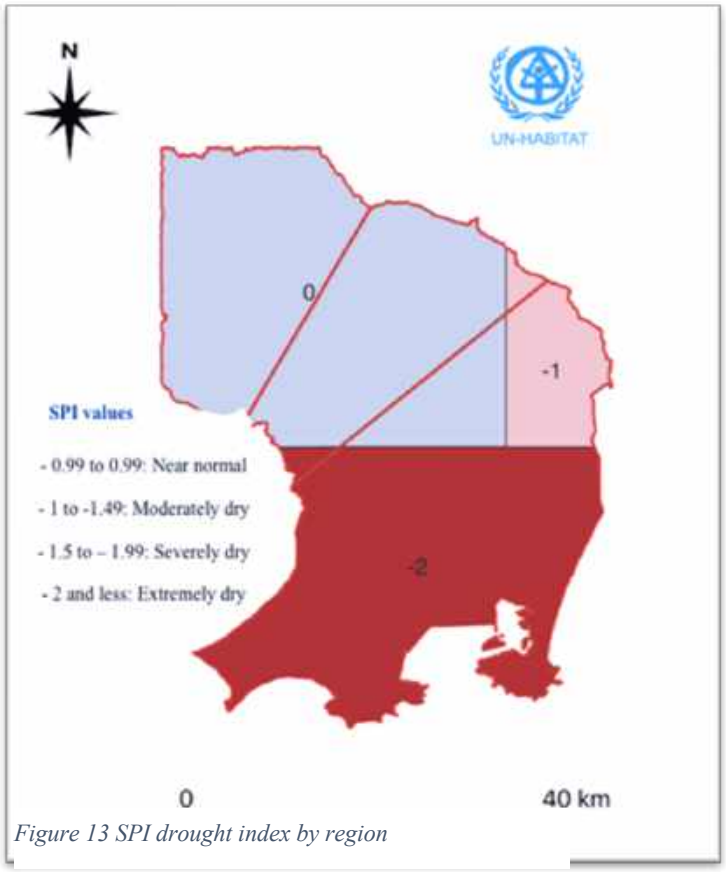


Figure 13 SPI drought index by region

Sea level rise is projected to affect the coastline along Aden with impacts on major infrastructure areas and buildings at low elevation area which includes the international airport which is located at 0m to –10m below sea level. The maps below show the risk to the coastal area by 2100 based on RCP 8.5, the high emission scenario.

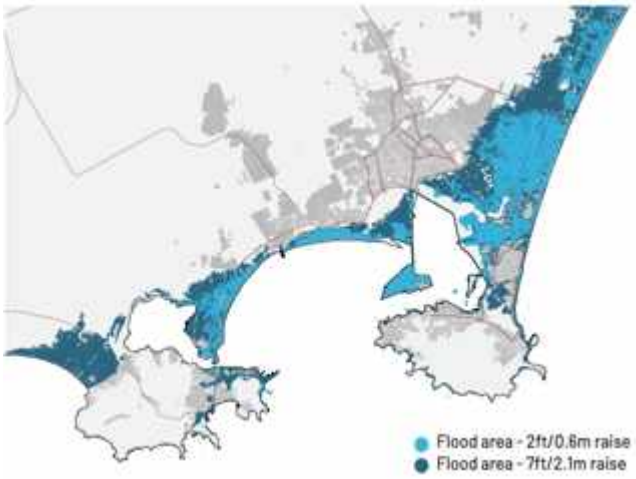


Figure 12. Sea Level Rise map of Aden

Figure 14. Projected sea level rise impact on Aden

Sea level rise also increases saltwater intrusion into many wells in Aden which affects the already limited water supply.

Rising sea levels will have a severe impact on the coastal cities, as well as further infiltrate groundwater aquifers. Sea level rise projections modelled on Digital Elevation Maps (DEM) by the Climate Central,[49] show that even a one-meter sea level raise will submerge parts of Aden, Al Hodeidah, and Al Mukalla (see Figure 7). In Aden large parts of central economic and residential districts will be fully submerged, including the airport, cutting the linkage to the Aden peninsula hosting the port facilities. A number of cities, towns and villages along the main road stretching from Aden, through Zinjibar and Al Mukalla, and further into Oman, as well as urban settlements located along the Red Sea coast to the west up towards Al Hodeidah, are similarly located on low lying planes that will be severely affected by sea level rise.

Yemen is a disaster-prone country that faces **natural hazards** every year with floods as the most important and recurring form of disaster. While *regular* flooding has historically been beneficial for agriculture in Yemen, *high-magnitude* flooding often leads to losses of cropland, uprooting of fruit trees, death of animals caught in high floodwater surges, and destruction of infrastructure, such as irrigation facilities and rural roads. The damages done by floods tend to be exacerbated by ongoing desertification processes and land degradation, partly caused by climate change. In addition, several models project higher rainfall levels for Yemen, thus potentially increasing the frequency and severity of floods.[50] Rising sea levels are expected to accelerate coastal erosion, damage key infrastructure, force community relocations, and threaten marine ecosystems and low-lying coastal wetlands. Greater variability in rainfall patterns will reduce food security because of the increasing severity of droughts and floods.[51]

Climate Change Risks and Vulnerability Analysis for the Tuban Delta

Greater rainfall variability could increase drought periods and diminish water supplies more rapidly while increased temperatures could lead to higher evapotranspiration rates, further slowing the replenishment of water sources.[52] The overexploitation of groundwater resources and the rising sea level due to climate change will result in increased salt water intrusion, especially in coastal aquifers.

[49] Climate Central, "Risk Zone Map," 2020, https://ss2.climatecentral.org/#9/13.5445/44.2831?show=satellite&projections=0-K14_RCP85-SLR&level=1&unit=meters&pois=hide.
[50] Wiebelt, M.; Breisinger, C.; Ecker, O.; Al-Riffai, P.; Robertson, R.; Thiele, R., (2011): *Climate Change and Floods In Yemen: Impacts on Food Security and Options for Adaptation* (IFPRI Discussion Paper 01139)
http://cdm15738.contentdm.oclc.org/utils/getfile/collection/p15738coll2/id/126748/filename/126959.pdf
[51] Climate Investment Funds (2012): *Pilot Programme for Climate Resilience.*
[52] USAID (2016)

Projections suggest that aquifers such as **Abyan, Tuban**, and Sa'adah will be depleted by 2025. Depletion of the **Tuban aquifer** is the most rapid (2015, versus 2019 for Abyan) because of a greater reliance on groundwater relative to discharge in the Tuban sub-basin.

UN-Habitat conducted a hydrological study for the Tuban Delta area which found that due to limited surface water availability in the Tuban Delta's Lower Region, groundwater recharge has been diminished, forcing farmers to increase groundwater extraction. Because of these issues, as well as internal migration, population expansion, and climate change, groundwater levels have decreased, saltwater intrusion has grown, soil qualities have changed, and desertification has worsened. If the imbalance between groundwater recharge and discharge persists, groundwater levels will fall further, and saltwater intrusion will rise. As a result, fresh groundwater of the lower region may endure no more than 35 years. The water balance was examined based on the gathered data and current conditions, taking into account future forecasts under RCP 8.5 and RCP 7, along with three alternative demand scenarios, to provide a comprehensive picture of the current and future water situation. According to the findings, the lower area would have the most severe water shortage beginning in the next decade, while the middle area may face a water crisis beginning in 2040.

An analysis of regional climate change impacts on agriculture in Yemen shows a mixed pattern, with production increases in the highlands (from Sa'adah to Taiz) due to higher temperatures. Significant yield reductions are expected in some lower and hotter areas such as around Raymah in the west, **Abyan-Aden** in the south, and in the eastern half of the country.[53] Annual desertification of cultivated land is 3-5 percent,[54] which negatively affects food production and decreases overall availability of arable land. The countrywide food insecurity impact of floods is minor; however, there are substantial consequences at the local level where the consequences can be severe, especially in the areas that are directly affected by floods. Within agricultural subsectors, fruits are the hardest hit by floods, followed by sesame and tomatoes.[55]

Extreme rainfall and urban flooding

Rainfall in the coastal and desert cities is rare, with few rainy days in a year. 2016 data show as little as 22-mm rainfall in Aden. Rainfall usually happens during short and localised deluge, often accommodated by heavy thunderstorms. Precipitation generally decreases towards the east, as the region is considered a transitional zone between the wetter western highlands and the dry Rub Al-Khali desert. Several cities are repeatedly affected by heavy rainfall resulting from persistent deep land atmosphere depressions and cyclonic storms, which in turn occasionally causes urban flash flooding.

Heavy rainfall was experienced both in June 2019 and April 2020. Aden, Sana'a and Ma'rib were severely affected by flooding after the April 2020 rains, and an estimated 148,680 people were affected across 13 governorates,[56] leaving 15 dead and 89 injured by the end of April.[57] The floods caused severe disruption to services, and damages to housing and infrastructure, such as roads, bridges and the electricity grid, as well as contaminated water supplies. In Aden, IDP shelters for 1,812 families were damaged.[58] From January to April, around 110,000 cases of cholera had been recorded, with a further hike in this figure expected as a result of the flooding.[59]

Aden's typology, with the characteristic slopes encapsulating the city, is conducive to debris slides being carried by flash floods. This has caused severe damages to people and physical assets, particularly on informal settlements constructed in the hillsides of the city. In the lowland areas in Aden, these floods create swamps and pools that stay unevaporated for several days. This is causing electricity outages, as well as contributing to health stresses such as cholera and malaria. The current city plans are not adjusted to prevent and adapt to such impacts.

A climate change vulnerability assessment of the three regions for two key hydrological climate change impacts, flooding and water security, was undertaken. For more details see annex 1 on page 72). 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.

[53] World Bank (2010): Y*emen: Assessing the Impacts of Climate Change and Variability on the Water and Agricultural Sectors and the Policy Implications.*
[54] Climate Investment Funds (2012): *Pilot Programme for Climate Resilience.*
[55] Wiebelt et al. (2011)
[56] OCHA, "Yemen : Flash Floods - Flash Update No. 3," *OCHA*, no. April, 2020.
[57] ACAPS, "Yemen - Heavy Rainfall and Flash Floods," *ACAPS Yemen Analysis Hub*, 2020.
[58] Ibid.
[59] OCHA, "Yemen : Flash Floods - Flash Update No. 3."

Table 3 Summary of water scarcity and flood risks in the Tuban delta regions

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

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. For flooding, the climate change indicators are precipitation and sea level rise which correlates to the hazards of both coastal and inland flooding.
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.
Outlined below is the data for the flood risk indicators for the Lower Region.

Table 4 flood risk 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.

Table 5 Lower Region vulnerability to flooding

	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:

Table 6 water scarcity risk indicators for the Lower Region

Exposure (Quantitative)	**Sensitivity (Qualitative)**	**Adaptive Capacity**
Hectares of Agricultural Land 2948 ha	Types of crops 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.

Table 7 Lower Region vulnerability of water security

	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

The Middle Region of the Tuban Delta is in the Lahj Governorate and includes the capital city of Al Hawtah. Outlined below are the Flooding indicators:

Table 8 Flood risk indicators for the Middle Region

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	Natural channel Encroachment and Degradation	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.
The Middle Region has a medium-high vulnerability to flooding with a score of 19.

Table 9 Middle Region vulnerability to flooding

	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:

Table 10 water scarcity risk indicators for the Middle Region

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

The Middle Region has a high vulnerability for water security with a score of 21.

Table 11 Middle region vulnerability to water scarcity

	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

Upper Region Tuban Delta CCVA

The Upper Region of the Tuban Delta is the least densely populated and most rural of the three regions and at the highest altitude.
Outlined below is the data for the indicators for flooding vulnerability.

Table 12 Flood risk indicators for the Upper Region

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

Utilizing the scoring system, this yields a vulnerability to flooding level of Medium, with a score of 15.

Table 13 Upper region vulnerability to flooding

	Exposure	Sensitivity	Adaptive Capacity	
Infrastructure	1	2	3	Knowledge
People	1	2	2	Plans
Ecosystems	1	1	2	Financial Assistance
Total	3	5	7	15

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

Table 14 Water scarcity indicators for the Upper Region

Exposure (Quantitative)	Sensitivity (Qualitative)	Adaptive Capacity
Hectares of Agricultural Land 2830 ha	Types of crops 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

The vulnerability of the Upper Region for Water Security is Medium-High with a score of 18.

Table 15 Upper region vulnerability to water scarcity

	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

The overall key points derived from the climate change vulnerability assessment for the Tuban Delta, which were then considered in the identification of adaptation options include:

- ✓ 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 plans 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. A 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:

Table 16 Overview potential adaptation options in the Tuban delta

Regions	Short-term options (1-3 years)	Medium-term options (4-6 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 consultation and further discussion with the government, and an analysis of priorities and the data and information, the following adaption measures were identified:

1. New desalination plant to cover the increasing drinking water demands in Aden (to be covered by GCF).
2. Greywater reuse from Mosques and schools in agriculture/creation areas (low priority communities)
3. Rehabilitate the existed wastewater treatment plants and reusing the treated wastewater in agriculture/creation areas (low priority communities)
4. Early warning Systems & Risk Management plans (low priority communities)
5. Re-utilization of desalinated water from Al-Hswah Thermal Power Plant (screened-out by the ministry of water and environment)
6. Rehabilitation and protection of irrigation system of Tuban Delta for effective water delivery and to reduce floods risks.

A pre-feasibility study (see annex 3 page 107) was then conducted, and the following project components and objectives were identified to pursue for this proposal. These would focus on the following concrete interventions:

1. Rehabilitation and protection of irrigation system of Tuban Delta for effective water delivery and to reduce floods risks.
2. Rehabilitate the existed wastewater treatment plants and reusing the treated wastewater in agriculture/creation areas.

1.2. PROJECT / PROGRAMME OBJECTIVES:

Overall objective

Increase the resilience of people and water resource systems in the Tuban Delta.

Intended impact

Increased resilience of people and the water sector in the Tuban delta to cope with climate variability and change.

Outcomes

1. Enhanced capacities of national and sub-national government institutions, communities and vulnerable groups to manage natural resources (focused on water and land) and respond to climate change risks in the Tuban Delta efficiently, sustainably and in a resilient way.

This is in line with the following AF outcomes:

- Outcome 2: Strengthened institutional capacity to reduce risks associated with climate-induced socioeconomic and environmental losses.
- Outcome 7: Improved policies and regulations that promote and enforce resilience measures.

2. Increased adaptive capacity of the water sector through rehabilitation and protection of irrigation systems in the Tuban Delta.

This is in line with the AF outcomes:

- Outcome 4: Increased adaptive capacity within relevant development sector services and infrastructure assets.

3. Increased innovative, efficient, sustainable and climate change resilient practices to improve the water supply systems for urban and agriculture purposes.

This is in line with the AF outcomes:

- Outcome 8: Support the development and diffusion of innovative adaptation practices, tools and technologies

4. Improved ownership and capacities at local level to respond to climate change, including operating, maintain and replicating resilient water and irrigation systems.

This is in line with the AF outcomes:

- Outcome 3: Strengthened awareness and ownership of adaptation and climate risk reduction processes at local level

1.3. PROJECT / PROGRAMME COMPONENTS AND FINANCING

Table 17 project / programme components and financing

Project Components	Expected Concrete Outputs	Expected Outcomes	Amount (US$)
I. Integrated and inclusive natural resource management for climate-resilient water systems	1.1 Government capacity strengthened at national and sub-national level on increasing climate change resilience and effective water management 1.2 Establishment of laboratory for wastewater quality testing and water supply quality testing. 1.3 Integrated and inclusive natural resource (focused on water and land) and climate change risk management process and plan	1. Enhanced capacities of national and sub-national government institutions, communities and vulnerable groups to manage natural resources (focused on water and land) and respond to climate change risks in the Tuban Delta efficiently, sustainably and in a resilient way (in line with AF Outcomes 2 and 7)	188.800 299.720 422.440 T: 910.960
II. Increased adaptive capacity of the water sector	2.1. Assessment and verification / technical specification and engineering studies, including surveys required, for improved irrigation canals and water intake systems. 2.2. Rehabilitated irrigation canals to improve water access for agricultural purposes in the Tuban. 2.3. Improved water intake structures to increase water supply in the irrigation canals. 2.4. Stone-gabions constructed (where feasible with hybrid greening option) to reinforce canals and protect agriculture lands and Al-what city from flashing floods (where feasible with hybrid greening option)	2. Increased adaptive capacity of the water sector through rehabilitation and protection of irrigation systems in the Tuban Delta (in line with AF Outcome 4)	60.000 1.665.216 88.500 1.572.350 T: 3.386.067
III. Innovative adaptation practices for water supply systems	3.1 Assessment and verification / technical specification and engineering studies, including surveys required, for water supply alternatives options outlined below 3.2 Developing efficient and safe water supply alternatives for Al-What, Al-Hawtah, Saber cities and surrounding villages. 3.3 Upgrade Tahror WWTP to treat wastewater for use in irrigation. 3.4 Upgrade Saber WWTP to treat wastewater for use in irrigation.	3. Increased innovative, efficient, sustainable and climate change resilient practices to improve the water supply systems for urban and agriculture purposes. (in line with AF Outcome 4 and 8)	45.000 1.569.400 400.020 360.490 T: 2.374.910
IV. Improved ownership and capacities at local level to respond to climate change	4.1 Support farmers' with modern irrigation techniques and systems (Urban and Rural Areas). 4.2 Develop maintenance plans for canals, irrigation system. 4.3 Strengthen water users associations for improved monitoring, maintenance and dissemination of information on irrigation techniques and skills development. 4.4 Skills development with women and youth on water management and climate change adaptation. 4.5 Capacity development for communities with a focus on women and youth civil society organizations on integrated and inclusive natural resource management plans. 4.6 Awareness raising with local communities on water conservation and climate change in Aden and the Tuban Delta.	4. Improved ownership and capacities at local level to respond to climate change, including to operate, maintain and replicate resilient water and irrigation systems. (in line with AF Outcome 3)	854.721 155.760 292.640 141.600 94.400 129.000 T: 1.668.121
V.	Total components		$8,340.057
VI.	Project/Programme Execution cost (9.5 %)[60]		$875.426
VII.	Total Project/Programme Cost		$9.215.483
VIII.	Project/Programme Cycle Management Fee charged by the Implementing Entity (if applicable) (8.5%)[61]		$783.077
Amount of Financing Requested			$9,998.560

[60] Max according to AF guidelines
[61] Max according to AF guidelines

1.4. PROJECTED CALENDAR

Milestones	Expected Dates
Start of Project/Programme Implementation	Jan 2024
Project/Programme Closing	Dec 2027
Terminal Evaluation	September 2027
Duration	3,5 years

PART II: PROJECT / PROGRAMME JUSTIFICATION

A. PROJECT / PROGRAMME COMPONENTS

To achieve the overall project objective to 'Increase the climate change resilience to water scarcity and flooding in the Tuban Delta' the projects' 'core' is a set of concrete adaptation actions (components 2 and 3). Around 2/3rd of the components budget will be allocated to these concrete interventions and these will directly benefit the populations living in the target area. Component 1 will consist of capacity building support and plan development to manage natural resources in the Tuban delta area as efficient, sustainably and climate change resilient as possible through vertical and horizontal cooperation, especially on water management, spatial planning and climate change. Component 1 will also include an inclusive process to bring together diverse stakeholders, especially women and youth (trained under Component 4) to identify natural resource management and climate priorities and other investment needs in the water sector in the Tuban Delta and more widely throughout Yemen.

Component 1: Integrated and inclusive natural resource management for climate-resilient water systems

In line with AF outcomes 2 and 7 and the priorities of the government of Yemen (see part II.D), this component will focus on strengthening the capacities of national and sub-national government institutions and build an inclusive process for the sustainable and climate resilient management of natural resources to ensure benefits to communities and vulnerable groups in the Tuban Delta through the following outputs:

1.1. Government capacity strengthened at national and sub-national level on increasing climate change resilience and effective water management
1.2. Establishment of laboratory for wastewater quality testing and water supply quality testing.
1.3. Integrated and inclusive natural resource (focused on water and land) and climate change risk management process and plan

These culminate into the expected outcome 1: Enhanced capacities of national and sub-national government institutions, communities and vulnerable groups to manage natural resources (focused on water and land) and respond to climate change risks in the Tuban Delta efficiently, sustainably and in a resilient way

As identified in the preparation of this project, there are many potential interventions to increase water security for the Tuban Delta and it is critical that all future investments are coordinated to ensure synergies and that the best possible interventions are selected. To reach this end goal, the national and sub-national government needs more capacity on climate change resilience, effective water management and the development of integrated and inclusive natural resource management plans. Although there is some capacity in the government on water management and climate change resilience, this is generally in silos related to the area of expertise and mandate of the ministry and a more integrated and comprehensive approach will help to ensure a coordinated approach for land and water resources for urban and agricultural uses that better reflects a landscape approach. In addition to more capacity, additional data is needed to ensure water quality, identify any hotspots of degradation or poor water quality, assure the public of the quality of water from innovative methods employed in this project (especially under Component 3), and build the data foundation for future interventions. Also, critically for a country with many vulnerable people and many development challenges, it is important that the development of plans for climate change resilience and natural resource management are inclusive and include diverse stakeholders from local communities, including farmers, women, youth, and migrants – which is why this component includes an output for a process to engage these stakeholders in identifying priorities and interventions.

Component 2: Increased adaptive capacity of the water sector

In line with AF outcomes 4 and the priorities of the government of Yemen (see part II.D), this component has the outcome of *Increase the adaptive capacity of the water sector through rehabilitation and protection of irrigation systems in the Tuban Delta*

To reach this outcome, there are four outputs focused on improving the irrigation canals and water intake systems in order to build the adaptive capacity of the water sector to reduced water supply and flooding.

2.1 Assessment and verification / technical specification and engineering studies, including surveys required, for improved irrigation canals and water intake system
2.2 Rehabilitated irrigation canals to improve water access for agricultural purposes in the Tuban Delta
2.3 Improved water intake structures to increase water supply in the irrigation canals
2.4 Stone-gabions constructed (where feasible with hybrid greening option) to reinforce canals and protect agriculture lands and Al-what city from flashing floods.

The canal system in the Tuban Delta is critical for providing water for irrigation as well as to prevent flooding. The Tuban Delta has an extensive canal system which services many agricultural areas however many of the canals require rehabilitation and strengthening and the water intake structures need to be improved in order to increase the water supply to the canals. This outcome is started with an output focused on the development of necessary assessments, including engineering studies to outline the technical specifications of the rehabilitations, improvements and strengthening which is necessary. The rehabilitation of the canals will cover 7 km of the over 61 km system and output 2.3 will improve the water intake systems. In addition, under output 2.4, 54km of the 61km canal system will be reinforced with stone-gabions (where feasible with hybrid greening option) to protect agricultural lands and Al-what city from flooding. The locations for all these works are identified in the map below.

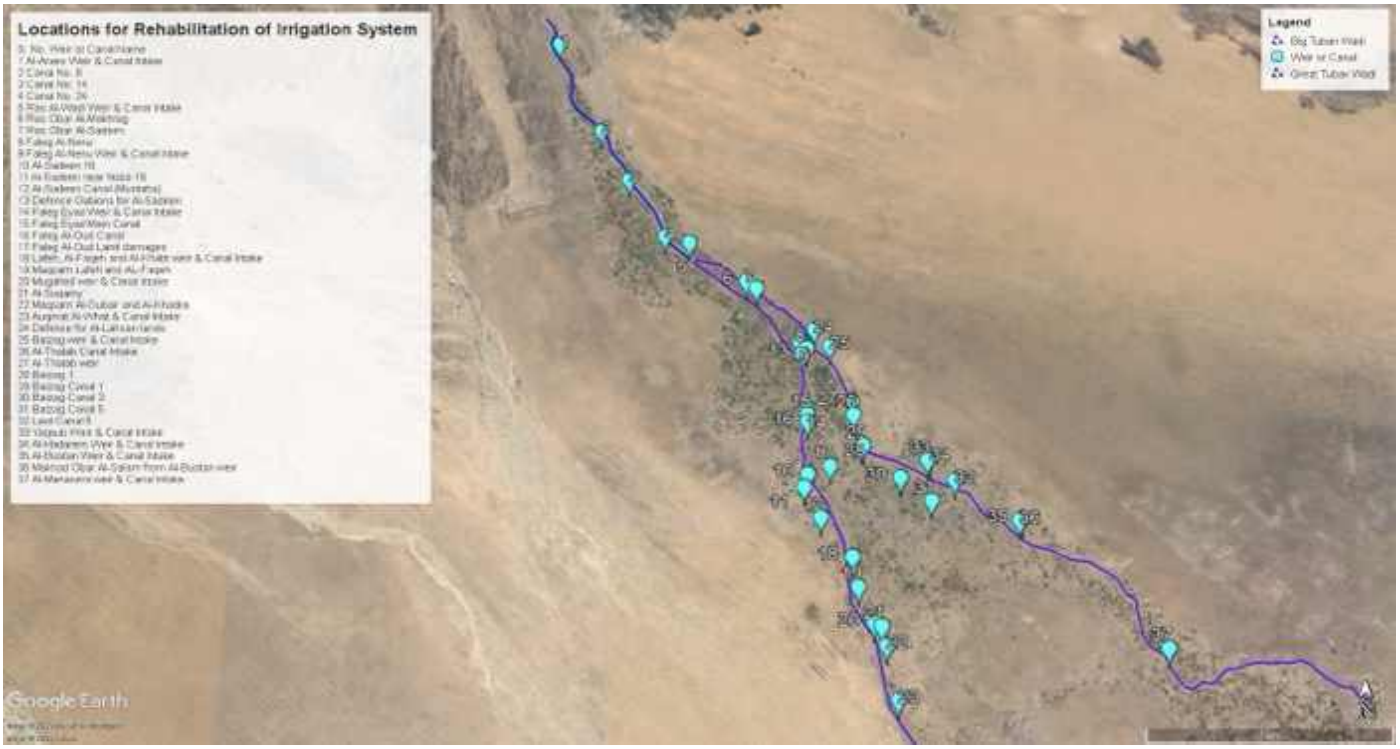


Figure 15. Locations for Rehabilitation of Irrigation System

Component 3: Innovative adaptation practices for water supply systems

In line with AF outcome 8 and the priorities of the government of Yemen (see part II.D), this component will focus on developing and scaling up innovative technologies for Yemen on treatment of wastewater to be used in irrigation and developing efficient urban water systems for Al-What city. The overall outcome of this component will be to *increase innovative, efficient, sustainable and climate change resilient practices to improve the water supply systems for urban and agriculture purposes.*

This will be accomplished through the following 5 outputs:

3.1 Assessment and verification / technical specification and engineering studies, including surveys required, for water supply alternatives options outlined below
3.2 Developing efficient and safe water supply alternatives for Al-What, Al-Hawtah, Saber cities and surrounding villages
3.3 Upgrade Tahror WWTP to treat wastewater for use in irrigation
3.4 Upgrade Saber WWTP to treat wastewater for use in irrigation

This component starts with the first output of providing detailed engineering studies for all four concrete interventions (one efficient urban water system, two upgraded wastewater treatment plants). The first concrete output is to develop efficient and safe water supply systems for Al-What, Al Hawtah and Saber cities. Currently residents in the cities rely on trucked water and illegal wells, both sources cannot guarantee safe water and are rife with exploitation in terms of expensive water tariffs and unregulated extraction of water. However, without safe and reliable alternatives, residents are forced to rely on these water sources. This intervention will therefore increase the provision of water from certified wells into safe water storage units which can then be distributed fairly and equitably to Al-What, Al Hawtah and Saber residents, ensuring fair tariffs and reducing overexploitation of groundwater resources. This will involve the installation of vertical pumping units in the sanctioned Magrs nagy wellfield. The current Al-What water supply station is shown in the map and images below. To ensure the water is of high quality, sediment units and filters will be utilized in the water collection and chlorination units before the distribution of water. The system will provide 330,000 m^3 of water per year for approximately 9,000 residents of Al-What

Figure 16. Maps of Al-What city and location of water supply pumping station

Figure 17. Map of Al-Hawtah city and location of water supply station

To improve the urban water systems for Al-Hawtah and Saber city, improved pumping units need to be installed in the Magrs Nagy wellfield which is connected to the Al-Hawtah water supply and also provides water to Saber city and surrounding villages. This system will also utilize solar energy for the pumping of water to increase reliability and reduce the carbon footprint of the system to zero. To ensure the water is of high quality, sediment units and filters will be utilized in the water collection and chlorination units before the distribution of water. The system will provide 2,200,000 m^3 of water per year for the 80,000 residents of Al-Hawtah and Saber cities. The current station is pictured in the figure below.

Figure 18 Tabor WWTP and agriculture land to serve

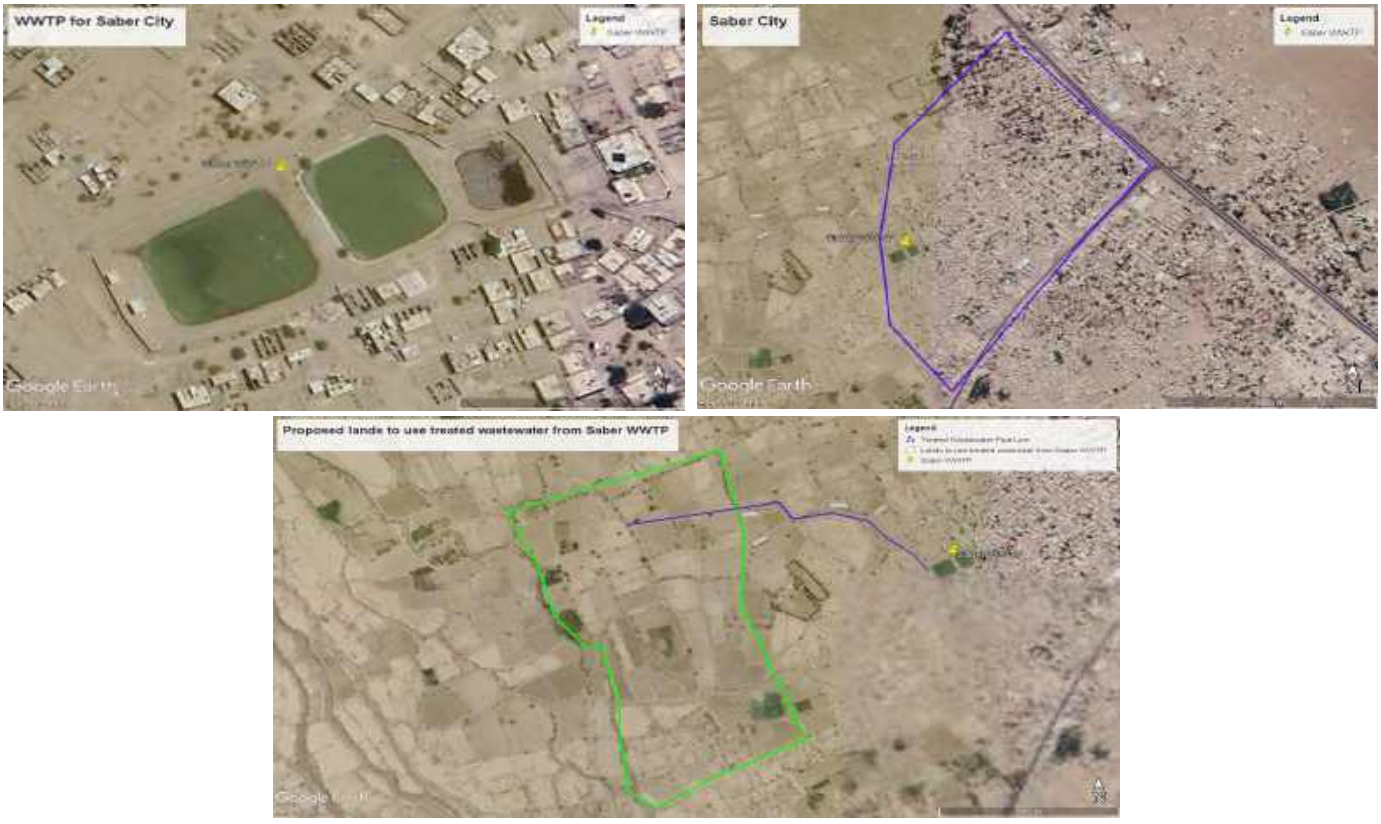


Figure 19. Saber WWTP, Saber city and agricultural land to be served

The second two concrete interventions are the upgrading of the wastewater treatment plants (WWTP) to treat the wastewater so that it can used for irrigation. There are two plants which have been identified, Tahror which is outside of Al-Hawtah city and Saber which is next to a small city of the same name. The Tahror WWTP is located in Al-Hawtah District – Lahj Governorate. The plant treats the wastewater of 26,830 people from Al-Hawtah City and Al-Duba village. With the upgraded design, the plant could convert 3,800 m^3 of water per day that can be utilized for agricultural uses. This will provide water for 75 hectares of agricultural land. The location of the WWTP and the agricultural lands which will benefit are in the figure below.

The Saber WWTP located in Lahj Governorate, treats the wastewater of Saber city and surrounding villages. With the upgraded design the plant could convert 900 m^3 of water per day that can be utilized for agricultural uses. This will provide water for 40 hectares of surrounding agricultural lands. The WWTP and the agricultural lands which will benefit are in the figure below.

Component 4: Improved ownership and capacities at local level to respond to climate change.

The final component is about ensuring that there are sufficient capacities and levels of ownership at the local level, especially with marginalized groups such as women and youth, for sustainable and long-lasting change. The outcome under component four is to *improve ownership and capacities at local level to respond to climate change, including to operate, maintain and replicate resilient water and irrigation systems.* This will be attained through six outputs:

4.1 Support farmers' with modern irrigation techniques and systems (Urban and Rural Areas)
4.2 Develop maintenance plans for measures
4.3 Strengthen water users associations for improved monitoring, maintenance and dissemination of information on irrigation techniques and skills development
4.4 Skills development with women and youth on water management and climate change adaptation
4.5 Capacity development for communities with a focus on women and youth civil society organizations on integrated and inclusive natural resource management plans
4.6 Awareness raising with local communities on water conservation and climate change in Aden and the Tuban Delta

The first output will ensure that farmers in the target areas receive training on modern irrigation techniques and the related equipment to implement. Three hundred fifty poor farmers will benefit directly from the modern irrigation training and equipment. This will ensure the efficient use of water provided in components 2 and 3 in agricultural systems to help reduce water demand and improve the resilience of the water sector. The second output is focused on developing the maintenance plans for the continued operation of the canals and irrigation system of component 2 with co-management between local government and the community to ensure joint ownership and the continued operation beyond the funding of the Adaptation Fund. In order to support this output and the rest, output 4.3 focuses on strengthening water users associations. In some cases, water user associations already exist but do not have sufficient skills or have become inactive. In other cases, the water user association needs to formed. In total, there will be 23 water user associations to cover the target areas and the aim is to have at least six of these headed by women.

The fourth output centres on skills development for women and youth on water management and climate change adaptation this can help women and youth to get jobs in the water sector or to improve water utilization in their current jobs and/or households. Building the capacity of water utility professional may be part of this output, depending on the need. The next output is on capacity development for communities on integrated water resource management plans so that they can participate in the inclusive process under Outcome 1 to develop plans for integrated and inclusive natural resource management and climate change. The final output is focused on awareness raising with local communities to ensure community-wide efforts on water conservation as well as to improve understanding of the impacts of climate change on water security in the Tuban Delta. This is also aimed at encouraging further community ownership over the interventions in the project and to encourage further uptake of the interventions as well as to generate ideas about future interventions. Age and disabilities will be considered for the targeted strategy of above outputs.

The Theory of Change diagram displayed below shows how the components work together to support each other as well as the barriers, risks and assumptions associated with the project. The overall project impact is to *reduce vulnerability and increase the adaptive capacity of people and water resource systems in the Tuban Delta to respond to the impacts of climate change at local and landscapes levels.* All four of the project components support this project goal by focusing on building the capacities and concrete interventions needed to reduce vulnerability in the water sector and increase the adaptive capacity of people, including the most vulnerable, and the government, at both national and sub-national level, to respond to climate change. Component 1 focuses on integrated and inclusive natural resource management for climate resilient systems. This component supports components 2 and 3 where improved irrigation and water systems will be implemented. Components 2 and 3 are also supported by the strengthening of Water Users Associations in Component 4. Component 2 specifically is supported by the support for modern irrigation techniques and the development of long-term maintenance and operation plans which will be developed in Component 4.

Components 1 and 4 have a strong relationship as the training of women, youth and Water Users Associations (under Component 4) will be integrated into the inclusive process for developing natural resource and climate change risk management being convened under Component 1.

The risks outlined were identified in the project development phase and these have been considered in the design of the interventions and the implementation arrangements.

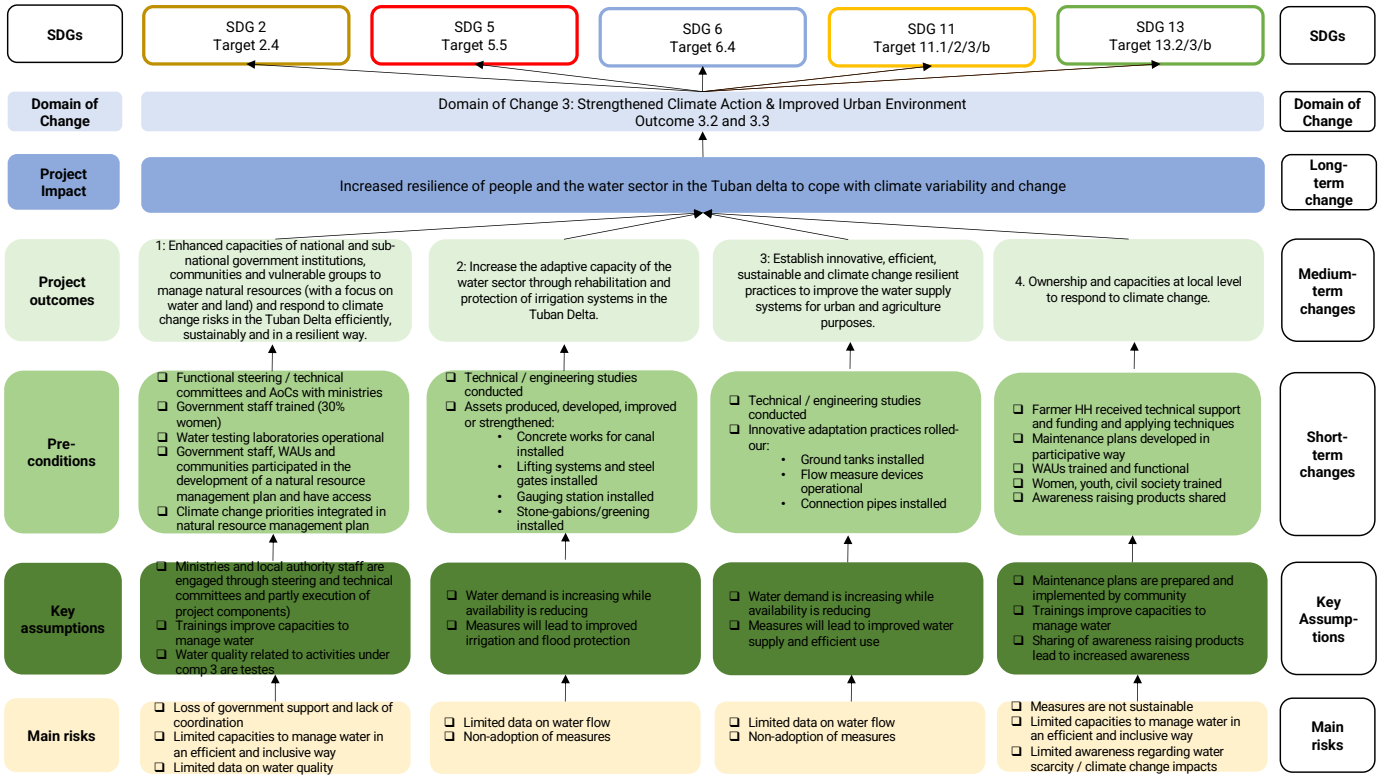


Figure 20. Theory of Change Diagram

B. PROJECT / PROGRAMME PROVIDES ECONOMIC, SOCIAL AND ENVIRONMENTAL BENEFITS

The proposed project aims to maximize benefits in the extremely vulnerable context of Yemen with an aim to maximize benefits for the most vulnerable groups, including women and youth. The number of direct beneficiaries for Component 2 are 73,317 people, of which 72,000 people will benefit from the irrigation systems and 1,245 people will be protected from floods. Under Component 3, Output 3.2 for the safe and efficient water supply will have 85,000 beneficiaries in Al-What, Al-Hawtah and Saber cities and surrounding villages. Outputs 3.3 and 3.4, treating wastewater for use in irrigation will benefit 33,730 people. Component 4 will support 78 poor small-holder farmer households with drip irrigation systems, of which 30% will be women. It will also provide skills development for 100 women and youth on water management and climate change adaptation. Component 1 will benefit all 1,255,888 of the population of the Tuban Delta through improved planning for the resilience of natural resources management.

Table 18 Economic, Social and Environmental benefits

Type of benefit	Baseline	With/after project
Economic	Climate change is already leading to economic and livelihood losses, especially caused by less rain, droughts and water evaporation, leading to water scarcity issues. Water dependent livelihoods, especially in the agriculture sector, are especially threatened.	- The agriculture sector in target areas will be more climate change / drought resilient, leading to improved livelihood security, benefitting especially farmers and communities depending on it for food security with more secure / higher income. Reduced costs for irrigation and water supply will also result in better financial outcomes for farmers. - The reinforcement of the canals will reduce the economic loss of farmlands and the cost of rebuilding in the case of extreme precipitation events. These avoided losses have a significant economic benefit for communities struggle to rebuild in the face of conflict in the region.

		- The more efficient water systems will reduce water costs for residents in Al-What and Al-Hawtah helping to reduce the amount of household budget needed to purchase water. - Skills development for women and youth will also support these populations to obtain income-generating activities that can help to supplement household incomes. - Rehabilitation of canals can also increase land values, by an estimated 20-30%. - Iimproving the irrigation systems can help reduce the reliance on rain-fed agriculture, making farming more predictable and stable and encouraging farmers to keep their farms. - The project will increase employment opportunities in the construction and maintenance phases, in addition to the farming opportunities.
Social	Climate change is already leading to social issues, especially caused by tensions from scarce water resources. There are also negative health implications from the lack of safe and treated water and risks to food and water security. Finally, women and youth have been marginalized in processes for integrated and inclusive natural resource management	- Participative assessment, planning and decision-making processes over scarce water resources, involving women and youth, will enhance social cohesion and build community ownership of natural resource management and equitable access to resources. - Climate change resilient livelihood skills building activities, including operating and sustaining these + resilient water supply systems, will benefit the most vulnerable and women and youth. - Improved or new climate resilient and sustainable water systems will contribute to social well-being and health outcomes, especially for children. - Improving water supply and distribution will lead to (20-30%) increase in food production, which can contribute to food security by increasing the availability of food crops and reducing the need for food imports, potentially lowering food prices.
Environmental	In addition to overexploitation of natural resources / water, climate change is already leading to negative environmental impacts, especially land / soil degradation, desertification, saltwater intrusion and lack of a natural water cycle.	- The government, at different levels, will be able to better assess, plan and manage natural resources / water, also considering environmental sustainability and climate change risks. - Water resources such as wells, and water dependent livelihoods (i.e. agriculture) may be protected from overuse / droughts through above. - This will mostly benefit the most vulnerable/poor groups dependent on these resources and women and youth. - Currently due to the overexploitation of water, there is insufficient water balance for there to be water returning to the natural environment. Through increased water efficiency, it is hoped that the negative water balance will be reduced and there will be water returning to wetlands, improving their ecosystem functioning.

C. COST-EFFECTIVENESS OF THE PROPOSED PROJECT / PROGRAMME

Through the proposal development phase, several options for building resilience of the water sector were discussed by the project team, government and stakeholders. To support the prioritization and selection of adaptation options, a cost-effectiveness analysis of the concrete interventions was included in the pre-feasibility study (see annex 3 on page 107) which covers Components 2 and 3 and Output 4.1 with details in the table below.

In addition, the broad rationale for the cost-effectiveness of Components 1 and 4 is outlined here. Over 1 million people live in the Tuban Delta and with the urbanization rates of Aden, this can be expected to grow. Developing capacities and supporting an inclusive approach to natural resource management will ensure a more climate resilient and sustainable future for the region. It will help to build adaptive capacity and identify future vulnerability and manage natural resources accordingly.

Alternatively in a scenario in which this capacity is not built and natural resource management is not supported to mainstream climate change, interventions will continue to be ad hoc and may not result in the best or most holistic approaches to natural resource management. They may also fail to properly account for climate change, the water balance and vulnerable communities and assets.

In addition, if the process is not inclusive and informed by data from the laboratory, there is a risk that the effectiveness of natural resource management planning is decreased because it does not consider the inputs of marginalized stakeholders such as women and youth and would fail to capture the latest information on water quality and water levels.

Table 19 Proposed adaptation actions' cost-effectiveness rationale

		Beneficiaries	**Cost-effectiveness (Total**		**Justification**

Adaptation Measure	Total intervention cost (USD)			Cost/Beneficiaries in USD)		Alternative Solutions	
		Direct	Indirect	Direct	Indirect		
2.2 Rehabilitated irrigation canals to improve water access for agricultural purposes in the Tuban Delta 2.3 Improved water intake structures to increase water supply in the irrigation canals	1,665.216	72,000	1.183.888	23	1	Alternative 1: Digging additional wells	1. There is already a proliferation of unauthorized wells in the Tuban Delta area which has resulted in overextraction of groundwater. In many places, it is now necessary to dig the wells deeper in order to access water and there are problems of desalination of the wells. 2. The irrigation canals are existing structures which have been utilized for a long time, their efficiency has decreased due to degradation and the decrease of the capacity of the water intake structures. Utilizing the existing structures is cost-effective and reduces the environmental impacts of creating new structures.
2.4 Stone-gabions constructed to reinforce canals and protect agriculture lands and Al-what city from flashing floods	1,572.350	50,140		31		(1) Reinforce housing and infrastructure to protect against flooding (2) Early Warning System	1. This solution takes advantage of the existing canals instead of creating new structures and causing disruptions within urban areas and it provides widescale to urban areas and agricultural lands instead of just reinforcing individual property and infrastructures. 2. An Early Warning System would be an important complimentary solution however while it could help reduce the loss of life, it would not necessarily help to protect against the loss of property and the disruption to the agricultural livelihoods and food security in the region.
3.2 Developing efficient and safe water supply alternatives for Al-What, Al-Hawtah, Saber cities and surrounding villages	1.569.400	89.000[62]		17		(1) Desalination plant (2) Rainwater harvesting	1. The cost of a new desalination plant for these medium-sized cities in Lahj is prohibitively expensive and there are high environmental risks to starting the system from scratch. 2. Unfortunately rainwater harvesting is not particularly feasible given the low levels of rainfall in the area.
3.3 Upgrade Tahror WWTP to treat wastewater for use in irrigation	400.020	525	26.830[63]	761	14	Digging additional wells	1. There is already a proliferation of unauthorized wells in the Tuban Delta area which has resulted in overextraction of groundwater. In many places, it is now necessary to dig the wells deeper in order to access water and there are problems of desalination of the wells. 2. The WWTP are existing structures and supplement water supply without having to utilize more groundwater. Utilizing the existing structures is cost-effective and reduces the environmental impacts of creating new structures.
3.4 Upgrade Saber WWTP to treat wastewater for use in irrigation	360.490	280	6.900[64]	1287	52	Digging additional wells	

[62] Inhabitants of Al What and Al-Hawtah and Saber cities
[63] Inhabitants of Al-Hwtah City and Al-Duba village
[64] Inhabitants of western part of Saber City

4.1. Support farmers' with modern irrigation techniques and system	854.721	514[65]	26.830[66]	1662	29	Using more water by surface irrigation	1. There is already a proliferation of unauthorized wells in the Tuban Delta area which has resulted in overextraction of groundwater. In many places, it is now necessary to dig the wells deeper in order to access water and there are problems of desalination of the wells. (2) Farmers are eager and interested to use modern irrigation techniques

A note of explanation for how the direct and indirect beneficiaries were calculated. For the outputs on water use for irrigation, this is based on one farmer/per hectare with an average family size of six as the direct beneficiaries. The indirect beneficiaries for irrigation are those benefitting from increased food security as a result of the reliable yields. This is estimated as 10 people per hectare.

For the more efficient urban water systems (output 2.2), the total population of the three cities are the direct beneficiaries. The indirect beneficiaries are the rest of the people connected to the water network in Aden.

Altogether, the project will be cost-effective by:

- Avoiding future costs associated with damage and loss due to climate change impacts (especially droughts) and to ensure the interventions are sustainable;
- Efficient project operations because of 'in-house' technical support options and capacity building expertise and because of direct partnering with communities (thereby building their capacity as well as reducing costs);
- Community involvement with development/construction of concrete interventions and because of community capacity building
- Selected technical options based on cost-feasibility and resilience/sustainability criteria (assessment to be done during full proposal)

D. CONSISTENCY WITH NATIONAL OR SUB-NATIONAL STRATEGIES

The proposed project is designed to be consistent with international, national and sub-national development strategies, plans and goals. From an international perspective, the project will directly support targets under SDG 2 (2.4), SDG 5 (5.5), SDG 6 (6.4), SDG 11 (11.1/2/3/b), SDG 13 (13.2/3/b). Besides climate change-, urban-, water-, hunger- and gender-related goals, the project will also support targets indirectly under: SDG 1, 3, 9, 10, 15 and 16. The project also seeks to be aligned with the United Nations Disabilities Inclusion Strategy and the Convention on the Rights of Persons with Disabilities.

As per below, the project directly supports UN-Habitat's Global priority / Domain of Change (DoC) number 3: Strengthened Climate Action and Improved Urban Environment (especially outcome 3.2 and 3.3, and there are synergies with DoC1: Reduced Spatial Inequality and Poverty in Communities Across the Urban-Rural Continuum and DoC4: Effective Urban Crisis Prevention and Response. The proposal is also aligned with the New Urban Agenda (with contributions to the following paragraphs of the New Urban Agenda: 79, 80, 143, 147, 165).

DoC1: Reduced spatial inequality and poverty in communities across the urban – rural continuum

DoC2: Enhanced shared prosperity of cities and regions

DoC3: Strengthened climate action and improved urban environment

DoC4: Effective urban crisis prevention and response

Yemen has been party to the UN Framework Convention on Climate Change (UNFCCC) since 1996, and to the Kyoto Protocol since 2008 as non–Annex I Party. The Environmental Protection Authority is the national focal point for the implementation of the UNFCCC Convention and Kyoto protocol. To meet its commitments under the Convention, Yemen has initiated a process to establishing legislation, institutional and policy frameworks to fulfil the requirements of the Convention and the Protocol with support from international development partners including UNDP, GEF, World Bank, and Netherland.

[65] 78 farmers with an average Household size of 6.6. Asuming average plot size small-holder farmers of 1.5 ha.
[66] Inhabitants of Al What and Al-Hawtah and Saber cities

Yemen has established the Inter-Ministerial Committee for Synthesis Paper 5 Governance of Climate Change in Yemen Climate Change (IMCCC) in 2009 to strengthen institutional coordination capacity and enhance climate change political leadership in the country.

The currently most relevant Climate change strategies are the INDC (2015), TNC (2018) and TNA (2023). These publications found that agriculture, water and coast areas are among the top vulnerable sectors.

Table 20 project alignment with National and sub-national priorities

Policy / Document	Year submitted / ratified	Mapped relevant priorities
Climate Change strategies / plans		
National Adaptation Programme of Action (NAPA)	2008	- Focus sectors: water, agriculture and coastal vulnerability to sea-level-rise - Priority projects: **Project # 1:** Develop and Implement Integrated Coastal Zone Management (ICZM). **Project # 2**: Water conservation through reuse of treated waste water and grey **Project #5:** Planting and re-planting of mangroves and palms for adaptation to sea level rise. **Project # 7:** Rainwater harvesting through various techniques including traditional methods**.** **Project # 9:** Promotion of research on drought, heat and salinity tolerant varieties
Initial National Communication INC)	2001	- Adaptation measures include; water (national water strategy, priority adaptive measures for Abyan delta), Agriculture (policy options for adaptations in agriculture, additional adjustments for crops studies), coastal zone (policy adaptations options, adaptation measures for city areas) - Vulnerability and adaptation assessments conducted for water (Wadi Surdud), coastal zone (Aden Governorate), Agriculture (Sorghum and Wheat)
Second National Communication (SNC)	2013	
Intended National Designated Contribution (INDC)	2015	- Focus sectors: water, agriculture and coastal vulnerability to sea-level-rise - Adaptation Priorities: o Promotion and scale-up of rainwater harvesting to reduce climate induced water shortage; o Promoting agriculture drought management as well as sustainable crop and livestock management; o Plan and implement proper land resources management programs. o Livelihood approaches for integrating natural resources management and preservation of sensitive ecosystems; o Disaster risk management including flood and drought management. o Capacity Building for integrated coastal zones and marine resources management. o Capacity building and awareness raising; and o Institutional capacity for building resilience climate change including planning, programming, monitoring and resources mobilization.
Third National Communication (TNC)	2018	- Focus sectors: water, agriculture and coastal vulnerability to sea-level-rise - Adaptation Priorities o Improved water irrigation efficiency: This involved the transition to the use of high- efficiency drip irrigation; o Reduced evapotranspiration: This involved the installation of enclosed conduits in place of open channels; o Reduced water losses: This involved the rehabilitation of traditional irrigation channels to reduce water infiltration to the underlying soil; and o Alternative cropping schemes: This involved changes to the type of crop cultivated through upstream and downstream areas.
Technology Needs Assessment (TNA)	2023	Water Sector Adaptation Technology Priorities identified by stakeholders; - Monitoring the Quality of Drinking Water, including fixed and mobile laboratories - Wastewater Recycling and Reuse - Desalination of Saline Water
National Adaptation Plan (NAP)	Forthcoming	Coordinate with UNDP
Fourth National Communication	Forthcoming	Coordinate with UNDP
Nationally Determined Contributions	Forthcoming	By UN-Habitat (GCF readiness project)
National Development strategies / plans		
The 4th Socio-Economic	2002	- Create income-generating opportunities and expand economic opportunities for the poor.

Development Plan for Poverty Reduction		- Enhance the capabilities of the poor and increase the return on their assets. - Reduce the suffering and vulnerability of the poor. - Develop potential economic sectors - Enhance human and capital assets of the poor. - Expand economic opportunities for the poor in the agriculture sector and in rural areas. - Improve and upgrade infrastructure - Rationalize water use - Combat desertification and environment degradation - Support measures that address issues limiting women's access to economic opportunities - Review and amend legislation to ensure consistency with the poverty reduction strategy and policies, with special emphasis that legislation can and will be implemented - Citizens participation and involvement of civil society institutions.
Environmental strategies / plans		
National Environmental Action Plan (NEAP)	2005	- Development and Implementation of an Integrated Coastal Zone Management - Essential Measures for the Conservation of Agro biodiversity in Yemen - Reviving Traditional and Indigenous Knowledge in Natural Resource
National Strategy for Environmental Sustainability (NSES)	2005	Focus sectors: a) water, b) land resources, c) biological diversity and coastal and marine environment, d) waste management. NSES aims to link the effect of environmental degradation with poverty
Sectoral strategies / plans, especially related to water		
National water sector Strategy and investment programme	2004	Proposes a set of institutional, financial and other measures, which are aimed at addressing discrepancies in five identified sub-sectors (water resources, urban water supply and sanitation, rural water supply and sanitation, irrigation and watershed management and environmental aspects of water) in order to protect the interests of all stakeholders in the resources
National Food Security Strategy	2010	Includes recommendation for investment in expanding the drinking water supply and water sector reform
National Agriculture Sector Strategy (NASS) 2012-2016	2012	Seeks to provide a comprehensive guide to the development of the agriculture sector, including to address food security issues, climate change, water resources challenges, and the role of government in developing the agriculture sector.
National Action Plan to Combat Desertification	2000	Includes options for water management and coastal zone management
National Biodiversity Strategy and Action Plan (NBSAP)	2017	- Biodiversity and ecosystem conservation - Conservation of natural resources - Sustainable use of natural resources - Integrating biodiversity and poverty into sectoral development plans - Focus on water management, including wastewater treatment and desalination
Yemen's Sixth National Report To Convention On Biological Diversity (CBD)	2019	- Aim to integrate / mainstream biodiversity values into national and local development and poverty reduction strategies and planning processes.
Sub-national / target area plans		
Yemen Aden Master Plan	2005-2025	- At present some 54,550 m3/day is available for consumers, which is insufficient to meet the current water demands. The need to identify additional resources as well as reduce unaccounted for water loss, which is very high, is therefore an imperative. - More effective use of the treated sewage effluent will be a priority in the future in order to maximize the utilisation of scarce water resources. - Low levels of rainfall mean that there is no specific provision for dealing with storm water run-off except in a limited number of locations, notably in Crater and at Wadi Kabir and Wadi Saghir.

E. Project / programme compliance with relevant national technical standards

Table 21 project compliance with relevant technical standards

Expected concrete output / intervention	Relevant rules, regulations, standards and procedures (to comply to AF principle 1)	Process / steps to comply	Authorizing offices
- Reuse of treated waste water	- Environment protection law no. (26) of 1995 - Law No. 33 of 2002 regarding water - Law No. (41) of 2006 AD - Amending some materials - Law No. 33 of 2002 regarding water - Yemen standards for water, water used for irrigation 1999	Coordinate with related Authorizing Offices	- Environmental Protection Authority - Local Corporation Water and Sanitation - National Water & Resources Authority – NWRA - Al- Aukaf - to have their permission for mosques
- Water efficient irrigation (e.g. drip) and closed conduits	- Law No. 33 of 2002 regarding water - Law No. (41) of 2006 AD - Amending some materials - Law No. 33 of 2002 regarding water - Law No. (26) of 1995 on the protection of the environment - Yemen standards for water, water used for irrigation 1999	Coordinate with related Authorizing Offices	- Environmental Protection Authority - Ministry of Agriculture & Irrigation - General Administration of Irrigation - General Authority for Agricultural Research and Extension - Agricultural Research Centre - AlKood – Abyan - General Ruler water Authority
- Develop and implement integrated and inclusive natural resource management plans	- Environment protection law no. (26) of 1995 - Law No. (26) of 1995 - On the protection of the environment	Coordinate with related Authorizing Offices	- Environmental Protection Authority - National Water & Resources Authority – NWRA - Agricultural Research Centre - AlKood - Abyan - Abyan Governorate - Aden Governorate - Lahj Governorate

Safeguarding / Environmental Impact Assessment requirements.

In Yemen, the following mechanism is in place to obtain environmental approval for projects:

1. Screening (list all positive and negative impacts); If the negative impacts are not serious, no need to continue.
2. Scoping (optional): This step should be based on consultations with the local people and national experts after listing the impacts.
3. Impact assessment
4. Develop possible mitigation measures (for the negative impacts)
5. Writing all in an Environmental Impact Assessment (EIA) report
6. **Send the EIA report to EPA to be approved.**

For the proposed interventions under this project, the process is at the last step (6) in bold above, awaiting approval from EPA. The ESIA-ESMP should be approved by EPA before resubmitting the proposal to the AF.

F. DUPLICATION WITH OTHER FUNDING SOURCES

Table 22 Duplication with other funding sources

Relevant projects and focus	Relevant focus and interventions / activities	Lessons learned	Complimentary potential and non-duplication (see also consultation section)
MENA region			
UN-Habitat – with AF funding – Increasing the climate change resilience of communities in Eastern Ghouta in Rural Damascus to water scarcity challenges through integrated natural resource management and immediate adaptation interventions – USD 10 million	- Integrated water and land resource management - The protection of water resources (and prevent contamination of surface and groundwater resources / wells) - The reduction of water losses; - The increase of water use efficiency, supporting water harvesting projects and using high efficiency irrigation methods; - The promotion of use of non-conventional water resources (e.g. treated wastewater) and: - Improved agricultural production practices (e.g. drought tolerant crops).	- Use lessons from wastewater treatment and reuse by coordinating with Syria office	Complementary - Align approach and lessons learned throughout project preparation and implementation (by ROAS) Non-Duplication - In Syria
Jordan government - with AF funding - Increasing the resilience of poor and vulnerable communities to climate change impacts in Jordan through Implementing Innovative projects in water and agriculture in support of adaptation to climate change (2015-2018) – USD 9,2 million	- Wastewater treatment plant + monitoring quality - Irrigation study - Rain/flood water harvesting dam / basin (400.000 m3) with solar panels to reduce evaporation - Permaculture – adaptation + ecosystem management in demonstration sites -	- According to manager Permaculture has promising results for adaptation, reducing pollution and protecting ecosystem - Water user associations / cooperation can be used to reach farmers and administer water	Complementary - Use permaculture concept in real farms and in urban context - Use similar approach for water harvesting basins at farms and in urban areas - Water user associations / cooperation can be used UN-Habitat is already in touch with manager and specialists (see also II.I) Non-Duplication - In Jordan Valley
Yemen			
Integrated Water Harvesting Technologies to Adapt to Climate Change Induced Water Shortage LDCF (USD 5 million); 2013	- Introduction and rehabilitate traditional water harvesting methods; - Introduction innovative water harvesting methods - Train local communities in maintenance and construction of these techniques - Promote awareness of the socioeconomic benefits of water harvesting. - Strengthen WUAs, increase the capacity of the SFD Engineering Unit and promote financial incentives to local communities for water harvesting	- Lessons related to strengthening WUAs and how to promote ownership of project activities by local community	Complementary - Rain harvesting Non-Duplication - Not in target area
Rural Adaptation in Yemen LDCF (USD 5 million); 2013	- Capacity strengthening of community associations on land planning and sustainable adaptive management of natural resources with a focus on climate-smart water and soil conservation. - Awareness programme on mainstreaming climate adaptation knowledge in decision making and planning processes - Programme on climate change adaptation and risk management in farming practices developed and implemented, targeting rural households in all target watersheds. - Education programme on climate change adaptation and the sustainable use of natural resources developed and implemented, targeting students and youth in all target watersheds	- Lessons related to how to run a successful awareness raising programme and the focus of capacity strengthening on community associations and natural resource management	Complementary - Complement approach in the Tuban Delta Non-Duplication - One of the watersheds involves the Turban delta. Overlap will be avoided through coordination

	- Four Community Action Plans (CAP) at the watershed level produced that are gender balanced and climate change smart, with focus on innovative and sustainable land and water management measures. - Water harvesting and storage improved through the implementation of a mix of measures combining innovative technology and traditional knowledge - Water efficiency in agriculture irrigation and domestic use improved - Action plans developed and implemented to restore and upgrade traditional terrace systems - Pilot actions implemented to stop/reverse soil erosion and loss of fertility, integrating agriculture, rangeland, and forest restoration		
Pilot Programme for Climate and Resilience (PPCR): CIF/PPCR For 3 focal areas) 2013	- Climate Information System and Pilot Program for Climate Resilience (CISPPCR) - Climate Services - (budget:US$19 Million); - Integrated Coastal Zone Management (budget: US$ 20 Million)	- Information utilized to better understand climate context in the country	Complementary - Use data produced Non-Duplication - Not in target area
Promote and build climate resilience to reduce vulnerability in Wadis and coastal areas; UNDP / GEF	- The aim is to explore the relevance of NWSSIP II under changing climate. In addition, this note is also grounded on a deliberate review of relevant climate change policy and thematic studies particularly on the water sector in Yemen	- Information utilized to better understand climate context in the country	Complementary - Use data produced Non-Duplication - Not in target area
The Enhancing Rural Resilience in Yemen Joint Programme (ERRY JP) funded by the EU (USD 40 million) UNDP, FAO, ILO and WFP in collaboration with a range of Implementing Partners	- Enhance the resilience and self-reliance of crisis affected rural communities through support to rehabilitation of community infrastructure, livelihoods stabilization and recovery, social cohesion and local governance and improved access to sustainable energy	- Lessons related to issues of social cohesion and local governance	Complementary - Use lessons and complement the approach is possible Non-Duplication - Not in target area
Sanaa Basin Project in Yemen FAO Dutch-funded (2014-2017) Water sustainability for farmers while empowering women	- Construction of wells through a cash-for-work formula for farmers to use for agricultural production. All Water User Associations choose their board members through elections and 30 percent of the seats are designated for women.	- Water association and women only access to water can be used as a water management system to reduce conflict between tribes	Complementary - Consider building upon lessons from Water association and women only access to water approach and cash-for-work formula for farmers to use for agricultural production. ROAS to contact FAO Non-Duplication - Not in target area
World Bank Climate information system and pilot program for climate resilience – USD 19 million	- The SPCR focuses on longer-term interventions aimed at enhancing climate resilience in Yemen. The SPCR cannot address all of the key risks that have been identified but aims to address the highest priority risks identified during the preparation process and through consultation with vulnerable communities. Four interrelated SPCR investments are proposed, each addressing a key risk related to climate change: - Climate Information System and PPCR Program Coordination - Improving the Climate Resilience of the Water Sector - Improving Rural Livelihood through Adaptation in Rain-fed Agriculture Project	- Lessons learned on long-term interventions and prioritizing interventions to address highest risk	Complementary - Use lessons and complement the approach is possible Non-Duplication - Not in target area

	- Climate-Resilient Integrated Coastal Zone Management"		
Resilience Programme in the Irrigation and Agricultural Sector project Funded by the German Federal Ministry for Economic Cooperation and Development (BMZ) through German Development Bank (KfW) Implemented by FAO and UNDP	- The overall objective of the project is to enhance livelihood resilience and sustainable peace in Yemen through sustainable water management. Specifically, the project aims to i) improve agricultural production and resilience to water scarcity, ii) enhance livelihood opportunities, iii) reduce water-related conflict and improve water management through awareness-raising and disaster preparedness at the local level. - Implemented in Abyan, Hadhramout and Dhamar governorates	- Lessons learned on engaging with WUAs and the importance of improving irrigation efficiency	Complementary - Use lessons and complement the approach is possible Non-Duplication Not in target area
In target area			
Netherlands Yemen NCAP Project	- Using an MCA analysis among local stakeholders, the highest priority initiative was identified in each area (Sanaa basin, Saada Basin, Aden), as an input to future planning efforts. The scoping effort included a sequenced plan for implementation and monitoring of the initiative as well as a cost estimate for required materials and labour	- Aden City: The implementation of drip irrigation was identified as the best strategy in terms of water savings both in terms of distribution and application of water on farmlands. This strategy was preferred by stakeholders over others, but is more expensive. As the majority of farmers are poor and barely coping with existing living costs, subsidization or donor support would be needed for implementation	Complementary - Recommendations to be adopted Non-Duplication - None
Aden water and sanitation project	- Prevention of Water Borne Disease Outbreak through Emergency Repair and Upgrade of Damaged Water and Waste Water Facilities in Aden City- Yemen aims at reducing the Cholera outbreaks and other water-borne diseases to mitigate the current situation in the higher risk plagued areas through infrastructures (water, sanitation, drainage), and public health awareness	- Incorporated data and findings from the project into community profile for the area - Continuing to check with lessons learned related to activities	Complementary - Provides UN-Habitat access and knowledge, plus valuable government and stakeholder access Non-Duplication - It aims to urban public health through infrastructure improvement and public awareness, not CC related
Yemen Integrated Urban Services Emergency Project World Bank and United Nations Office for Project Services	- Improving and repairing urban infrastructure including water and sanitation infrastructure, rainwater drainage, and rehabilitation of public parks in Aden (as well as other cities) - Improve Yemen's response capacity in the event of an emergency	- Improved understanding of effective upgrades to urban infrastructure and potential challenges, including timing of implementation	Complementary - Knowledge and information on current status of critical infrastructure in Aden and helps to provide accurate cost estimates Non-Duplication - Focused on existing urban infrastructure but limited to Aden so does not include the medium-sized cities in the rest of the Tuban Delta where this project primarily focuses
UNICEF supporting solar water pumps in Tuban Delta	- UNICEF is supporting solar water pumping systems for 6 wells that are under the control of LAWSC Lahj, as of 2023, they were at the stage of	- Discussion with team about need for coordination and water	Complementary - Interest in coordinating approaches

	evaluating bids	testing capacities in the region	Non-Duplication -The solar pumping systems for wells is part of the diversified approach for increased water security and does not conflict with or duplicate this project's efforts
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' Implemented by UN-Habitat	- Undertook a CCVA and hydrology study which were utilized to develop this proposal - Undertook consultations at sub-national and national level which were utilised to determine the adaptation priorities developed in this proposal	- Adaptation priorities in the area	Complementary - The AF proposal builds on the outcomes (field assessment, planning process and consultations) from the GCF readiness project Non-Duplication -Project closed
Integrated Water Resource Management to Enhance Resilience of Agriculture (ERA) and Food Security Implemented by UNDP	- Undertook inception workshops at Tuban district in Lahj to gather information about the potential interventions including rehabilitation of water diversion infrastructure, irrigation canals, sub-surface dams, soil erosion and flood protection works. - Will develop a hydrological study with a focus on hydrological process and flow patterns in the whole catchment area.	- UNDP will provide equipment for water infrastructure maintenance, which can also be used for this project	Complementary - Coordination underway to compliment interventions and avoid overlap Non-Duplication -In upper Tuban delta, avoiding geographical overlap

G. LEARNING AND KNOWLEDGE MANAGEMENT COMPONENT TO CAPTURE AND DISSEMINATE LESSONS LEARNED

Taken the alarming water scarcity and coastal management challenges in Yemen, approach, methods and techniques to manage natural resources / water and efficiently, sustainably and in a climate change resilient way benefitting the most vulnerable groups need to be urgently showcased for replication throughout the country. Capacities of government institutions and officials will be strengthened to replicate these approaches and techniques. The Ministry of Water & Environment or Environment Protection Authority will capture lessons and share these among ministries, sub-national government bodies and the wider public. Knowledge sharing tools used will include social media streams (twitter, Facebook, etc.) plans and guidelines.

Lessons will be relevant beyond the Yemen context. Therefore, the project team will also share lessons through international events, with relevant climate change bodies such as the UNFCCC and with UN agency offices, especially in the MENA region. UN-Habitat Yemen will coordinate with the UN-Habitat Regional Office for the Arab State (ROAS) to share knowledge, lessons learned and success stories with ESCWA and ENEP Regional Office, through the different regional forums, including the Regional Coordination on the Issue-Based Coalition Theme on Climate Change, and Theme on Urbanization lead by UN-Habitat, under the leadership of ESCWA. The Focal Point of Knowledge Management and Communications at ROAS will support the learning and knowledge management initiative of the project, through regular coordination with UN-Habitat HQ Knowledge and Innovation Section, to ensure two ways knowledge sharing from different global Climate Change Forums, to benefit the project and disseminate knowledge on Yemen project successful results, lessons learned and success stories that worthwhile sharing for future similar Climate Change Adaptation related initiatives.

Table 23 Learning and knowledge management

Expected Concrete Outputs	Learning objectives (lo) & indicators (i)	Knowledge product
1.1. Government capacity strengthened at national and sub-national level on increasing climate change resilience and effective water management 1.2. Establishment of laboratory for wastewater quality testing and water supply quality testing. 1.3. Integrated and inclusive natural resource (focused on water and land) and climate change risk management process and plan	(lo): To strengthen capacities of national sub-national government institutions, communities and vulnerable groups to manage natural resources / water in an efficient, coordinated, sustainable and climate resilient way, and to replicate the approach in other areas, to capture and share lessons and to mainstream these in strategies and regulations (i): capacity development program on climate change resilience with a focus on natural resource management and the development of integrated management plans	• Training package • Guidelines and methodologies for the establishment and running of the laboratory for water quality testing • Studies and assessments developed related to natural resource management planning • Lessons learned and guidance for conducting an inclusive process, bringing in women, youth and water users associations into the development of plans to mainstream climate change adaptation and manage natural resources
2.1. Assessment and verification / technical specification and engineering studies, including surveys required, for improved irrigation canals and water intake systems 2.2. Rehabilitated irrigation canals to improve water access for agricultural purposes in the Tuban Delta 2.3. Improved water intake structures to increase water supply in the irrigation canals 2.4. Stone-gabions constructed to reinforce canals and protect agriculture lands and Al-what city from flashing floods.	(lo): collect and share information on effective rehabilitation of irrigation canals and reinforcement of canals to reduce flood risk (i): Number of techniques showcased and identification of lessons and recommendations in knowledge products in the column on the right	• Showcased models of successfully completed works • Guidelines for replication
3.1. Assessment and verification / technical specification and engineering studies, including surveys required, for water supply alternatives options outlined below 3.2. Developing efficient and safe water supply alternatives for Al-What, Al-Hawtah, Saber cities and surrounding villages	(lo) collect and share information on best practice low-cost and replicable innovative techniques on efficient urban water supply systems, the utilization of wastewater for irrigation (i): Number of techniques showcased and identification of lessons and recommendations in knowledge	• Showcased models of the urban water systems, utilization of wastewater for irrigation • Guidelines for replication

3.3. Upgrade Tahror WWTP to treat wastewater for use in irrigation 3.4. Upgrade Saber WWTP to treat wastewater for use in irrigation	products in the column on the right	
4.1 Support farmers' with modern irrigation techniques and systems (Urban and Rural Areas) 4.2 Develop maintenance plans for canals, irrigation system 4.3 Strengthen water users associations for improved monitoring, maintenance and dissemination of information on irrigation techniques and skills development 4.4 Skills development with women and youth on water management and climate change adaptation 4.5 Capacity development for communities with a focus on women and youth civil society organizations on integrated and inclusive natural resource management plans 4.6 Awareness raising with local communities on water conservation and climate change in Aden and the Tuban Delta	(lo) To build capacities of farmers, water users associations, women, and youth on water management and climate change. (lo) To raise awareness on water conservation and climate change in the Tuban Delta (i) Number of farmers, water users associations, women and youth trained on water management and climate change (i) Number of communications products developed to share information on water management and climate change with local communities in the Tuban Delta	• Training programs for farmers, water users associations, women and youth • Communications products utilizing print materials, radio, and social media to share information about how climate change affects water security and individual measures which can be taken to reduce vulnerability and increase resilience

H. CONSULTATIVE PROCESS

The proposed project has been designed based on inputs from key stakeholders in Yemen and project beneficiary groups, including representatives of vulnerable groups. During project preparation four types of consultations shaped the full proposal:

1. Consultations to align with National and local priorities. This has been mainly done with the Environmental Protection Authority.
2. Consultations to avoid duplication with other projects (government, UN agencies, etc.)
3. Consultations to identify needs of target communities and vulnerable groups.
4. Consultations to identify potential environmental and social risks and impacts, in line with AF policies.

In summary, the following actors have been consulted. The purpose of the consultations are show by the numbers, which are aligned with above.

- ☐ Environmental Protection Authority Aden and Sana's (1, 2, 3, 4)
- ☐ Ministry of Water and Environment Aden and Sana's (1, 2, 3)
- ☐ Ministry of Agriculture & Irrigation (1, 2, 3)
- ☐ Ministry of Planning & International Cooperation (1, 2)
- ☐ Aden and Lahj governorate authorities (1, 2, 3)
- ☐ Ministry of Works and Highway (1, 2, 3)
- ☐ Local Water & Sanitation Corporation (1, 2, 3)
- ☐ General Authority of Water Resources (1, 2, 3)
- ☐ General Rular Water Authority (1, 2, 3)
- ☐ Social Development Fund – Aden and Sana`a (1, 2, 3)
- ☐ Water & Environment Centre - Aden and Sana's Universities (1, 2, 3)
- ☐ Estidamah Foundation for Capacity Development (1, 2, 3, 4)
- ☐ UNDP (2, 3)
- ☐ FAO (2, 3)
- ☐ UNOPS (2, 3)

Table 24 Overview of consultations conducted

Date	Location	Consultation Objective	Key Outcomes.	Key Stakeholders Consulted	Total Number of male and female participants
17-18 July 2023	Aden, Yemen	Identify, assess and prioritize adaptation measures	The group developed a long list of adaptation measures for consideration to further development into proposals	EPA, Water Authority, NWRA, Al-Houtah district, Tuban District, Agriculture Authority, Irrigation office, Lahj and Aden Universities, Water Users, Ministry of Planning and International Cooperation, CAMA,	Total Number: 42 Men: 32 Women: 10
16/Mar/2023	Aden, Yemen	Workshop to present, discuss and verify the initial results / outcomes of the CCVA and hydro study	The initial results of the CCVA and hydrological study were presented and verified by the participants.	EPA, Water Authority, NWRA, Al-Houtah district, Tuban District, Agriculture Authority, Irrigation office, Lahj and Aden Universities, Water Users, Ministry of Planning and International Cooperation, CAMA.	Total number: 33 Men:25 Women:8
31/ Jan – 14/ Feb/2023	Al-Waht, Lahj, Yemen	Focus Group Discussion in Lower Region To discuss with stakeholders in the Lower Region about their perspective on climate change, water, key issues in the region and key priorities in order to inform the hydrology and CCVA studies.	Qualitative information on economic development, jobs, water usage, marginalized groups, available financial assistance, communication methods, and crops which were integrated into the hydrology and CCVA studies and informed the selection of adaptation options.	Local Authorities, Farmers, Water Users, Men and Women	Total: 86 Men:62 Women:24
31/ Jan – 14/ Feb/2023	Al-Hawtah, Lahj, Yemen	Focus Group Discussion in Middle Region To discuss with stakeholders in the Middle Region about their perspective on climate change, water, key issues in the region and key priorities in order to inform the hydrology and CCVA studies.	Qualitative information on economic development, jobs, water usage, marginalized groups, available financial assistance, communication methods, and crops which were integrated into the hydrology and CCVA studies and informed the selection of adaptation options.	Local Authorities, Farmers, Water Users, Men and Women	Total: 87 Men: 64 Women: 23
31/ Jan – 14/ Feb/2023	Al-Anad, Lahj, Yemen	Focus Group Discussion in Upper Region To discuss with stakeholders in the Upper Region about their perspective on climate change, water, key issues in the region and key priorities to inform the hydrology and CCVA studies.	Qualitative information on economic development, jobs, water usage, marginalized groups, available financial assistance, communication methods, and crops which were integrated into the hydrology and CCVA studies and informed the selection of adaptation options.	Local Authorities, Farmers, Water Users, Men and Women	Upper Region:89 Men:67 Women:22
26-29 Nov 2023	Saber, Lahj, Yemen	Field Consultations for rehabilitation of irrigation system. Consultations / workshops with project beneficiaries per proposed intervention to identify possible concerns, specific needs and potential environmental and social risks and impacts.	The following should be identified per beneficiary group: - Possible concerns regarding proposed intervention - Proposed solution to concerns - Specific needs for group regarding the proposed intervention - potential environmental and social risks and impacts regarding the proposed intervention	- Irrigation Department-Lahj. Communities that will benefit from project interventions. - Farmers associations - Women farmers group - Youth farmers group - Vulnerable and IDPs farmers group	Total: 38 Men: 27 Women: 11
3-5 Dec 2023	Al-Hawtah, Lahj, Yemen	Field Consultations for rehabilitation of wastewater treatment plants.	The following should be identified per beneficiary group: - Possible concerns regarding proposed intervention - Proposed solution to concerns	- Water and Sanitation Corporation-Lahj Communities that will benefit from project interventions. - Men group - Women group	Total: 40 Men: 28 Women: 12

Date	Location	Consultation Objective	Key Outcomes.	Key Stakeholders Consulted	Total Number of male and female participants
		Consultations / workshops with project beneficiaries per proposed intervention to identify possible concerns, specific needs and potential environmental and social risks and impacts.	- Specific needs for group regarding the proposed intervention - potential environmental and social risks and impacts regarding the proposed intervention	- Youth group - Vulnerable and IDPs group.	

Further consultations were also held with international partners to determine synergies, avoid overlaps and document any lessons learned. A summary of these consultations are in the table below:

Stakeholder	Consultation objective	Outcome	Conclusion	Evidence
UN Women **Jumana Albayaa** *Programme Analyst Women Economic Empowerment (WEE) & Climate Change* **Paola Foschiatto** Programme Management Specialist - Gender Equality and Women's Empowerment (GEWE), Women Peace and Security (WPS)	Identify challenges and opportunities for women involvement and empowerment in AF project activities in Yemen	- Shared latest gender analysis for Yemen. - Shared National government women focal points. - Suggest increasing share / % of women in project committees. - Suggest targeting existing community structures, including for women and other vulnerable groups (and mapping of women and youth leaders organizations and networks) - Suggest ensuring social cohesion (and piece building) by engaging both host communities, IDPs, and vulnerable groups, while also engaging Engage elders / community leaders / religious leaders. - Suggest not using the term gender but Participation / social cohesion / inclusive instead	- Target share of women in project committees to be agreed with government focal point but at least 20 % - Women and youth groups and networks have been mapped and will be engaged. - Community-level planning and management of water will include women and youth groups, as well as community leaders, religious leaders and IDPS. - Using the term gender will be avoided during engagement at national and local level	Date: 29 November 2023 Technique: a call
UNICEF **Khaled Ahmed Mohammed Ali Mushara** WASH Officer, UNICEF Aden **Patrick Sijenyi** WASH Officer, UNICEF **Farida Elmashgary** WASH Specialist, UNICEF **Robert Odong** WASH Specialist, UNICEF	Identify synergies and potential overlap on work on water and climate change as well as lessons learned from projects	- UNICEF shared their planned interventions for the Tuban Delta to support solar water pumping systems for 6 wells that are under control of LAWSC Lahj, currently they are at bid evaluation stage. - A map and exact location of wells was shared by email - Discussed that the beneficiaries are those who live directly around the well - Discussed how water quality is measured and UNICEF shared that they use ad hoc, random sampling but they would like to expand capacity building on collection - UNICEF expressed interest in further collaboration on a system to analyse and collect data on water, including water quality	- There is a gap on systematic water quality monitoring and surveillance in the region and a need for this to be better integrated into water supply interventions -	Date: 14 November 2023 Technique: call Email exchange with map and coordinates of wells
IOM **ALKALADI Abdulmageed** Senior Emergency Operation Assistant **TEFERA Fantahun Getachew** WASH Programme Officer	Identify synergies and potential overlap on work on water and climate change as well as lessons learned from projects; Identify challenges and opportunities for building	- IOM shared that they are working in Lahj on irrigation and WASH with the local Lahj office, including the rehabilitation of wadis and channels. - They have also reactivated several water users' associations, including re-registration with local authorities and they also provide them with capacity buildings and trainings, and they are working with water users associations on maintenance - They have also provided some farmers with solar systems for the irrigation, working with Ministry of Agriculture – who were responsible for selecting the farms which need the solar systems.	- On-going discussions with IOM would be beneficial to continue learning from their experiences with water users associations and rehabilitation of wadis - Lesson learned on identification of beneficiaries which happened through working with the Ministry of Agriculture	Date: 26 October 2023 Technique: call

Stakeholder	Consultation objective	Outcome	Conclusion	Evidence
	resilience of migrants	- They are also working on the sewage system in Al-Hawtah city. - On gender empowerment, they discussed that the number of women in water users' associations vary based on the locality. - They clarified that there work with migrants is mostly on helping them to receive humanitarian ais because there is a lack of land ownership for migrants		
WFP **Sergio Fernandez** Environmental and Social Safeguards Specialist **Abdulhafeed Alameri** **Angela Santucci** External Partnerships, Regional Office in Cairo **Aymeric Faure** External Partnerships **Doaa Bahubaish** **James Mercer** **Kira Paulemon** External Partnerships **Lauren Lepage** **Matthew Hochbrueckner** **Shahida Akhter** **Shiho Akamatsu** Livelihoods Expert	Identify synergies and potential overlap on work on water and climate change as well as lessons learned from projects	- WFP shared the work that they are doing in Lahj and the Tuban Delta, including work on irrigation, water gabions and cash for work and food programmes in insecure communities. - WFP also shared that there is a WASH cluster for UN agencies with UNICEF as a focal point and a water and sanitation coordination group organized by GIZ and UNDP	- Contacts for the WASH cluster and coordination group were shared by email - Plans were made for a follow-up meeting in person	Date: 29 November 2023 Technique: call
World Bank **Marcus Wishart** Regional water specialist, based in Amman **Naif Mohammed Abu-Lohom** Water programme lead for Yemen, based in Amman **Elvira Cusiqoyllor Broeks Motta** Water specialist **Shambhavi Priyam** Economist working with water team in Amman	Identify synergies and potential overlap on work on water and climate change as well as lessons learned from projects	- The World Bank is currently undertaking a rapid water security diagnostic and a Country Climate and Development Report. - They also have on-going programmes in the water sector including rehabilitation of water supply infrastructure in Aden, implemented with UNOPS. - Also working with UNICEF and WHO on WASH emergency response but they are looking at transitioning from emergency response to development aid. - The research on the water sector has included what are the investment opportunities and some of the challenges with water tariff pricing and developing the business model for long-term operation and maintenance	- The studies under development from the World Bank can be useful for informing the business model for water sector interventions - World Bank can help to convene potential donors	Date: 11 December 2023 Technique: call

Figure 22. Consultation with women's group in Tuban Delta

Figure 21. Consultation with focus groups in the Tuban Delta

Figure 24. Workshop to share initial findings of CCVA and hydrology studies

Figure 25. Workshop to review GCF and AF proposal packages

Figure 23. Adaptation measures identification and prioritization workshop

I. JUSTIFICATION FOR FUNDING REQUESTED

The proposed project components, outcomes and outputs fully align with national and local government / institutional priorities and gaps identified (with a clear and direct response to needs in natural resource / water management identified in the national strategies mentioned in Part II.D.

The components, outcomes and outputs also align with the needs of identified community and vulnerable groups and with the Adaptation Fund outcomes. This alignment has resulted in the design of a comprehensive approach to address climate change related water scarcity and coastal issues in a fragile state.

Due to the crisis, government capacity, both in terms of human resources and financing, is reduced compared to before the crisis. As such, Yemen depends to a large extent on external financial support from other countries, and on assistance from the UN and other agencies.

The Yemeni economy faces multiple challenges, including a prolonged armed conflict which has resulted in loss of life, destruction of property and an internationally recognized food security crisis. Yemen's Gross Domestic Product (GDP) is calculated by the International Monetary Fund (IMF) as $21 billion dollars which is a per capita GDP of only $617 and the GDP declined by .5% in 2023. Yemen is a least developed country (LDC) with high poverty rates and persisting conflicts. One of the challenges is the lack of confidence in the local currency (Yemeni Rial) and a scarcity of US dollars and other international currencies in the market. The Yemeni economy suffers from hyperinflation, and available information show that food and essentials costs in some Governorates has increased by as much as 76%.

Given this situation in Yemen, the already limited national finance is therefore directed at emergency responses and the finance available for addressing climate change adaptation and mitigation is extremely scarce. Local governments also rely on the federal government for the majority of their funding, however given the national budget crisis, the funds available to small and medium-sized cities such as Al-Hawtah and Al-What are extremely limited.

Given its current situation and overall exposure and sensitivity to climate change risks, Yemen is highly dependent on closely collaborating with international multilateral climate finance donors, such as the GCF, the AF, and the CFI, to mobilize urgently needed climate finance. However, gaining access to multilateral climate finance, including via mechanisms established under the UNFCCC, remains challenging for Yemen. In fact, as of January 2022, the Climate Funds Update database, which collates information from 27 multilateral climate funds, listed only 19 single-country projects in Iraq, Syria and Yemen that have been approved for funding, with the amount disbursed totaling just 20.6 million US dollars – less than 0.5% of the money disbursed to climate projects worldwide. To date, Yemen has received approximately US$ 2 million from the GCF through GCF Readiness projects and a proposal to the Adaptation Fund for US$ 10 million for climate change adaptation focused on improved irrigation canals and wastewater treatment is under development.

A detailed climate finance needs assessment of Yemen is currently being conducted and will be available in 2024. Even though the climate finance needs assessment is not yet available, it is apparent that current climate finance available in Yemen is not sufficient to induce a paradigm shift towards low carbon, climate resilient and sustainable socio-economic development.

In fact, Yemen finds itself in a vicious cycle driven by conflict, the eradication of its environmental resources, and climate change – the latter further worsening the already dire food security and water situation, which causes further conflict. Vast amounts of concessional climate finance is urgently needed from bilateral and multilateral donors, to support climate finance capacity development of key stakeholders and the implementation of large-scale climate change projects and programmes across Yemen.

At least 2/3 of the funding will be allocated to components 2 and 3, which are concrete adaptation activities. Concrete interventions have been selected and prioritized based on priorities, cost-effectiveness / high impact and sustainability criteria. Table 12 provides a justification for funding requested, focusing on the full cost of adaptation reasoning, by showing the impact of AF funding compared to no funding (baseline) related to expected project outcomes.

Table 25 Overview of impact of AF funding compared to no funding (baseline) related to expected project outcomes

Project outcomes	Baseline (without AF)	Additional (with AF)	Comment and alternative adaptation scenario's
Enhanced capacities of national and sub-national government institutions, communities and vulnerable groups to manage natural resources (focused on water and land) and respond to climate change risks in the	Lack of climate change-related water security and risk of flooding are major hindrances to sustainable development in the country. However, due to the crisis, both human and financial resources are so limited that governments and communities are not able to respond. Moreover, in Yemen, water is	The activities related to this outcome will allow government institutions to assess, plan and manage natural resources in the Tiban delta an inclusive, efficient, sustainable and resilient way. The activities related to this outcome will enable communities and vulnerable	Without sustainable and climate change resilient water management approaches (considering larger water systems and techniques to reduce water consumption), target areas will become even more water scarce, which will be disastrous. Alternatives are to only manage water more locally, but this would not improve the overall efficiency of the system and could have negative impacts downstream

Tuban Delta efficiently, sustainably and in a resilient way	usually managed at local scale and not by looking at larger systems (delta / watersheds), which leads to inefficient and unsustainable management.	groups to participate in the planning for natural resource management and sustain natural resource systems	
Increased adaptive capacity of the water sector through rehabilitation and protection of irrigation systems in the Tuban Delta	Target communities have very limited options (capacity – skills and technically - and financial resources) to adapt to climate change-related water scarcity and flooding. Traditional irrigation is not efficient and drought tolerant crops and livestock limited.	The activities related to this outcome will build the adaptive capacity of target communities to adapt to water scarcity and flooding through concrete interventions which will also benefit irrigation and subsequently food production	The alternatives currently being sought by communities and farmers are digging additional wells, but given the limited groundwater resources, this is not a sustainable option for maintaining irrigation levels to improve crop production. This will also further decrease the water balance.
Increased innovative, efficient, sustainable and climate change resilient practices to improve the water supply systems for urban and agriculture purposes	Target communities have limited access to innovative and efficient practices to increase the resilience of urban and agricultural water systems	The activities related to this outcome will allow communities to improve efficiencies of water systems through utilizing innovative sources for water as well as improving system functioning to benefit both urban water users and agricultural uses.	Currently utilized alternatives are to dig additional wells, but given the limited groundwater resources, this is not a sustainable option for maintaining irrigation levels to improve crop production. This will also further decrease the water balance. Another option is large-scale desalination but this is beyond the scope of this project.
Improved ownership and capacities at local level to respond to climate change, including to operate, maintain and replicate resilient water and irrigation systems	Target communities do not have the ownership, skills, capacities and information to change their inefficient water use practices, manage water resources or participate meaningfully in inclusive natural resource planning processes.	The activities related to this outcome will build the capacity of target communities to utilize modern irrigation techniques, sustainably manage water resources and the maintenance and operations of resilient water interventions as well as participate in holistic and inclusive natural resource planning processes.	The alternative would be to have a top-down, centralized planning and management processes that does not build ownership and capacity at the local level, with target communities.

J. SUSTAINABILITY OF THE PROJECT/PROGRAMME

Investing in increasing the resilience of vulnerable assets and livelihoods is a sustainable economic approach. It will not only avoid future costs related to climate change and disaster impacts, but it will also enhance livelihood options, improve the health and security of the community.

By engaging communities and vulnerable groups in project activities, including assessments, planning and decision-making processes, the project aims to achieve building of communities' awareness and capacities, and furthermore ownership and leadership in the area of natural resource / water management. Specific emphasis will be given to community capacity strengthening to operate and maintain the systems, tapping into and strengthening the network of Water Users Associations. Farmers, women and youth will also be targeted for skills development and to ensure the planning for sustainable and climate resilience natural resources management will be inclusive.

With all components, the project aims to support sustainable development in Yemen compared to a currently humanitarian driven approach.

Table 26 Proposed arrangements to sustain /maintain, replicate and upscale project activities and supporting mechanisms

Proposed outputs	Maintenance measures and responsible authorities	Replication and upscaling arrangements and mechanisms to support this + exit strategy
1.1 Government capacity strengthened at national and sub-national level on increasing climate change resilience and effective water management 1.2 Establishment of laboratory for wastewater quality testing and water supply quality testing. 1.3 Integrated and inclusive natural resource (focused on water and land) and climate change risk management process and plan	Monitoring and updating of strategies and plans and the laboratory for testing <u>Responsible</u>: - Ministry of Ministry of Water & Environment - General Authority of Water Resources	Approach and lessons learned captured from the inclusive planning natural resource management process for replication in other basins in Yemen, including building capacities of other ministries, municipalities and local communities to extend beyond the Tuban, Aden and Abyan Basins <u>Responsible</u>: - Ministry of Water & Environment - General Authority of Water Resources - Local Corporation of Water & Sanitation <u>How:</u> identify responsibilities, coordinate with municipalities, local communities and allocate required budget to develop new plans

2.1. Assessment and verification / technical specification and engineering studies, including surveys required, for improved irrigation canals and water intake systems 2.2. Rehabilitated irrigation canals to improve water access for agricultural purposes in the Tuban 2.3. Improved water intake structures to increase water supply in the irrigation canals 2.4. Stone-gabions constructed to reinforce canals and protect agriculture lands and Al-what city from flashing floods.	Operation and Maintenance plans for the canals will be developed under Component 4 by the Ministry of Agriculture. This will also include longer term maintenance plans beyond the life of the project. The training of farmers and water users associations under Component 4 will also support the maintenance of activities under this component. Responsible: - Ministry of Agriculture & Irrigation working with the Ministry of Water and Environment and the, General Authority of Water Resources - Local Corporation of Water & Sanitation	Approach and lessons learned captured for replication in other regions in Yemen, including building ministry and municipalities, local communities capacities to do so and guidelines Responsible: - Ministry of Water & Environment - Ministry of Agriculture and Irrigation - General Authority of Water Resources - Local Corporation of Water & Sanitation
3.1. Assessment and verification / technical specification and engineering studies, including surveys required, for water supply alternatives options outlined below 3.2. Developing efficient and safe water supply alternatives for Al-What, Al-Hawtah, Saber cities and surrounding villages 3.3. Upgrade Tahror WWTP to treat wastewater for use in irrigation 3.4. Upgrade Saber WWTP to treat wastewater for use in irrigation	Operations and Maintenance plans will be developed as part of this component for each of the concrete interventions to ensure continuity of operations Responsible: - Ministry of Water and Environment working with the Local Corporation of Water & Sanitation	Approach and lessons learned captured for replication in other regions in Yemen, including building ministry and municipalities, local communities capacities to do so and guidelines Responsible: - Ministry of Water & Environment - General Authority of Water Resources - Local Corporation of Water & Sanitation
4.1 Support farmers' with modern irrigation techniques and systems (Urban and Rural Areas) 4.2 Develop maintenance plans for canals, irrigation system 4.3 Strengthen water users associations for improved monitoring, maintenance and dissemination of information on irrigation techniques and skills development 4.4 Skills development with women and youth on water management and climate change adaptation 4.5 Capacity development for communities with a focus on women and youth civil society organizations on integrated and inclusive natural resource management plans 4.6 Awareness raising with local communities on water conservation and climate change in Aden and the Tuban Delta	All of the activities in this component support maintenance and sustainability of the previous three components, especially the emphasis on strengthening water users associations so that they are involved with monitoring, maintenance and dissemination of information. Responsible: - Ministry of Agriculture & Irrigation - Ministry of Water and Environment - General Authority of Water Resources - Local Corporation of Water & Sanitation	The awareness raising can be replicated to other cities and regions in Yemen to further spread messaging on water conservation and climate change. The materials for capacity development and skills development can be utilized in other areas in Yemen. Lessons learned from strengthening of water users and supporting farmers with modern irrigation techniques can support replication throughout Yemen. Responsible: - Ministry of Agriculture & Irrigation - Ministry of Water and Environment - General Authority of Water Resources - Local Corporation of Water & Sanitation

The Ministry of Water and Environment and its departments in the governorates, including the Local Water and Sanitation Corporations (LWC) of Aden and Lahj are responsible for water management. These institutions have a mechanism to manage, monitor and maintain the proposed water-related project activities in the target area based on the national requirement and compliance with ESIA policies. Through the ministries' related department and LWC, participatory processes will take place with local community representatives and beneficiaries' groups, including water

user associations, as well as with the municipalities through meetings and training sessions to assure sustainability and quality of the interventions.

The ministry of Agriculture and its departments in in the governorates of Aden and Lahj are responsible for agricultural and irrigation activities. In line with their national and sub-national strategies, they are to define the type of climate resilient crops, etc. Water use / farmer associations will participate in the process to identify the most efficient irrigation options and innovative farming systems, but also to identity maintenance needs and arrangements and options for replication.

If water user association are not functional in the target areas, these will be set-up. Their main responsibilities will be to: 'equally' distribute available water resources among farmers according to the developed irrigation schedule and to operate and maintain the rehabilitated /installed irrigation system.

K. OVERVIEW OF THE ENVIRONMENTAL AND SOCIAL IMPACTS AND RISKS IDENTIFIED AS BEING RELEVANT TO THE PROJECT / PROGRAMME

The proposed project seeks to fully align with the Adaptation Fund's Environmental and Social Policy (ESP) and its 15 safeguard areas and the AF Gender Policy (GP). An Environmental and Social Impact Assessment has been conducted and an Environmental and Social risks Management Plan (ESIA-ESMP) developed – see annex 4 on page 124). This shows how the project complies to the AF ESP and GP in detail and how the project will manage any potential risks and impacts. As shown in Section II.H, consultations have been conducted to identify potential environmental and social risks and impacts and to identify specific group's needs and possible concerns. Based on the screening against the 15 AF principles and impacts, the project has been categorized as a "B" category project in terms of the environmental and social risks it poses. As long as the proposed follow-up actions mentioned in the ESIA-ESMP are taken, and the main proposed risks mitigation measures are fully implemented, any potential environmental and social risks and impacts will small and site-specific and localized.

Activities under components 1 and 4 consist of activities to develop strategies and to raise awareness and strengthen capacities of national, sub-national and local actors. The project will ensure relevant actors and beneficiary groups will be equally represented and that they'll equally benefit from the project activities.

Activities under Components 2 and 3 are 'concrete' adaptation actions. Because of the scope of the proposed activities, which are localized, potential direct risks and impacts will be minimal. Transboundary impacts are highly unlikely because the target delta is not close to a boarder. Given this, cumulative impacts are also unlikely.

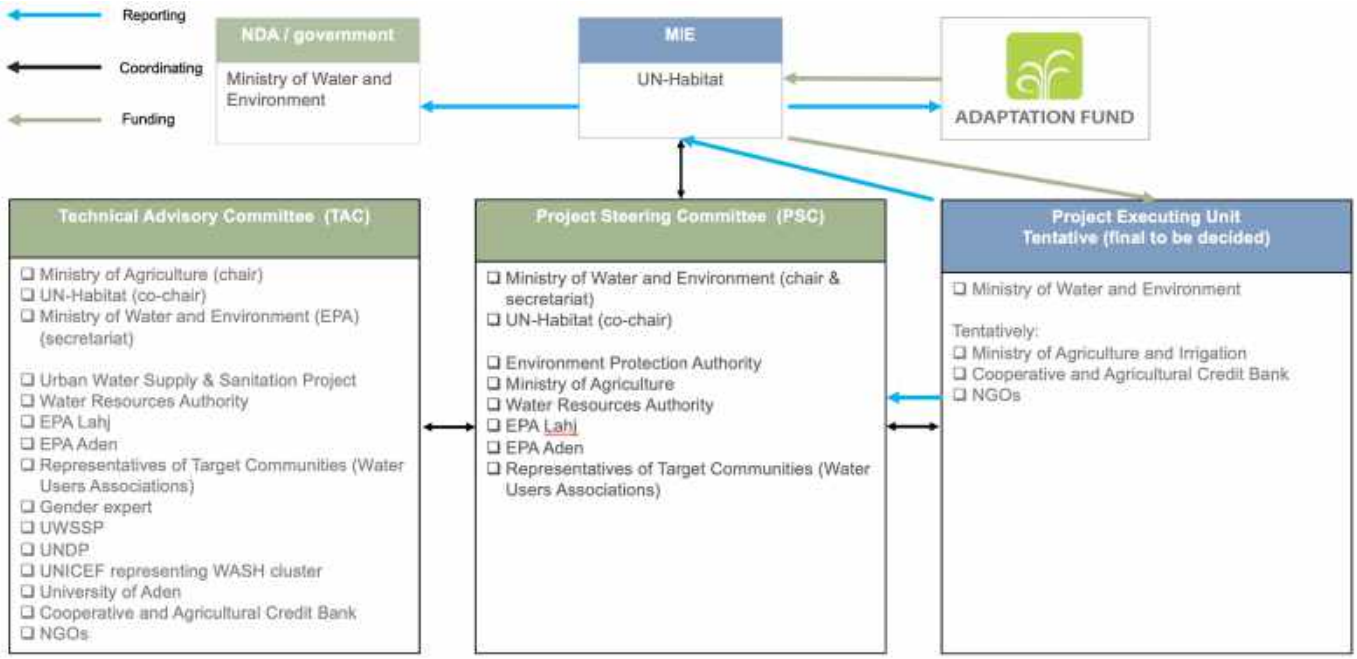
The project is designed to generate positive economic, social and environmental impacts, using inputs from vulnerable groups and women and youth in target communities and by incorporating best practices from other projects.

Table 27 Overview of environmental and social impacts and risks for which further assessments and management are required.

Checklist of environmental and social principles	No further assessment required for compliance (during project implementation)	Potential impacts and risks – further assessment and management required for compliance
1. Compliance with the Law		X
2. Access and Equity		X
3. Marginalized and Vulnerable Groups		X
4. Human Rights	X	
5. Gender Equality and Women's Empowerment	X	
6. Core Labour Rights		X
7. Indigenous Peoples	X	
8. Involuntary Resettlement	X	
9. Protection of Natural Habitats	X	
10. Conservation of Biological Diversity	X	
11. Climate Change	X	
12. Pollution Prevention and Resource Efficiency		X
13. Public Health		X
14. Physical and Cultural Heritage	X	
15. Lands and Soil Conservation	X	

PART III: IMPLEMENTATION ARRANGEMENTS

A. ARRANGEMENTS FOR PROJECT/PROGRAMME IMPLEMENTATION.



The organigram above (shows how the project will be funded, coordinated and executed. As UN-Habitat is the Multilateral Implementing Entity (MIE) of the project, UN-Habitat will be responsible for contracting of the executing entities and reporting to the AF. The UN-Habitat Yemen Country Office, in cooperation with Ministry of Water and Environment, will coordinate with UN-Habitats' Headquarter (HQ) and regional office (ROAS) to ensure project compliance with AF and UN-H policies and reporting / M&E requirements, incl. safeguarding system.

The Ministry of Water and Environment and UN-Habitat will chair and co-chair the Project Steering Committee (PSC) whereas the Ministry of Agriculture will chair the Technical Advisory Committee (TAC) with UN-Habitat being the co-chair. The PSC will supervise and ensure the smooth implementation of the project from start to completion and review plans and reports. The target governorate and municipalities will also be represented through the PSC. Representation in both the TAC and PSC will be 30% women.

Table 28. Key Stakeholders and Committees' Roles and Responsibilities

Stakeholder /Committee	Roles and responsibilities
UN-Habitat	• Multilateral Implementing Entity • Project coordination with UN-H HQ and regional office (ROAS) and government actors • Ensuring project compliance with AF and UN-H policies and reporting / M&E requirements, incl. safeguarding system • Contracting and coordination with execution partners and Ministry of Water and Environment • Co-chair Project Steering Committee • Co-chair Technical Advisory Committee
Ministry of Water and Environment (& Environment Protection Authority)	• Adaptation Fund Designated Authority • Coordinate with UN-Habitat and PSC, including on hiring / procurement processes. • Chair of Project Steering Committee • Recommend the additional expert advisory members to the PSC when needed to ensure project compliance with the National laws and plans. • Technical and financial guidance for all activities and implementing stages of the project.
Project Steering Committee (PSC)	• Supervision on smooth implementation of the project from start to completion, including ensuring alignment with the agreed upon timetable and compliance with the National laws and plans. • Review any deviations and consider amendments to work plans and contractual arrangements • Review work progress reports for the activities to be executed by Executing Entities for each component. • Conduct meetings regularly with the Technical Advisory Committee and review related reports and comments.
Technical Advisory Committee (TAC)	• Review technical outputs and provide input and feedback as necessary. • Provide updates about relevant and complementary work undertaken in Yemen. • Make recommendations to the Project Steering Committee

Project Execution Unit (PEU)	• Ministry of Water and Environment (Urban Cities Projects Unit) • Other execution entities will be identified / agreed upon • Provide periodic reports / plans to the TAC and PSC • Provide required work progress reports to UN-Habitat / Ministry of Water and Environment to release further disbursements. • Report on each problem delay / amendment on work plan/contractual arrangement /time deficit or problem to PSC • Implement ESIA-ESMP

Legal and financial arrangements

UN-Habitat and the Ministry of Water and Environment will sign a joint Memorandum of Understanding to which this Project Document will be attached, to ensure that all partners are fully committed to the project.

UN-habitat will contract Project Execution Entities through Memorandum of Understanding (MoU) or Agreements of Cooperation (AoC), which are legally binding financial tools. The contract will be negotiated by the UN-Habitat Project Team and cleared by UN-Habitat ROAS / HQ. For any NGO to be hired, a competitive procurement process will be administered once the proposal has been approved and the agreement between the Adaptation Fund and UN-Habitat is signed. The procurement process will follow all procedures of the United Nations to ensure an open and fair recruitment and outcome.

UN-Habitat will develop an operational manual that clearly outlines the roles and responsibilities of the key project stakeholders and contain all the necessary tools, forms and templates required to administer the project. The operation manual will be shared with the Project Execution Entities Unit for inputs. All contractors will be required to have 'external' audits of their budgets. The contractors will also be required to support the independent final evaluation.

Roles and responsibilities for environmental and social risks management / AF ESP and GP compliance

The Project Execution Unit (PEU) will be responsible for implementing the project ESIA-ESMP. Guidelines showing how to comply to the AF ESP and GP will be developed with all execution entities and they will be guided on process, including monitoring. Policy and reporting compliance and safeguarding system compliance experts will be part of the project team (see for details the budget section). The PEU will be backstopped by UN-Habitat HQ, with experts on climate change, human rights, environmental and social risks managements and gender policies.

Government stakeholders responsible for compliance to national environmental and social policies and standards, as well as government gender focal points, will be part of the Project Steering Committee.

All project-related ToR's and contracts will include clauses stating contractors require to comply to the AF ESP, especially principle 1 (law), 4 (human rights), 5 (gender), 6 (core labour standards) 8 (involuntary resettlement), 11 (GHG emissions), 12 (waste and pollution), 13 (health and safety) and 14 (heritage sites) and to the AF GP

Adaptive management: when changes in project activities or additional activities are required, these will need to go through a new risks screening and impact assessment process in compliance with AF, UN-habitat and national policies and standards. When this is required, this will be led by the UN-Habitat Project Team and the Project Steering Committee would need to approve the changes.

Launch of the project

At the launch of the project, an inception workshop with members of the Project Steering Committee, Technical Advisory Committee, Executing Partners and other key stakeholders will be organized. The project approach and the proposed outputs and outcomes of the project will be presented and discussed with the purpose to solicit feedback and inputs in a participatory manner. Comments and feedback will be incorporated in project frameworks and workplans. The Inception Workshop aims to:

(i) Enhance participants' understanding of the project objectives and activities and take ownership of the project
(ii) Discuss and confirm the organizational structure of the project, including roles and responsibilities
(iii) Confirm / agree upon project monitoring framework and workplan
(iv) Confirm / agree upon project risks management framework
(v) Discuss and agree upon project knowledge management framework and plan
(vi) Confirm / agree upon the project Environmental and social Risks Management Plan
(vii) Agree on the annual work plan for year one.

The inception workshop will be organized within three months after signing the project agreement between the Adaptation Fund and UN-Habitat.

B. MEASURES FOR FINANCIAL AND PROJECT/PROGRAMME RISK MANAGEMENT.

Under guidance of the regional Programme Manager and supported by the national Project Coordinators, Monitoring and Evaluation Officers will monitor the status of financial and project management risks, including those measures required to avoid, minimise or mitigate these risks, throughout the project. The table below indicates potential risks, likelihood and impact.

Table 29. Overview of financial and management risks and measures to mitigate these

Potential Issues	Likelihood (1-5)	Impact (1-5)	Mitigation Measures	Indicator to verify
Institutional				
1. Delay of project start-up because critical staff is not in place and/ or lengthy contracting process, incl. negotiations with execution entities	3 – medium	3 – medium	1.1 UN-Habitat appointed critical staff at UN-H ROAS to start the process required to start the project. 1.2 Proposed project activities and budgets have mostly been agreed upon with Executing Entities 1.3. The inception workshop will be organized within three months of the signed project agreement between UN-Habitat the AF	The inception workshop is organized within three months after the signed project agreement between UN-Habitat; Execution entities to execute activities in the 1st project year are contracted within six months after the inception workshop
2. Loss of Government support for programme, project and activities due to elections and related functions due to lack of prioritisation of AF project activities or different pace of execution of activities	1 – Low	3 – medium	2.1 Technical staff at execution level in sector ministries and local governments to be engaged in all aspects of programme development and implementation	Confirming steering committee members and roles and responsibilities during inception workshop + report Government focal point to coordinate MoU signed within 6 months six months after the inception workshop
3. Lack of coordination between and within national government Ministries and Departments and municipalities.	2 – Low	4 – High	3.1 Project Steering Committee to address coordination of sector ministries towards enhanced collaboration to achieve expected accomplishments. 3.2 Representatives from the target municipalities are members of the PSC. 3.3 Should UN-Habitat observe coordination problems, the agency will try to resolve issues directly with government focal point and / or concerned parties	Terms of Reference for Steering Committee outline coordination mechanisms and indicate mitigation measures
4. Capacity constraints of executing entities, local institutions, communities and the private sector may limit the effective implementation of interventions	3 – Medium	3 - Medium	4.1 The project has a strong capacity building and training component designed to operate, maintain, sustain and replicate project activities, esp. at the community and sub-national level. 4.2 UN-Habitat will have dedicated project staff with expertise in climate change, community organization and technical design, M&E and safeguards to ensure quality control from UN-Habitat side.	Capacity building indicators established as part of monitoring plan Critical staff as mentioned included under project cycle management section
5. Communities may not adopt activities during or after the AF project, including infrastructure maintenance	2 – Low	4 – High	5.1 A strong participatory approach at the community level is used and will be used (component 4) during project implementation to ensure ownership and support of communities to the realized interventions in the targeted project areas. 5.2 Capacity building and training of communities, with a focus on water users associations, will be undertaken to improve awareness and understanding of the benefits of the activities, including long-term maintenance (component 4).	Same as above
Financial management and Requisite Institutional Capacity				

6. Complexity of financial management and procurement. Administrative processes could delay the project execution or could lack integrity or needed capacity.	3 – Medium	3 – Medium	6.1 Financial management arrangements have been defined during project preparation, including identification of potential executing entities 6.2 UN-Habitat's control framework, under the financial rules and regulations of the UN secretariat, will ensure documentation of clearly defined roles and responsibilities for management, internal auditors, the governing body, other personnel and demonstrates proof of payment / disbursement; In line with AF and UN-Habitat policies, audits will take place annually and / or for each contract of USD 500k. 6.3 Activity specific procurement will be managed by the executing entities as agreed through standard Agreements of Cooperation (with relevant conditions, incl. evidence of recognized procurement policies and procedures and specific terms and conditions for timely disbursement of funds for project activities while at the same time ensure provisions on good financial management, hence minimizing the risk of fund mismanagement or corruption).	Timely audit reports (inception and yearly + following UN-H regulations) Timely evidence of recognized procurement policies and procedures provided by Execution Entities
7. Inflation and instability of the national currency leading to budget issues and increased prices for infrastructure delivery.	3 – Medium	2 – Medium	7.1 Monitoring of potential threats to stability of national currency as part of the UN Development System, systemic response to this challenge recommended. 7.2 All budgets will be in US$	Financial management and procurement strategy Budgets in US$
Physical				
8. Political instability / conflict inhibits movement to and in the target areas	3 – Medium	4 – High	8.1 The selected project sites are labelled as being safe. However, UN-habitat will only let field work proceed if agreed with the UN security unit 8.2 Execution entities will require having permanent field staff at project sites, recuing the need to travel 8.3 If target areas are not accessible, UN-Habitat and the proposed execution entities will identify alternative intervention locations and request approval from the PSC and AF	Permanent field staff at project locations
Environmental				
9. Poor weather conditions affect implementation of activities	2 - Low	3 - Medium	9.1 UN-Habitat and the proposed execution entities have developed their work plan according to expected weather conditions. If unexpected weather patterns occur, the proposed activities and work plan will be reviewed to make practical adaptations.	Work plans avoiding critical concrete works being planned in rainy seasons

C. MEASURES FOR ENVIRONMENTAL AND SOCIAL RISK MANAGEMENT

Part II.L of this proposal shows the outcome of the environmental and social risks screening and impacts assessment that has been conducted for this project to comply to the AF ESP and GP. Part II.I describes the consultation process conducted to support the development of this proposal, including for this project to comply to the AF ESP and GP. Part III.A describes the allocated roles and responsibilities for environmental and social risk management, including for the implement of the project ESMP. A budget for environmental and social risks management, including the implementation of the ESMP, is part of the project execution costs. In annex 4 on page 124), all the details of the risks screening, impact assessment, ESMP, incl. the risks monitoring system and budget, are provided.

Based on the screening against the 15 AF principles, the project has been categorised as a "B" category project in terms of the environmental and social risks it poses.

Table 30 ESP and GP compliance requirements and how the proposal complies to these requirements

ESP and GP compliance requirements	Project compliance to the AF ESP and GP	Reference / evidence

Have all potential environmental and social risks been identified for *all* project/programme activities prior to funding approval?	All potential environmental and social risks (incl. for gender and considering their significance) have been identified) for all project/programme activities at the project preparation phase. An ESIA-ESMP has been conducted / prepared in compliance with the AF ESP and GP and in line with national requirements for conducting ESIAs; Outcomes have been consolidated in the proposal	Part II.I Part II.L Annex 4 (ESIA-ESMP)
Has the environmental and social assessment been completed before the project/programme proposal submission to the Adaptation Fund, and its findings included in the proposal document?	In compliance with the AF ESP and GP and national requirements for conducting ESIAs, above reports are being reviewed by the government of Yemen. Outcomes have been consolidated in the proposal.	Annex 4 (ESIA-ESMP)
Has an ESMP been developed and does this include safeguard measures to be implemented during a project/programme?	A project ESMP has been developed, including safeguarding measures. The following has been included in the ESMP: - Allocated roles and responsibilities environmental and social risk management / implement of the ESMP - Opportunities for adaptive management - Arrangements to supervise executing entities for implementation of ESMP - Budget provision to manage environmental and social risks / implement of the ESMP - Measures to avoid, minimize, or mitigate potential risks - Risks monitoring system / indicators - Grievance mechanism	Part III.A (roles and responsibilities for env. and social risk management) Annex 4 (ESIA-ESMP)
Will a grievance mechanism be put in place and how will it be made widely known to identified and potentially affected parties	A project grievance mechanism will be put in place, as described in the ESMP. It will be made widely known to identified and potentially affected parties through community mobilisers, posters and online content	Annex 4 (ESIA-ESMP)

D. MONITORING AND EVALUATION ARRANGEMENTS

Monitoring and Evaluation (M & E) arrangements for this project will be in compliance with the AF M&E guidelines and ESP and GP and with UN-Habitat M & E policies and guidelines. As such, the following will be monitored and evaluated: project Milestones, Financial data, Procurement data, Risks assessment, ESP Compliance, GP Compliance, Project indicators, Lessons learned, Project Results. The M & E for Project Results will be based on targets and indicators, including gender-disaggregated targets where possible, established in the Project Results Framework (see Part III.E).

The annual project performance reports (PPRs) will include a section on the status of implementation of any environmental and social management plan, including those measures required to avoid, minimize, or mitigate environmental and social risks. The reports shall also include, if necessary, a description of any corrective actions that are deemed necessary. The terminal evaluation report will include an evaluation of the project's performance with respect to environmental and social risks.

UN-Habitat will ensure timely and high-quality M & E by keeping oversight of the process by providing guidance to the Project Execution Entities and national government partners through full briefing of M & Requirements. Where possible, the M & E process will be participatory, involving key stakeholders at national, municipal and communities. Project activities will be monitored by the TAC including compliance to the AF ESP and GP. The M & E framework and plan will also need to be endorsed by the Project Steering Committee. Audits of the project's financial management will follow AF regulations and rules and applicable audit policies. The M&E plan will be implemented as proposed in the table below.

Table 31. M&E Activities with responsible parties, timeframe and budget

Type of M&E activities	Responsible Parties	Time Frame	Budget
Inception and completion workshop	Project Coordinator MWE-EPA UN-Habitat	Inception meeting within first 3 months	Inception meeting **Sub-Total: US$ 8,000**
Direct Project Monitoring and Quality Assurance, including progress and financial reporting, and risk management	Project Coordinator Monitoring and Evaluation expert UN-Habitat	Quarterly, half-yearly and annually as needed	Monitoring and Evaluation expert, including responsibilities for ESP and GP compliance, Renumeration
Compliance with ESP and GP	Project Coordinator Monitoring and Evaluation expert UN-Habitat	Annually	**Sub-Total: US$ 70,900**
Overall project monitoring and evaluation	UN-Habitat	Annually	

Audits	Project Coordinator UN-Habitat	Annually at year end	Conducted by AF, supported by UN-Habitat HQ
			Sub-Total: US$15,000
Mid-term and Final evaluations	Project Coordinator UN-Habitat External	At midpoint and then no later than 3 months upon termination of the project	Terminal Evaluation
			Sub-Total: US$ 50.000
Community consultations/ workshops/ trainings	Project Coordinator UN-Habitat Executing Entities	Quarterly, half-yearly and annually as needed	As part of ongoing pilot initiatives
			Sub-Total: not applicable
Visit to field sides	Project Coordinator UN-Habitat Executing Entities	Quarterly, half-yearly and annually as needed	As part of ongoing pilot initiatives
			Sub-Total: not applicable

The Project Coordinator will develop an **M&E Plan** during the project's inception phase, which will be distributed and presented to all stakeholders during the initial workshop. The emphasis of the M&E plan will be on (participatory) outcome/result monitoring, project risks (financial & project management risks and environmental social safeguard risks) and learning and sustainability of the project. Periodic monitoring will be conducted through visits to the intervention sites. UN-Habitat will ensure that all executing partners are fully briefed on the M&E requirements to ensure that baseline and progress data is fully collected and that a connection between the Knowledge Management component and M&E is established. The Agreement of Cooperation will also reflect these.

An **Annual Project Performance Review** (PPR) will be prepared to monitor progress made since the project's start and in particular for the previous reporting period. The PPR includes, but is not limited to, reporting on the following: progress on the project's objective and outcomes – each with indicators, baseline data and end of project targets (cumulative); project outputs delivered per project outcome (annual); lessons learned/ good practice; Annual Work Plan and expenditure; annual management; environmental and social risks (i.e. status of implementation of ESMP, including those measures required to avoid, minimize, or mitigate environmental and social risks. The reports shall also include, if necessary, a description of any corrective actions that are deemed necessary; and project financial and management risks (same as per above).

The **reports** that will be prepared specifically in the context of the M&E plan are: **(i) M&E plan; (ii) project inception report; (iii) the annual-, and terminal project performance reports, and (iv) the technical reports.**

For the M&E budget and a breakdown of how implementing entity fees will be utilized in the supervision of the M&E function, please see the detailed budget (Part III. Section G). For related data, targets and indicators, please see the project proposal results framework (Part III, Section E).

E. RESULTS FRAMEWORK

Table 32 Results framework

Expected Result	Indicators	Baseline	Targets	Means of verification	Assumptions, risks/impacts and mitigations	Interval	Responsibility
Component 1 Integrated and inclusive natural resource management for climate-resilient water systems							
Outcome 1. Enhanced capacities of national and sub-national government institutions to manage natural resources (focused on water and land) and respond to climate change risks in the Tuban Delta efficiently, sustainably and in a resilient way (in line with AF outcomes 2 and 7)	Capacity of national and sub-national government staff to plan for the management of natural resources and respond to climate change is increased: No. of public staff targeted - Total - Female *sector: multi-sector Operational laboratories Climate change and gender/social inclusion priorities are integrated into natural resources management plan UN-H indicator 3.2: Number of partner cities that are implementing resource efficiency policies, plans and standards in urban management UN-H indicator 3.3: Number of partner cities that are implementing strategies, policies, plans and standards aimed at achieving adaptation, mitigation and/or integrated adaption and mitigation to climate change	 0 0 Capacity: low 0 Integration level: none 0 0	 900 and 300 unique[67] 30% Capacity: medium (80 % of target staff) 2 Integration level: most 2 2	Change of capacity Workshop/training reports and/or survey (from low to medium capacity – exact requirements to be agreed during project) Integration level by checking climate change and gender/social inclusion priorities in plan Lab establishment reports	Sustained engagement and interest by key ministries on climate change Risk: targeting non-relevant staff Mitigation: targeting strategy	Baseline, mid-term and end	TBC with UN-Habitat
Output 1.1. Government capacity strengthened at national and sub-national level on increasing climate change resilience and effective water management	No. of staff trained / participated in workshops. Type: public - Total - Female	 0 0	 900 and 300 unique[68] 30%	Workshop reports Count on attendance sheets Review pictures	Risk: target women involvement not reached Mitigation: quotas will be applied	Every meeting	TBC with UN-Habitat
Output 1.2 Establishment of laboratory for wastewater quality testing and water supply quality testing	No of laboratories established for wastewater quality testing and water supply quality testing. Laboratories should be accessible for disabled.	0 Currently there is insufficient capacity for testing to ensure the quality of wastewater and water supply is	2	Review pictures of labs	Risk: non-agreement on safe consumption levels Mitigation: agree on safe consumption levels before tests start	Baseline, mid-term and end	TBC with UN-Habitat

[67] Unique individuals. Assumption that one individual attends 3 trainings/workshop. 16 training and 20 workshops with 25 participants.
[68] Unique individuals. Assumption that one individual attends 3 trainings/workshop. 16 training and 20 workshops with 25 participants.

		safe for human and agricultural consumption					
Output 1.3 Integrated and inclusive natural resource (focused on water and land) and climate change risk management process and plan	- No of meetings bringing together stakeholders to discuss climate-resilient water management plans - % Female - % Youth *Consider elderly and disabled (venues need to be accessible) No. of plans developed to manage natural resources and address climate change risks (scale: regional)	0 0	70 (20 participants each = 1400 people total) 30% 20% 1	Meeting reports Count on attendance sheets Review pictures	Facilitation which encourages participation of all stakeholders in the process Risk: benefits and concerns of women not fully identified Mitigation: include in ToR and review	Baseline, mid-term and end	TBC with UN-Habitat
Component 2: Increased adaptive Capacity of the Water Sector							
Outcome 2. Increased adaptive capacity of the water sector through the rehabilitation and protection of irrigation systems in the Tuban Delta (in line with AF outcome 4)	Assets produced, developed, improved or strengthened Length of irrigation canals improved to withstand climate change and variability-induced stress Sector: water management	3km Change in asset: somewhat improved	61km (change 58) Change in asset: mostly improved	Identify irrigation canals improved; provide photos	Risk: unclarity about change in asset improvement required Mitigation: agree on typology and compare to baseline	Baseline, mid-term and end	TBC with UN-Habitat
Output 2.1. Assessment and verification / technical specification and engineering studies, including surveys required for improved irrigation canals and water intake systems	No of tools and guidelines developed and shared with relevant stakeholders and: - Detailed engineering studies and designs of below interventions	0	3	Detailed technical specification prepared and advertised	Risk: studies do not comply with law requirements Mitigation: include in ToR and assess studies with purpose to identify compliance	Baseline, mid-term and end	TBC with UN-Habitat
Output 2.2. Rehabilitated irrigation canals to improve water access for agricultural purposes in the Tuban	No. of physical assets strengthened or constructed to withstand conditions resulting from climate variability and change: - Km of Irrigation canals	3km Change in asset: no improvement	7km (change 4km) Change in asset: fully improved	Report of delivery of work	Delivery of work accepted by recipient local Authority Risk: unclarity about change in asset improvement required Mitigation: agree on typology and compare to baseline	Baseline, mid-term and end	TBC with UN-Habitat
Output 2.3 Improved water intake structures to increase water supply in the irrigation canals	No. of physical assets strengthened or constructed to withstand conditions resulting from climate variability and change: - Canal intake structures	0	35 strengthened / constructed (in 13 locations)	Report of delivery of work	Delivery of work accepted by recipient local Authority	Baseline, mid-term and end	TBC with UN-Habitat
Output 2.4 Stone-gabions constructed to reinforce canals and protect agriculture lands and Al-what city from flashing floods.	No. of physical assets strengthened or constructed to withstand conditions resulting from climate variability and change: - Reinforced irrigation canals	0	54km Change in asset: fully improved	Report of delivery of work	Delivery of work accepted by recipient local Authority Risk: unclarity about change in asset improvement required	Baseline, mid-term and end	TBC with UN-Habitat

		Change in asset: no improvement			Mitigation: agree on typology and compare to baseline		
Component 3: Innovative adaptation practices for water supply systems							
Outcome 3. Increased innovative, efficient, sustainable and climate change resilient practices to improve the water supply systems for urban and agriculture purposes. (in line with AF outcomes 4 & 8).	Assets produced, developed, improved or strengthened: number of physical infrastructure improved to reduce water stress as the result of climate change - Water supply systems - Wastewater treatment plants	0 0 Change in assets: somewhat improved	1 2 Change in assets: fully improved	Identify physical infrastructure improved; provide photos	Agree on typology and compare to baseline	Baseline, mid-term and end	TBC with UN-Habitat
	Innovations adaptation practices are rolled-out and encouraged at national and / or subnational level through: - Demonstration visits	0	3	Count workshop reports review content	Workshops / guidelines should explain how interventions can be installed, operated, maintained, replicated	Baseline, mid-term and end	TBC with UN-Habitat
Output 3.1 Assessment and verification / technical specification and engineering studies, including surveys required, for water supply alternatives options outlined below	No of tools and guidelines developed and shared with relevant stakeholders: - Detailed engineering studies and designs of below interventions - O & M and exit strategy plan	0 0	3 3	Count number of reports / guidelines and review content	Assessments and specification reports should provide info for technical design of interventions; Guidelines should explain how interventions can be installed, operated, maintained, replicated Risk: studies do not comply with law requirements Mitigation: include in ToR and assess studies with purpose to identify compliance	Baseline, mid-term and end	TBC with UN-Habitat
Output 3.2 Developing efficient and safe water supply alternatives for Al-What, Al-Hawtah, Saber cities and surrounding villages	No. and type of adaptation assets (tangible and intangible) created or strengthened in support of individual or community livelihood strategies - No of water infrastructure assets rehabilitated No. of natural resource assets created, maintained or improved to withstand conditions resulting from climate variability and change (by type and scale) - Improved Water Resources	0 0	1 (total system) 2,500,000 m^3/year	Report of delivery of work	Urban water systems rehabilitated and functioning to provide improved water resources	Baseline, mid-term and end	TBC with UN-Habitat
Output 3.3 Upgrade Tahror WWTP to treat wastewater for use in irrigation	No. of innovative adaptation practices, tools and technologies accelerated, scaled-up and/or replicated - WWTPs	0	1	Report of delivery of work	Wastewater treatment unit is installed in time and function to complete the irrigation system	Baseline, mid-term and end	TBC with UN-Habitat

	No. and type of adaptation assets (tangible and intangible) created or strengthened in support of individual or community livelihood strategies - Ha irrigated by efficient irrigation systems of treated water	 0	 75ha				
Output 3.4 Upgrade Saber WWTP to treat wastewater for use in irrigation	No. of innovative adaptation practices, tools and technologies accelerated, scaled-up and/or replicated - WWTPs No. and type of adaptation assets (tangible and intangible) created or strengthened in support of individual or community livelihood strategies - Ha irrigated by efficient irrigation systems of treated water	 0 0	 1 40ha	Report of delivery of work	Wastewater treatment unit is installed in time and function to complete the irrigation system	Baseline, mid-term and end	TBC with UN-Habitat
Component 4: Improved ownership and capacities at local level to respond to climate change							
Outcome 4 Improved ownership and capacities at local level to respond to climate change, including to operate, maintain and replicate resilient water and irrigation systems. (in line with AF outcome 3)	No. of people with increased capacity to respond to climate change - Female - Youth *elderly and disabled to be considered No. of technical committees / associations transferring climate change adaptation knowledge, incl. plans Female-headed	0 0 0 0 0	1430 30% 20% 22 6	Training/workshop reports and pictures and survey Count on attendance sheets		Baseline, mid-term and end	TBC with UN-Habitat
Output 4.1 Support farmers with modern irrigation techniques and systems (Urban and Rural Areas)	Number of farmers supported with modern irrigation techniques to respond to the impact of climate change - Of which Female - Of which youth *+Consider elderly and disabled	Unknown Unknown Unknown	78HH (514 people) 30 % 10 %	Check procurement Review pictures Survey to check impact		Baseline, mid-term and end	TBC with UN-Habitat
Output 4.2 Develop maintenance plans for canals, irrigation system	No of tools and guidelines developed and shared with relevant stakeholders and: - O&M plan and exit strategy	 0	 1	Review tool/guidelines and relevance		Baseline, mid-term and end	TBC with UN-Habitat
Output 4.3 Strengthen water users associations for improved monitoring, maintenance and dissemination of information on irrigation techniques and skills development	No. of technical committees/associations strengthened/trained to ensure transfer of knowledge - Water Users Association (WUA) - Female-headed WUA	 0 2	 22 (20 people / WUA)[69] 6	Training/workshop reports and pictures Count on attendance sheets		Baseline, mid-term and end	TBC with UN-Habitat
Output 4.4 Skills development with women and youth on water management and climate change adaptation	No of people participating in workshops/trainings - Total Number - Female - Youth	 0 0 0	 250[70] 30% 20%	Training/workshop reports and pictures Count on attendance sheets	Agree on how to assess skills development	Baseline, mid-term and end	TBC with UN-Habitat

[69] Total of 440 individuals

[70] Unique individuals. Assumption that one individual attends 3 trainings/workshop

Output 4.5 Capacity development for communities with a focus on women and youth civil society organizations on integrated and inclusive natural resource management plans	No of people participating in workshops/trainings - Total Number - Female - Youth	 0 0 0	 166[71] 30% 20%	Training/workshop reports and pictures Count on attendance sheets	Agree on how to assess capacity	Baseline, mid-term and end	TBC with UN-Habitat
Output 4.6 Awareness raising with local communities on water conservation and climate change in Aden and the Tuban Delta	Field visits conducted No of people participating in field visits - Total - Female - Youth *+Consdier elderly and disabled	0 0 0 0	3 60 30% 20%	Field visit reports and pictures Count on attendance sheets	Target direct beneficiaries involved in the project	Baseline, mid-term and end	TBC with UN-Habitat

[71] Unique individuals. Assumption that one individual attends 3 trainings/workshop

Table 33 Indicative AF core indicator targets

Impact-level results	Core indicator	Targets		Comment
		Direct	Indirect	
Reduced vulnerability and increased the adaptive capacity of people and water resource systems in the Tuban Delta to respond to the impacts of climate change at local and landscape levels.	AF Core Indicator: No. of beneficiaries Under Component 1	Directly participating workshops/trainings: T: 900 from government W: 30 %	1,255,888	
	AF Core Indicator: No. of beneficiaries: Under Component 2	T: 73317 W: 50 %	1,183,888	
	AF Core Indicator: No. of beneficiaries: Under Component 3	T: 89805 W: 50 %	876,356	
	AF Core Indicator: No. of beneficiaries: Under Component 4	T: 1430 W: 30 %	3,500	
	AF Core Indicator 4.2: Assets produced, developed, improved or strengthened - Physical assets	- Rehabilitated irrigation canals: 58 km - Reinforced irrigation canals: 54 km - Rehabilitated water infrastructure assets: 1 - Rehabilitated wastewater treatment plants: 2		
UN-Habitat DoC 3.2: Improved resource efficiency and protection of ecological assets	Number of partner cities that are implementing resource efficiency policies, plans and standards in urban management	2 (Lahj and Aden)		
UN-Habitat DoC 3.3: Effective adaptation of communities and infrastructure to climate change	Number of partner cities that are implementing strategies, policies, plans and standards aimed at achieving adaptation, mitigation and/or integrated adaption and mitigation to climate change	2 (Lahj and Aden)		

F. PROJECT ALIGNMENT WITH THE RESULTS FRAMEWORK OF THE ADAPTATION FUND

Table 34 Project alignment with the results framework of the AF

Project Objective(s)[1]	Project Objective Indicator(s)	Fund Outcome	Fund Outcome Indicator	Grant Amount (USD)
Reduce vulnerability and increase the adaptive capacity of people and water resource systems in the Tuban Delta to respond to the impacts of climate change at local and landscape levels	Number of people with reduced vulnerability and increased adaptive capacity to climate change as the result of improved physical infrastructure for water-related climate hazards	Outcome 4: Increased adaptive capacity within relevant development sector services and infrastructure assets.	4.2. Physical infrastructure improved to withstand climate change and variability-induced stress.	
Project Outcome(s)	**Project Outcome Indicator(s)**	**Fund Output**	**Fund Output Indicator**	**Grant Amount (USD)**
Enhanced capacities of national and sub-national government institutions, communities and vulnerable groups to manage natural resources (focused on water and land) and respond to climate change risks in the Tuban Delta efficiently, sustainably and in a resilient way	Capacity of national and sub-national government staff to plan for the management of natural resources and respond to climate change is increased: No. of national-level staff - Total - Female No of municipal-level staff - Total - Female	Output 2.1: Strengthened capacity of national and sub-national centers and networks to respond rapidly to extreme weather events.	2.1.1. No. of staff trained to respond to, and mitigate impacts of, climate-related events (by gender)	910.960
Increased adaptive capacity of the water sector through rehabilitation and protection of irrigation systems in the Tuban Delta	Number of irrigation canals improved to withstand climate change and variability-induced stress	Output 4: Vulnerable development sector services and infrastructure assets strengthened in response to climate change impacts, including variability.	4.1.2. No. of physical assets strengthened or constructed to withstand conditions resulting from climate variability and change (by sector and scale)	3.386.066
Increased innovative, efficient, sustainable and climate change resilient practices to improve the water supply systems for urban and agriculture purposes.	Number of innovative adaptation practices and technologies implemented	Output 8: Viable innovations are rolled out, scaled up, encouraged and/or accelerated.	8.1. No. of innovative adaptation practices, tools and technologies accelerated, scaled-up and/or replicated.	2.374.910
Improved ownership and capacities at local level to respond to climate change, including to operate, maintain and replicate resilient water and irrigation systems.	No. of technical committees/associations strengthened to ensure transfer of knowledge	Output 3.2: Strengthened capacity of national and subnational stakeholders and entities to capture and	3.2.1 No. of technical committees/associations formed to ensure transfer of knowledge.	1.668.121

		disseminate knowledge and learning.		

[1] The AF utilized OECD/DAC terminology for its results framework. Project proponents may use different terminology but the overall principle should still apply

G. DETAILED BUDGET

Table 35. Detailed Budget

Project Components	Expected Concrete Outputs	Expected Concrete Outcomes	TOTAL	Year 1 12 m	Year 2 12 m	Year 3 12 m	Year 4 6 m	% total
1. Integrated and inclusive natural resource management for climate-resilient water systems	1.1.Government capacity strengthened at national and sub-national level on increasing climate change resilience and effective water management	1. Enhanced capacities of national and sub-national government institutions, communities and vulnerable groups to manage natural resources (focused on water and land) and respond to coastal CC risks in the Tuban Delta efficiently, sustainably and in a resilient way	188.800	52.640	62.640	59.760	13.760	1,9%
	1.2 Establishment of laboratory for wastewater quality testing and water supply quality testing		299.720	299.720	-	-	-	3,0%
	1.3 Integrated and inclusive natural resource (focused on water and land) and climate change risk management process and plan		422.440	123.332	165.332	96.888	36.888	4,2%
	TOTAL		**910.960**	475.692	227.972	156.648	50.648	9,1%
2. Increased adaptive capacity of the water sector	2.1 Assessment and verification / technical specification and engineering studies, including surveys required for improved irrigation canals and water intake systems	2. Increased adaptive capacity of the water sector through rehabilitation and protection of irrigation systems in the Tuban Delta	60.000	60.000	-	-	-	0,6%
	2.2 Rehabilitated irrigation canals to improve water access for agricultural purposes in the Tuban		1.665.216	-	1.665.216	-	-	16,7%
	2.3 Improved water intake structures to increase water supply in the irrigation canals		88.500	-	88.500	-	-	0,9%
	2.4 Stone-gabions constructed to reinforce canals and protect agriculture lands and Al-what city from flashing floods.		1.572.350	-	1.572.350	-	-	15,7%
	TOTAL		**3.386.066**	60.000	3.326.066	-	-	33,9%
3. Innovative adaptation practices for water supply systems	3.1 Assessment and verification / technical specification and engineering studies, including surveys required, for water supply alternatives options outlined below	3. Increased innovative, efficient, sustainable and climate change resilient practices to improve the water supply systems for urban and agriculture purposes	45.000	45.000	-	-	-	0,5%
	3.2 Developing efficient and safe water supply alternatives for Al-What, Al-Hawtah, Saber cities and surrounding villages		1.569.400	-	1.569.400	-	-	15,7%
	3.3 Upgrade Tahror WWTP to treat wastewater for use in irrigation		400.020	50.000	350.020	-	-	4,0%
	3.4 Upgrade Saber WWTP to treat wastewater for use in irrigation		360.490	-	360.490	-	-	3,6%
	TOTAL		**2.374.910**	95.000	2.279.910	-	-	23,8%
4. Improved ownership and capacities at local level to respond to climate change	4.1 Support farmers with modern irrigation techniques and systems (Urban and Rural Areas)	4. Improved ownership and capacities at local level to respond to climate change, including to operate, maintain and replicate resilient water and irrigation systems	854.721	20.000	834.721	-	-	8,5%
	4.2 Develop maintenance plans for canals, irrigation system		155.760	-	53.504	79.880	22.376	1,6%
	4.3 Strengthen water user associations for improved monitoring, maintenance and dissemination of information on irrigation techniques and skills development		292.640	69.392	113.856	109.392	-	2,9%

	4.4 Skills development with women and youth on water management and climate change adaptation		141.600	42.480	52.640	46.480	-	1,4%
	4.5 Capacity development for communities with a focus on women and youth civil society organizations on integrated natural resource management plans		94.400	41.760	37.760	14.880	-	0,9%
	4.6 Awareness raising with local communities on water conservation and climate change in Aden and the Tuban Delta		129.000	28.700	48.700	39.800	11.800	1,3%
	TOTAL		**1.668.121**	202.332	1.141.181	290.432	34.176	16,7%
Sub-total Project Components Costs			**8.340.057**	833.024	6.975.129	447.080	84.824	83,4%
Project Execution Costs	Consultants		611.520	195.120	184.920	144.120	87.360	
	Tavel		20.706	5.916	5.916	5.916	2.958	
	Operations		178.200	61.200	41.200	41.200	34.600	
	audit		15.000				15.000	
	Terminal evaluation		50.000				50.000	
Sub-total Project Execution Fee		9,50%	**875.426**	262.236	232.036	191.236	189.918	8,8%
SUB-TOTAL Component + execution fee			**9.215.483**	1.095.260	7.207.165	638.316	274.742	92,2%
Project Cycle Management Fee	UN-H ROAS Project Support Costs	1,40%	128.777	15.305	100.713	8.920	3.839	
	UN-H HQ Project Support Costs	7,10%	654.299	77.763	511.709	45.320	19.507	
Sub-total Project Cycle Managament Fee		8,50%	**783.077**	93.069	612.422	54.240	23.346	7,8%
Amount of Financing Requested			**9.998.560**	**1.188.329**	**7.819.588**	**692.557**	**298.088**	**100,0%**

Table 36 Budget notes

Component	Output	Activities	Notes / Staff	%	TOTAL	Year 1	Year 2	Year 3	Year 4		No.	Unit	Rate USD	Year 1	Year 2	Year 3	Year 4	T
														12	12	12	6	42
Project component 1																		
1. Integrated and inclusive natural resource management for climate-resilient water systems	1.1.Government capacity strengthened at national and sub-national level on increasing climate change resilience and effective water management	Trainings	16 trainings with 25 participants each		**80.000**	20.000	30.000	30.000	-		1	no	5.000	4	6	6		**16**
		Workshops	20 workshops with 25 people each		**80.000**	24.000	24.000	24.000	8.000		1	no	4.000	6	6	6	2	**20**
		Technical support	Expertise needed to implement above		**28.800**	8.640	8.640	5.760	5.760		1	Item	28.800	0,3	0,3	0,2	0,2	**1**
	Sub-total				**188.800**	**52.640**	**62.640**	**59.760**	**13.760**									
	1.2. Establishment of laboratory for wastewater quality testing and water supply quality testing	Establish 1 lab	For wastewater quality testing at LWSC-Lahj (Instruments, tools and furnisher). Time needed: 16 months		**141.000**	141.000	-	-	-		1	Item	141.000	1				**1**
		Establish 1 lab	For water supply quality testing at LWSC-Lahj (Instruments, tools and furnisher). Time needed: 16 months		**113.000**	113.000	-	-	-		1	Item	113.000	1				**1**
		Technical support	Expertise needed to implement above		**45.720**	45.720	-	-	-		1	Item	45.720	1				**1**
	Sub-total				**299.720**	**299.720**	**-**	**-**	**-**									
	1.3.Integrated and inclusive natural resource (focused on water and land) and climate change risk	Field workshops	57 workshops with 20 participants each (Water Users Associations, community organisations, women's and youth groups in Tuban Delta		**114.000**	20.000	54.000	40.000	-		1	no	2.000	10	27	20		**57**

	management process and plan	Workshops	13 workshops with 20 participants each		**52.000**	12.000	20.000	20.000	-		1	no	4.000	3	5	5		**13**
		Technical expert (international)	International expert on climate change adaptation and water resource management		**128.000**	48.000	48.000	16.000	16.000		1	Months	8.000	6	6	2	2	**16**
		Technical expert (national)	National Expert on climate change adaptation and water resource management		**64.000**	24.000	24.000	8.000	8.000		1	Months	4.000	6	6	2	2	**16**
		Technical support	Expertise needed to implement above		**64.440**	19.332	19.332	12.888	12.888		1	Item	64.440	0,3	0,3	0,2	0,2	**1**
	Sub-total				**422.440**	**123.332**	**165.332**	**96.888**	**36.888**									
TOTAL Component 1				**9,1%**	**910.960**	**475.692**	**227.972**	**156.648**	**50.648**									
Project component 2																		
2. Increased adaptive capacity of the water sector	2.1. Assessment and verification / technical specification and engineering studies, including surveys required for improved irrigation canals and water intake systems	Technical study for output 2.2.	Detailed engineering study and tender documents for the project, incl. technical specifications		**20.000**	20.000	-	-	-		1	no	20.000	1				**1**
		Technical study for output 2.3.	Detailed engineering study and tender documents for the project, incl. technical specifications		**20.000**	20.000	-	-	-		1	no	20.000	1				**1**
		Technical study for output 2.4.	Detailed engineering study and tender documents for the project, incl. technical specifications		**20.000**	20.000	-	-	-		1	no	20.000	1				**1**
	Sub-total				**60.000**	**60.000**	**-**	**-**	**-**									
	2.2. Rehabilitated Irrigation canals to improve water access for agricultural purposes in the Tuban	Concrete works for canal intake structure, diversions, small box culvert and protection works.	Unit: m3; quantity: 2135; unit cost: UDS500; time needed: 18 months		**1.067.500**	-	1.067.500	-	-		1	m3	500		2135			**2135**
		Supply and install lifting system + steel gates for intakes of main canals and diversions.	Unit: no; quantity: 35 (13 locations); unit cost: UDS2.500; time needed: 12 months		**87.500**	-	87.500	-	-		1	no	2.500		35			**35**
		Repair and maintenance of the lifting system and steel gates and steel handrails over the intakes of canals.	Unit: no; quantity: 20; unit cost: UDS1.800; time needed: 12 months		**36.000**	-	36.000	-	-		1	no	1.800		20			**20**
		Removal of deposited soil from canal intake structure and along the canal and earth works	Unit: m3; quantity: 73400; unit cost: UDS3; time needed: 12 months		**220.200**	-	220.200	-	-		1	m3	3		73400			**73400**
		Technical support	Expertise needed to implement above		**254.016**	-	254.016	-	-		1	Item	254.016		1			**1**
	Sub-total				**1.665.216**	**-**	**1.665.216**	**-**	**-**									
	2.3. Improved water intake structures to increase water supply in the irrigation canals	Construct, supply and install automatic wadi flow gauging station at Dukeim (old stream gauging station)	Unit: BoQ; quantity: 1; unit cost: USD75.000; time needed: 9 months		**75.000**	-	75.000	-	-		1	BoQ	75.000		1			**1**
		Technical support	Expertise needed to implement above		**13.500**	-	13.500	-	-		1	item	13.500		1			**1**
	Sub-total				**88.500**	**-**	**88.500**	**-**	**-**									
	2.4. Stone-gabions constructed to reinforce canals and protect agriculture lands and Al-what city from flashing floods	Construction of stone-gabions works for protection of irrigation canals, agriculture lands and Al-what city from flashing floods.	Unit: m3: quantity: 20.500; unit cost: UDS50; time needed: 18 months. Includes hybrid option with greening		**1.332.500**	-	1.332.500	-	-		1	m3	65		20500			**20500**
		Technical support	Expertise needed to implement above		**239.850**	-	239.850	-	-		1	Item	239.850		1			**1**
	Sub-total				**1.572.350**	**-**	**1.572.350**	**-**	**-**									

TOTAL Component 2				**33,9 %**	**3.386.066**	**60.000**	**3.326.066**	**-**	**-**									
Project component 3																		
3. Innovative adaptation practices for water supply systems	3.1. Assessment and verification / technical specification and engineering studies, including surveys required, for water supply alternatives options outlined below	Technical study for output 3.2.	Detailed engineering study and tender documents for the project, incl. technical specifications		**15.000**	15.000	-	-	-		1	Item	15.000	1				**1**
		Technical study for output 3.3.	Detailed engineering study and tender documents for the project, incl. technical specifications		**15.000**	15.000	-	-	-		1	Item	15.000	1				**1**
		Technical study for output 3.4.	Detailed engineering study and tender documents for the project, incl. technical specifications		**15.000**	15.000	-	-	-		1	Item	15.000	1				**1**
					-	-	-	-	-									**0**
	Sub-total				**45.000**	**45.000**	**-**	**-**	**-**									
	3.2. Developing efficient and safe water supply alternatives for Al-What, Al-Hawtah, Saber cities and surrounding villages	Rehabilitation of buildings and accessories of the pumping station for Al-Waht City.	Unit: BoQ; quantity:3; unit cost: USD55.000; time needed: 12 months		**165.000**	-	165.000	-	-		1	BoQ	55.000		3			**3**
		Construction of Ground Tank made of RCC/stone masonry with capacity of 2000 m3, including the pipings and pups and solar energy	Unit: no; quantity:4; unit cost: USD200 per m2; capacity of 1000m3; time needed: 12 months		**800.000**	-	800.000	-	-		1	no	200.000		4			**4**
		Supply and install seven vertical pumping units for re-pumping station (Magrs nagy wellfield to Al-Hwtah) with all required accessories	Unit: no; quantity:7; unit cost: USD45.000; time needed: 6 months		**315.000**	-	315.000	-	-		1	no	45.000		7			**7**
		Supply and install PV system (33 KwH)	Unit: BoQ: 100 solar panels (550 watt each). All inclusive installation cost/panel: USD500); time needed: 6 months		**50.000**	-	50.000	-	-		1	BoQ	500		100			**100**
		Technical support	Expertise needed to implement above		**239.400**	-	239.400	-	-		1	Item	239.400		1			**1**
	Sub-total		.		**1.569.400**	**-**	**1.569.400**	**-**	**-**									
	3.3. Upgrade Tahror WWTP to treat wastewater for use in irrigation	Remove the sludge and trees from the ponds and the plant.	Unit: m3; quantity:10.000; unit cost: USD5; time needed: 6 months		**50.000**	50.000	-		-		1	m3	5	10.000				**10000**
		Install flow measuring device at the inlet chanel to the plant.	Unit: no; quantity:1; unit cost: USD5.000; time needed: 6 months		**5.000**	-	5.000		-		1	no	5.000		1			**1**
		Supply emergency pumping unit	Unit: no; quantity:1; unit cost: USD15.000; time needed: 6 months		**15.000**	-	15.000		-		1	no	15.000		1			**1**
		Supply and Install steel coated mesh fence around the plant including concrete foundation, steel columns and main steel door.	Unit: ml; quantity: 600; unit cost: USD65; time needed: 6 months		**39.000**	-	39.000		-		1	ml	65		600			**600**
		Construction of Ground Tank made of RCC/stone masonry with capacity of 1000 m3	Unit: no; quantity: 1; unit cost: USD200 per m2; capacity: 1000m3; time needed: 6 months		**200.000**	-	200.000	-	-		1	no	200.000		1			**1**
		Connection pipes and irrigation channels	Unit: no; quantity: 1; unit cost: USD30.000; time needed: 6 months		**30.000**	-	30.000		-		1	no	30.000		1			**1**
		Technical support	Expertise needed to implement above		**61.020**	-	61.020		-		1	Item	61.020		1			**1**
	Sub-total		.		**400.020**	**50.000**	**350.020**	**-**	**-**									
	3.4. Upgrade Saber WWTP to treat	Install flow measuring device at the inlet chnnel to the plant.	Unit: no; quantity:1; unit cost: USD5.000; time needed: 3 months		**5.000**	-	5.000		-		1	no	5.000		1			**1**

	wastewater for use in irrigation	Supply emergency pumping unit	Unit: no; quantity:1; unit cost: USD15.000; time needed: 6 months		**15.000**	-	15.000		-		1	no	15.000		1			**1**
		Supply and Install discharge pipe	Unit: ml; quantity: 700; unit cost: USD65; time needed: 6 months		**45.500**	-	45.500		-		1	ml	65		700			**700**
		Rehabilitate guard room	Unit: BoQ; quantity:1; unit cost: USD4.000; time needed: 6 months		**4.000**	-	4.000		-		1	BoQ	4.000		1			**1**
		Rehabilitate pumping house.	Unit: BoQ; quantity:1; unit cost: USD6.000; time needed: 6 months		**6.000**	-	6.000		-		1	BoQ	6.000		1			**1**
		Construction of Ground Tank made of RCC/stone masonry with capacity of 1000 m3	Unit: no; quantity: 1; unit cost: USD200 per m2; capacity: 1000m3; time needed: 6 months		**200.000**	-	200.000	-	-		1	no	200.000		1			**1**
		Connection pipes and irrigation channels	Unit: no; quantity: 1; unit cost: USD30.000; time needed: 6 months		**30.000**	-	30.000		-		1	no	30.000		1			**1**
		Technical support	Expertise needed to implement above		**54.990**	-	54.990		-		1	Item	54.990		1			**1**
	Sub-total		.		**360.490**	**-**	**360.490**	**-**	**-**									
TOTAL Component 3				**23,8 %**	**2.374.910**	**95.000**	**2.279.910**	**-**	**-**									
Project component 4																		
4. Improved ownership and capacities at local level to respond to climate change	4.1 Support farmers' with modern irrigation techniques and system (Urban and Rural Areas) (Agriculture and Irrigation Office - Lahj)	Support farmers' with modern irrigation techniques and system (Urban and Rural Areas) using bubbler irrigation techniques	Unit: ha; quantity: 117; unit cost: USD6.020; includes 'horizontal' solar pumps. time needed: 24 months		**704.340**	-	704.340	-	-		1	ha	6.020		117			**117**
		Technical study	Detailed engineering study and tender documents for the project, incl. technical specifications		**20.000**	20.000						item	20.000	1				**1**
		Technical support	Expertise needed to implement above		**130.381**	-	130.381	-	-		1	Item	130.381		1			**1**
	Sub-total				**854.721**	**20.000**	**834.721**	**-**	**-**									
	4.2 Develop maintenance plans for canals, irrigation system and wastewater treatment plants and KM of all components	Workshops	10 workshops with 25 people each		**40.000**	-	20.000	20.000	-		1	no	4.000		5	5		**10**
		Technical expert (national)	National Expert on maintenance of canal and irrigations systems		**72.000**	-	24.000	48.000	-		1	Months	4.000		6	12		**18**
		Guidelines and knowledge management materials	Guidelines for on-going maintenance of canal and irrigation systems		**20.000**	-			20.000			item	20.000				1	
		Technical support	Expertise needed to implement above		**23.760**	-	9.504	11.880	2.376		1	Item	23.760		0,4	0,5	0,1	**1**
	Sub-total				**155.760**	**-**	**53.504**	**79.880**	**22.376**									
	4.3 Strengthen water users associations for improved monitoring, maintenance and dissemination of information on irrigation techniques and skills development	Trainings	22 trainings for Water Users Associations		**88.000**	16.000	36.000	36.000	-		1	no	4.000	4	9	9		**22**
		Workshops	22 workshops		**88.000**	16.000	36.000	36.000	-		1	no	4.000	4	9	9		**22**
		Technical expert (national)	National Expert with expertise on climate-resilient irrigation techniques and skills development		**72.000**	24.000	24.000	24.000	-		1	Months	4.000	6	6	6		**18**
		Technical support	Expertise needed to implement above		**44.640**	13.392	17.856	13.392	-		1	Item	44.640	0,3	0,4	0,3		**1**
	Sub-total				**292.640**	**69.392**	**113.856**	**109.392**	**-**									
	4.4 Skills development with women and youth on water management	Trainings	20 trainings for 25 people each		**80.000**	24.000	28.000	28.000	-		1	no	4.000	6	7	7		**20**
		Workshops	10 workshops with 25 people each		**40.000**	12.000	16.000	12.000	-		1	no	4.000	3	4	3		**10**

	and climate change adaptation	Technical support	Expertise needed to implement above		**21.600**	6.480	8.640	6.480	-		1	Item	21.600	0,3	0,4	0,3		**1**
	Sub-total				**141.600**	**42.480**	**52.640**	**46.480**	**-**									
	4.5 Capacity development for communities with a focus on women and youth civil society organizations on integrated and inclusive natural resource management plans	Trainings	10 trainings for 25 people each		**40.000**	20.000	20.000	-	-		1	no	4.000	5	5			**10**
		Workshops	10 workshops with 25 people each		**40.000**	16.000	12.000	12.000	-		1	no	4.000	4	3	3		**10**
		Technical support	Expertise needed to implement above		**14.400**	5.760	5.760	2.880	-		1	Item	14.400	0,4	0,4	0,2		**1**
	Sub-total				**94.400**	**41.760**	**37.760**	**14.880**	**-**									
	4.6 Awareness raising with local communities on water conservation and climate change in Aden and the Tuban Delta	Communications material	10 communications products		**50.000**	10.000	20.000	20.000	-		10	no	5.000	2	4	4		**10**
		Field visits	3 Field visits for awareness raising with local communities		**30.000**	-	10.000	10.000	10.000		1	no	10.000		1	1	1	**3**
		Technical expert (national)	Communications consultant to develop strategy and communications products		**40.000**	16.000	16.000	8.000			1	Months	4.000	4	4	2		**10**
		Technical support	Expertise needed to implement above		**9.000**	2.700	2.700	1.800	1.800		1	Item	9.000	0,3	0,3	0,2	0,2	**1**
	Sub-total				**129.000**	**28.700**	**48.700**	**39.800**	**11.800**									
TOTAL Component 4				**16,7 %**	**1.668.121**	**202.332**	**1.141.181**	**290.432**	**34.176**									
TOTAL Components				83%	8.340.057	833.024	6.975.129	447.080	84.824									
Project execution costs																		
Project execution		Project team	Project execution supervisor (climate change; safeguards/ESMP, etc. (international)	50%	**214.200**	81.600	71.400	30.600	30.600		1	Month	10.200	8	7	3	3	**21**
			Project coordinator(s) (national)	100%	**172.200**	49.200	49.200	49.200	24.600		1	Month	4.100	12	12	12	6	**42**
			Project admin / finance (national)	100%	**126.000**	36.000	36.000	36.000	18.000		1	Month	3.000	12	12	12	6	**42**
			Project monitoring	50%	**99.120**	28.320	28.320	28.320	14.160		1	Month	4.720	6	6	6	3	**21**
		Travel	International travel		**20.706**	5.916	5.916	5.916	2.958		1	Mission	2.958	2	2	2	1	**7**
		Operations in Yemen	Inception and completion workshops		**8.000**	4.000	-	-	4.000		1	workshop	4.000	1			1	**2**
			Project execution meetings		**14.000**	4.000	4.000	4.000	2.000		1	Meeting	1.000	4	4	4	2	**14**
			Office Rental Cost in Aden	25%	**46.200**	13.200	13.200	13.200	6.600		1	Month	4.400	3	3	3	1,5	**10,5**
			Office security costs in Aden	25%	**21.000**	6.000	6.000	6.000	3.000		1	Month	2.000	3	3	3	1,5	**10,5**
			Common Services Cost Share	25%	**15.750**	4.500	4.500	4.500	2.250		1	Month	1.500	3	3	3	1,5	**10,5**
			Communication and knowledge management (inc. pre- and post-project video)		**20.000**	10.000	-	-	10.000		1	Item	10.000	1			1	**2**
			Vehicle rental and transportation for project only	100%	**31.500**	9.000	9.000	9.000	4.500		1	Month	750	12	12	12	6	
			Office Operating Costs	25%	**15.750**	4.500	4.500	4.500	2.250		1	Month	1.500	3	3	3	1,5	**10,5**

		Equipment (computers)		**6.000**	6.000	-	-	-		1	Per item	2.000	3	0	0	0	**3**
	Audits	Audits		**15.000**	-	-	-	15.000		1	Item	15.000				1	**1**
	Terminal evaluation	Independent (lump sum)		**50.000**	-	-	-	50.000		1	Item	50.000				1	**1**
TOTAL Execution costs	**9,50%**		**8,8%**	**875.426**	**262.236**	**232.036**	**191.236**	**189.918**									
TOTAL Project costs				**9.215.483**	**1.095.260**	**7.207.165**	**638.316**	**274.742**									
				100,00%	11,88%	78,21%	6,93%	2,98%									
Project cycle management fee costs																	
Project cycle management	**1,25%**	UN-H ROAS Project oversight (P4)	2%	**20.580**	2.446	16.095	1.425	614		1	Month	24.500	0,1	0,7	0,1	0,0	**0,8**
		UN-H ROAS PMO	3%	**17.136**	2.037	13.402	1.187	511		1	Month	13.600	0,1	1,0	0,1	0,0	**1,3**
		UN-H ROAS PMA	30%	**77.238**	9.180	60.406	5.350	2.303		1	Month	6.130,00	1,5	9,9	0,9	0,4	**12,6**
		Total		**114.954**	13.662	89.902	7.962	3.427									
	0,15%	UN-H ROAS M & E (esp ESP and GP), incl. Travel	0.15 %	**13.823**	1.643	10.811	957	412									
	7,1%	UN-H HQ PSC - Overall project supervision, incl .compliance to UN-H and AF policies (gender, human rights, climate change, etc.).	7,1%	654.299	77.763	511.709	45.320	19.507									
TOTAL management fee	**8,50%**		**7,8%**	783.077	93.069	612.422	54.240	23.346									
TOTAL amount of financing requested				**9.998.560**	**1.188.329**	**7.819.587**	**692.556**	**298.088**									

H. DISBURSEMENT SCHEDULE

Table 37. Disbursement Schedule

	Year 1	**Year 2**	**Year 3**	**Year 4**
Schedule	1st disbursement	2nd disbursement – One year after project inception	3rd disbursement – Two years after project inception	4th disbursement – Three years after project inception
Milestones	Upon agreement signature	Upon finalization of First Annual Report & financial report indicating disbursement of at least 70% of funds from the 1st year	Upon finalization of Second Annual Report & financial report indicating disbursement of at least 70% of funds from the 2nd year	Upon finalization of Third Annual Report & financial report indicating disbursement of at least 70% of funds from the 3rd year

	Upon Signing	One Year after project inception	Two years after project inception	Three years after project inception
A. Project Funds (US$)	833.024	6.975.129	447.080	84.824
B. Programme Execution (US$)	262.236	232.036	191.236	189.918
C. Programme Cycle Mgmt (US$)	93.069	612.422	54.240	23.346
TOTAL (US$)	1.188.329	7.819.588	692.557	298.088

A. Record of endorsement on behalf of the government[2]

Mr. AbdulWahid Omar Arman AF Designated Authority Ministry of Environment and Water	Date: *(30 June 2024)*

Republic of Yemen
Ministry of Water & Environment

الجمهورية اليمنية
وزارة المياه والبيئة

الرجيع:

التاريخ:

Letter of Endorsement by government

06,30,2024

To: Adaptation Fund Board
c/ Adaptation Fund Board Secretariat
Email: Secretariat@Adaptation-Fund.org
Fax: 202 522 3240/5

Subject: Endorsement for the project: Increase climate change resilience to water scarcity and flooding in the Tuban Delta.'

In my capacity as the designated authority for the Adaptation Fund in Yemen, I confirm that the above single-country project proposal is in accordance with the government's priorities, especially those in the INDC, TNA, and TNC, It directly addresses the critical need to reduce the adverse impacts and risks posed by climate change in the Tuban Delta.

Accordingly, I am pleased to endorse the above project proposal with support from the Adaptation Fund. If approved, the project will be implemented by UN-Habitat. Execution entities include the Ministry of Water and Environment (MWE), and other execution entities that will be identified through a tendering as part of the procurement process.

Sincerely,

Mr. AbdulWahid Omar Arman

AF Designated Authority
Ministry of Water and Environment

Yemen – Aden www.mwe-ye.org E-mail: mwe@mwe-ye.org

B. Implementing Entity certification

I certify that this proposal has been prepared in accordance with guidelines provided by the Adaptation Fund Board, and prevailing National Development and Adaptation Plans (including the INDC, TNA and TNC) and subject to the approval by the Adaptation Fund Board, commit to implementing the project/programme in compliance with the Environmental and Social Policy of the Adaptation Fund and on the understanding that the Implementing Entity will be fully (legally and financially) responsible for the implementation of this project/programme.	
 Rafael Tuts, Director, Global Solutions Division Implementing Entity Coordinator	
Date: 07/19/2024	Tel. and email: +254-713-601278; raf.tuts@un.org
Project Contact Person: Muslim Qazimi; Joris Oele	
Tel. And Email: muslim.qazimi@un.org Joris.oele@un.org	

ANNEXES

Annex 1: Climate Change Vulnerability Assessment Report for the Tuban Delta, Yemen

1. PROJECT INTRODUCTION AND VULNERABILITY ASSESSMENT SUMMARY

This study was completed as 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. 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.

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 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. 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.

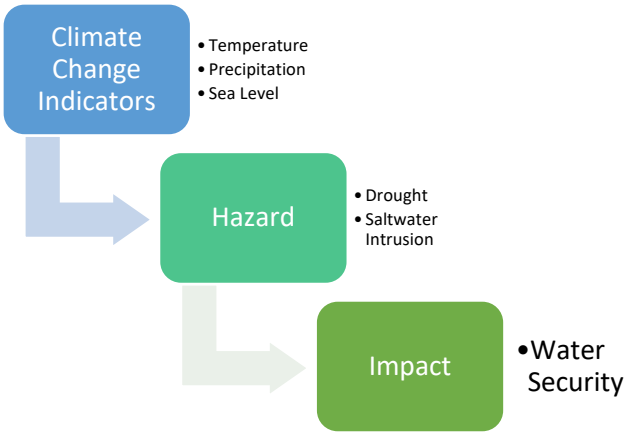


Figure 26. Climate Change Indicators, Hazard and Impact for Water Security

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

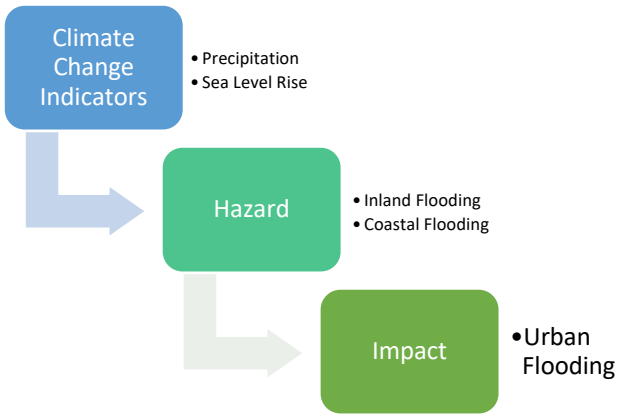


Figure 27. Climate Change indicators, hazards, and impacts for flooding

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.

Table 38. Adapted from Table 36 Urban Flood Risk Assessment for Tuban Delta from Hydrology Study

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

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 Infrastructure Assets**	**# of People**	**# of critical Ecosystems**	**Infrastructure**	**People**	**Ecosystems**	**CC Knowledge**	**Plans**	**Financial Assistance**
3	>10	>500,000	>5	Critical infrastructure of regional importance at risk	People living in IDP camps; people living in informal settlements at risk; elderly; disabled; women and children	Endangered ecosystems or species	Limited	0	None
2	5 to 10	100,000 to 499,999	1 to 5	Critical infrastructure 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. primarily for men or certain groups such as farmers
1	<5	>100,000	0	No critical infrastructure at risk	Elderly; disabled; women and children		High	At least 2	Accessible 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, and the same scoring scale as flooding was utilized.

	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 10-33% of households not linked to water grid	0 to 20 MCM	10-25% 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

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 km^2 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.

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.

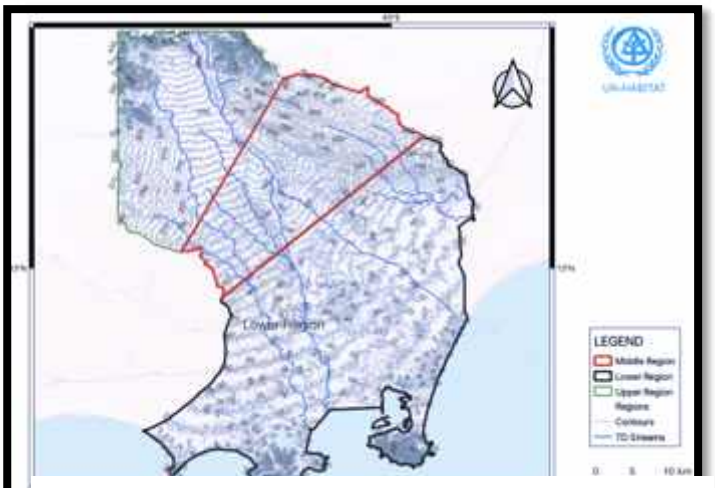


Figure 28. The three regions of the Tuban Delta and major streams and elevation. UN-Habitat, 2023.

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. [72]

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.[73] 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. 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.[74] 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.

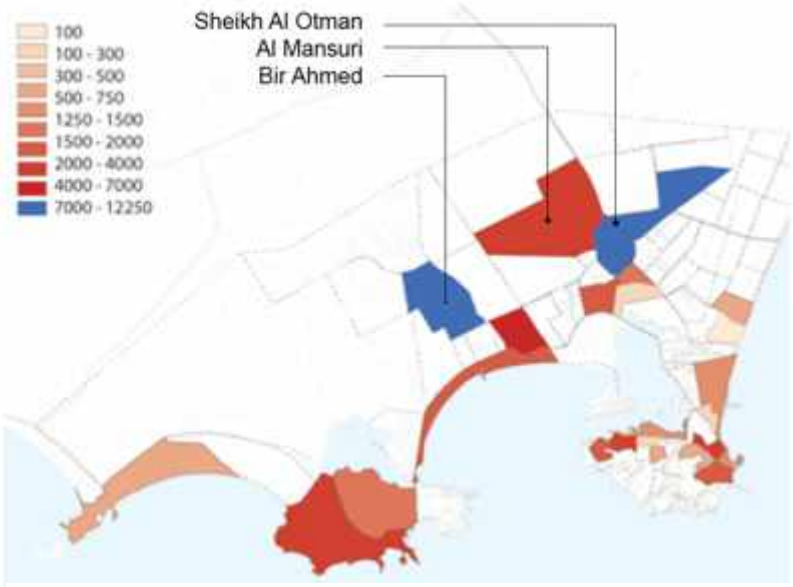


Figure 29. IDPs residing in regular accommodation in Aden, Yemen. UN-Habitat, 2019.

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.

[72] UN-Habitat (2020) Aden City Profile
[73] UN-Habitat (2020) Aden City Profile
[74] 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.

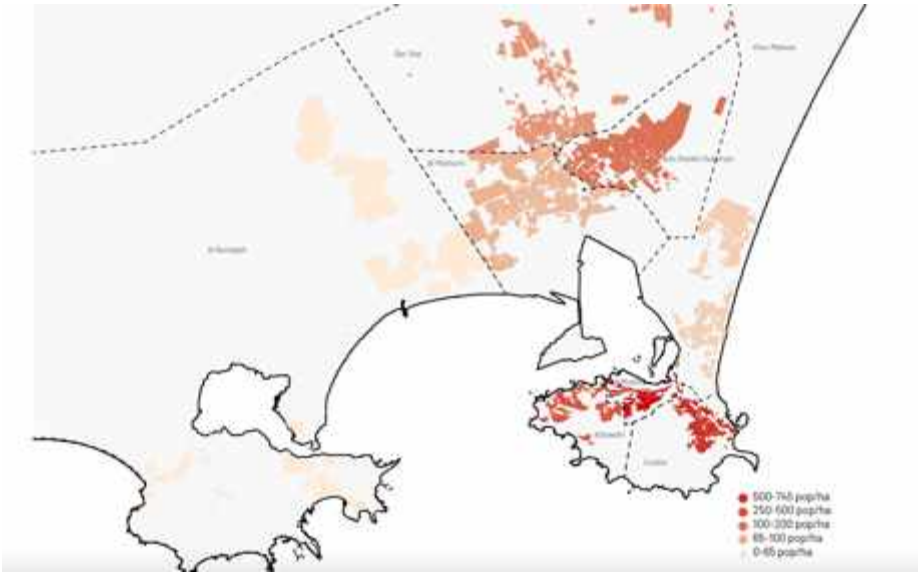


Figure 30 Urban densities in districts in Aden. UN-Habitat, 2019.

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. 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.

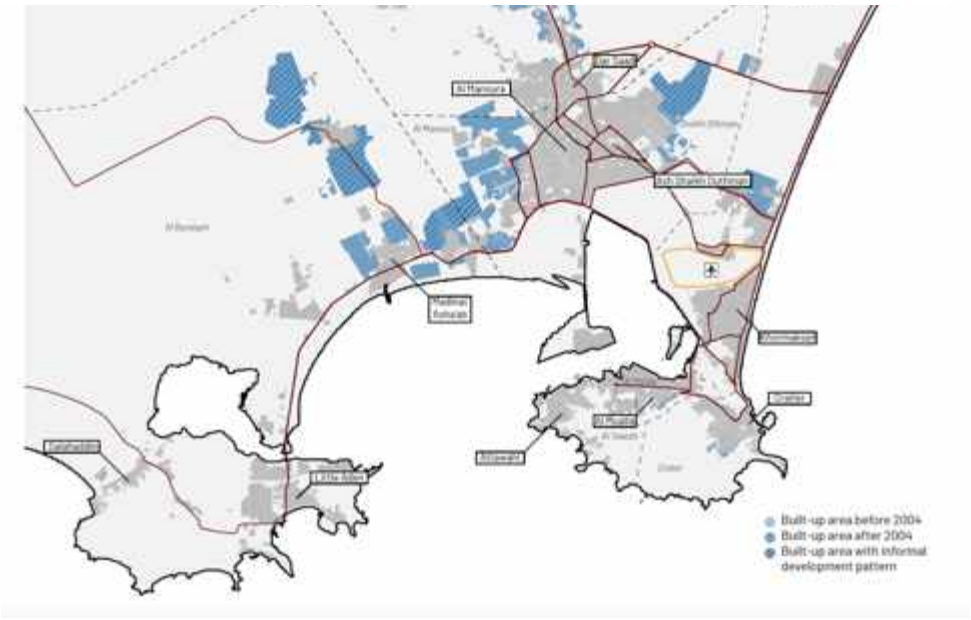


Figure 31. Population, density, and built-up area per district in Aden. UN-Habitat, 2019.

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.

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 Crater, UN-Habitat (2019). According to UNESCO field surveys, over 95% of heritage sites in the city have sustained significant damages from conflict related causes.

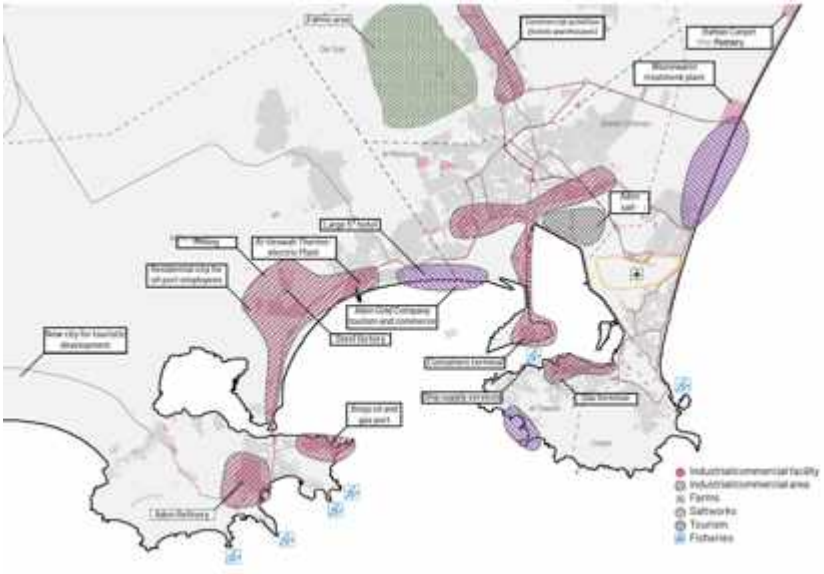


Figure 32. Aden production zones. UN-Habitat, 2019.

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, mudflats, marshes and beaches and are habitats for many bird species.[75] There are many pressures on wetland ecosystems in the Aden area, 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.[76]

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.[77] 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.[78]

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.[79] However, oil and gas production has slowed due to the conflict. 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.[80]

For the Tuban District of the Lahj Governorate in the Lower Region, 70 percent of the population works in agriculture but this only represents 75 percent of their income and the remaining 25 percent is supplemented by informal and irregular daily work. In Aden, around 7 percent of population work in agriculture, but this is only 50 percent of their income source, while the remaining 50 percent comes from irregular, informal daily work.

[75] https://www.equatorinitiative.org/wp-content/uploads/2017/05/Al-Heswa-Yemen.pdf
[76] UN-Habitat (2020) Aden City Profile
[77] https://www.equatorinitiative.org/wp-content/uploads/2017/05/Al-Heswa-Yemen.pdf
[78] UN-Habitat (2020) Aden City Profile
[79] 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
[80] UN-Habitat (2020) Aden City Profile

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.[81] 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.[82] 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.

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.

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.

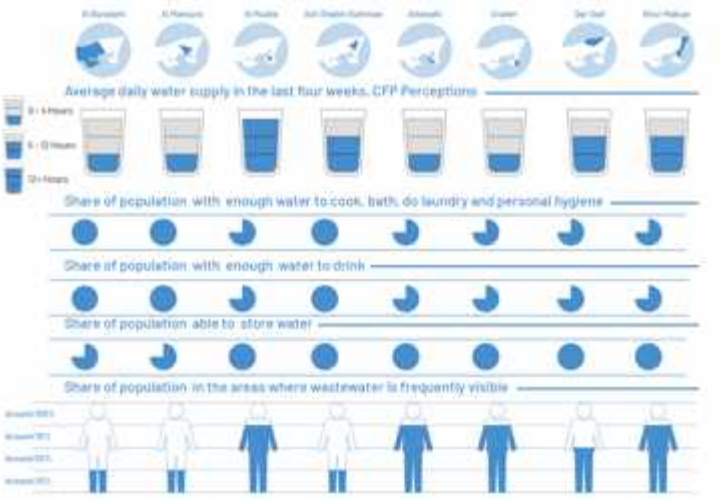


Figure 33. Availability of WASH Services in Aden City. UN-Habitat,

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 Craiter), 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 Craiter) 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, Craiter and Khur Maksar reported that wastewater is frequently visible; due to non-functioning pumps and intermittent electricity.[83]

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.

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.[84]

---

[81] *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).*

[82] UN-Habitat (2020) Aden City Profile

[83] UN-Habitat (2020) Aden City Profile

[84] UN-Habitat (2020) Aden City Profile

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.[85]

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 Craiter.

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.

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. 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%. [86] 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.[87]

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.

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.[88] A full breakdown is portrayed in the figure below.

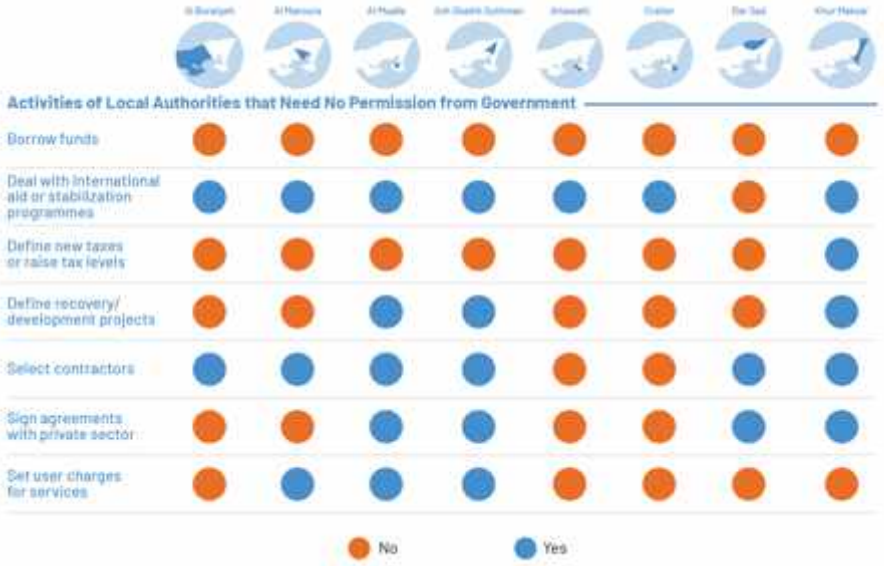


Figure 34 Which local authority activities in Aden require permission from the central government. UN-Habitat, 2019.

[85] UN-Habitat (2020) Aden City Profile
[86] *Save the Children, Yemen Education Cluster, Joint Education Needs Assessment Report, Aden – Yemen, (2016).*
[87] UN-Habitat (2020) Aden City Profile
[88] 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.[89]

3.2 Middle Region of the Tuban Delta

The Middle Region of the Tuban Delta is located in the Lahj Governorate. The area covers 570 km^2 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. 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.

Figure 35. Map of the three regions and Lahj Governorate. UN-Habitat, 2023.

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. 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[90]. The Humanitarian Needs Overview (HNO) conducted in 2019 found that there are 7,356 IDPs in Al

[89] UN-Habitat (2020) Aden City Profile
[90] https://data.unhcr.org/en/country/yem#_ga=2.51079209.1447391314.1679905938-1498650503.1679905938

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.

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

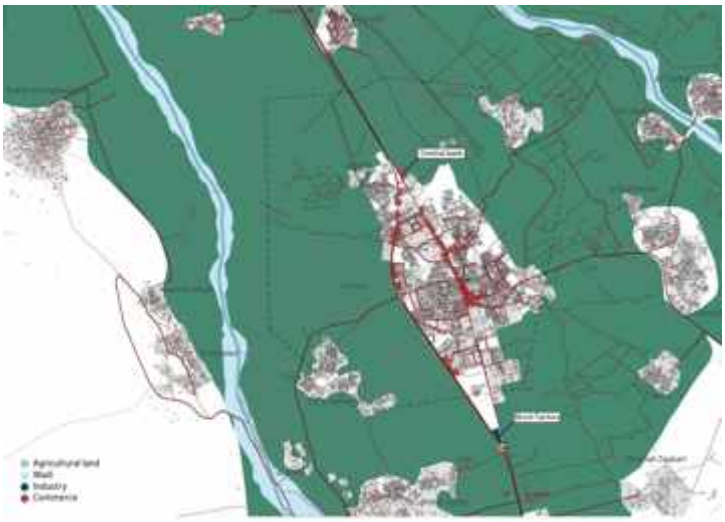


Figure 36. Agricultural Land and Industrial and Commercial Activities in Al Hawtah. UN-Habitat, 2019.

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.

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.

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. 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).

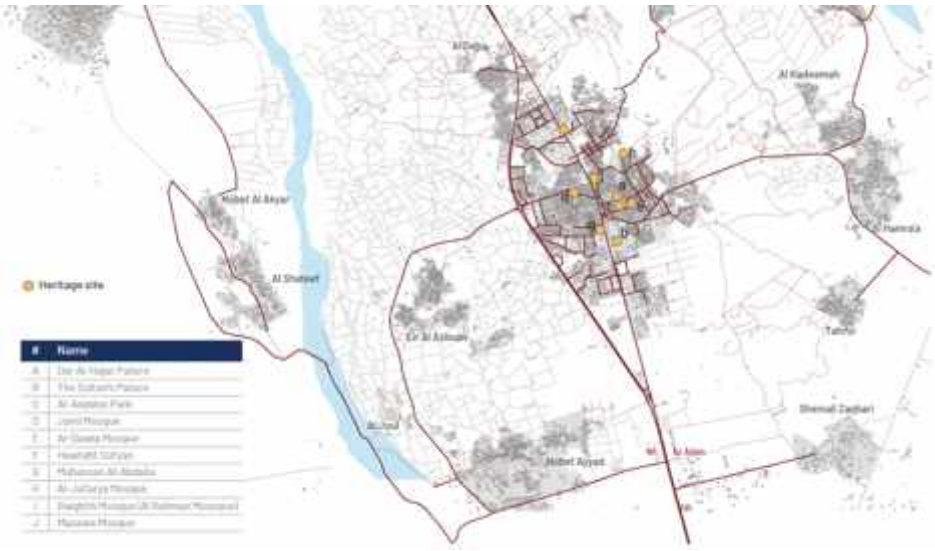


Figure 37. Main Heritage Sites in Al Hawtah. UN-Habitat, 2020.

The Tuban Delta used to be known for the purity of its water and gardens of jasmine trees and roses.[91] 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.[92] 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. 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.[93] 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 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.

[91] UN-Habitat (2020) Al Hawtah City Profile
[92] UN-Habitat (2020) Al Hawtah City Profile
[93] https://data.worldbank.org/country/yemen-rep

Women noted for agriculture that there is a lack of some crops such as cotton, sesame, Djar[94] 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%.[95] 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.[96] 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.

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. 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.

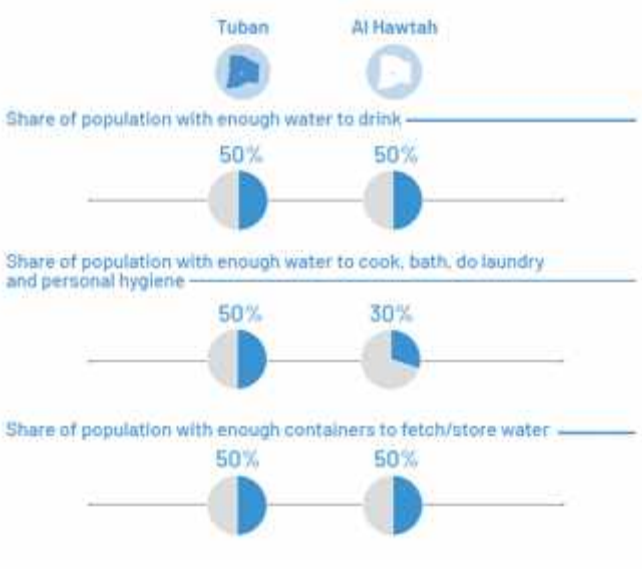


Figure 38. Perceptions of WASH in Tuban District and Al Hawtah. UN-Habitat, 2020.

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. 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.[97] 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.

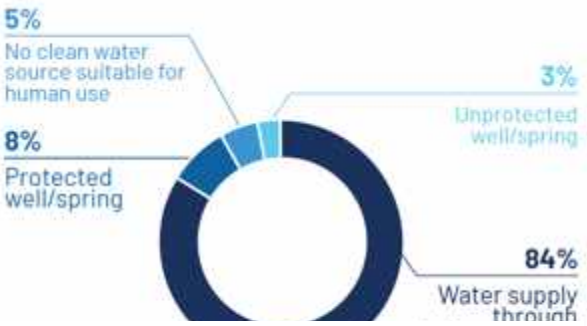


Figure 39. Main Source of Water in Al Hawtah city based on Community Focal Point survey. UN-Habitat, 2020.

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.

[94] A type of edible bean, smaller than soya bean
[95] UN-Habitat (2020) Al Hawtah City Profile
[96] UN-Habitat (2020) Al Hawtah City Profile
[97] GIZ (2018), Damage Assessment Report of Twelve Water Supply and Sanitation Local Corporations (LCs), (Bonn and Eschborn, Germany: GIZ, 2018).

While there was an increase of children due to the arrival of IDPs, the number of facilities in the Tuban district has not increased.

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.[98]

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.[99]

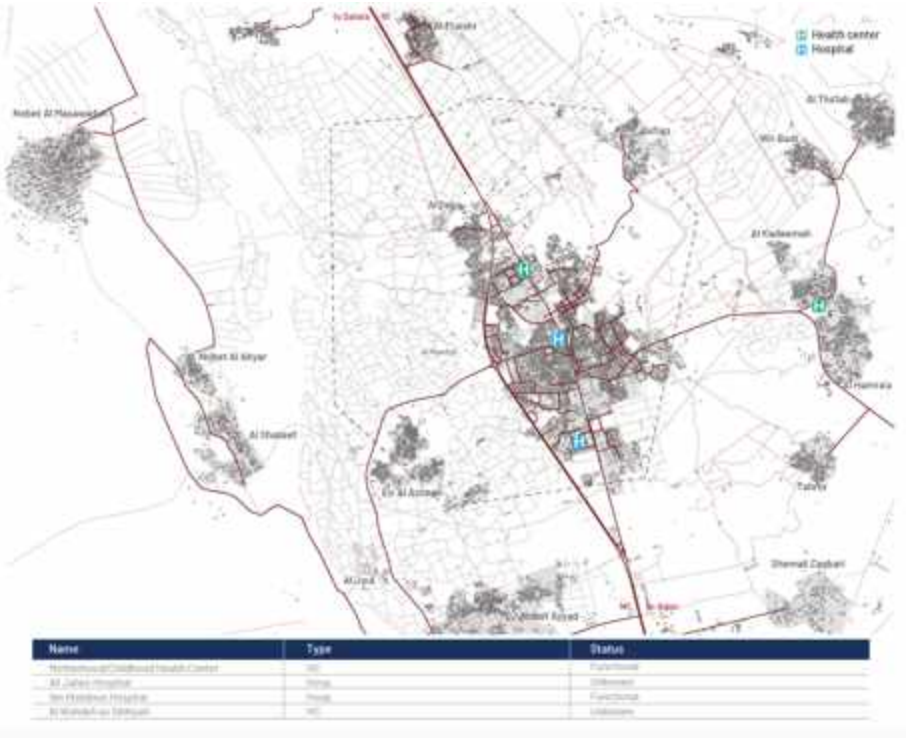


Figure 40. Main governmental health facilities in Al Hawtah. UN-Habitat, 2020.

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. 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.[100]

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.

3.3 Upper Region of the Tuban Delta

The Upper Region of the Tuban Delta is located in the Tuban District in the Lahj Governorate. The area covers 450 km^2 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.

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

[98] UN-Habitat (2020) Al Hawtah City Profile
[99] UN-Habitat (2020) Al Hawtah City Profile
[100] UN-Habitat (2020) Al Hawtah City Profile

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.

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.

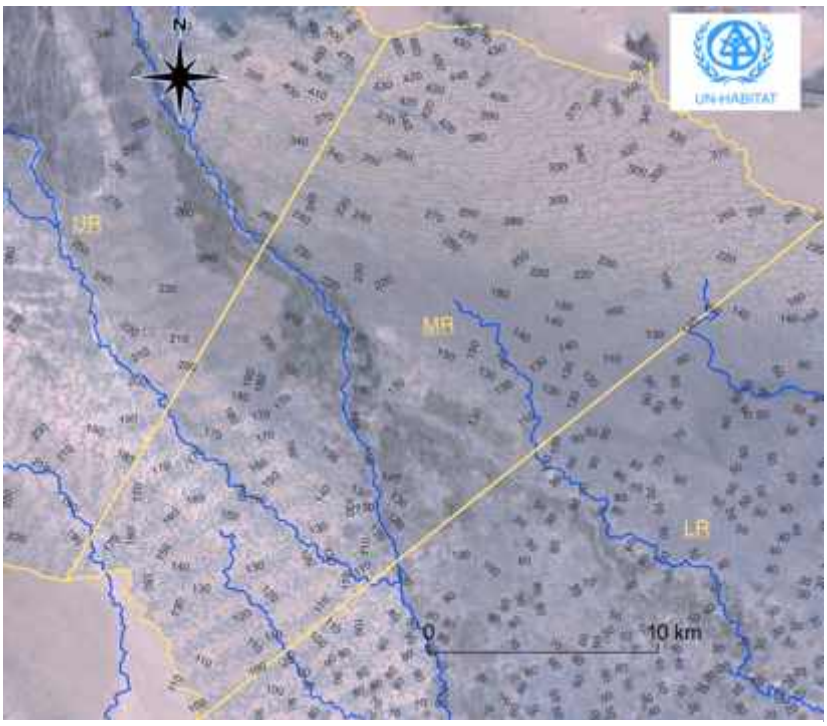


Figure 41. Elevations and streams in the Upper Region of the Tuban Delta. UN-Habitat, 2023.

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.[101] 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.

[101] 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.

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. ***Governance:*** 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.

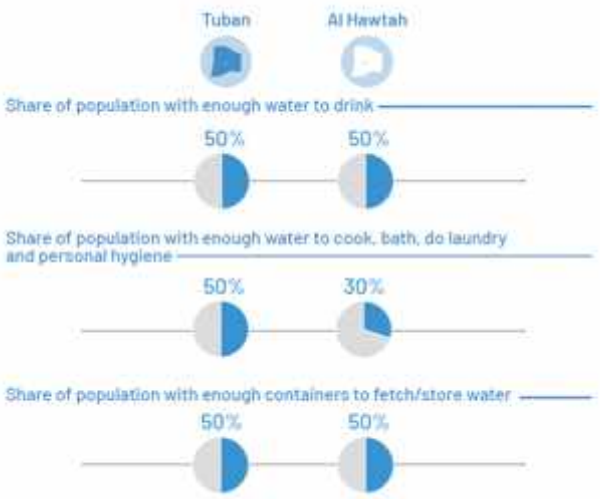


Figure 42. Perceptions of WASH in Tuban District and Al Hawtah. UN-Habitat, 2020.

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.[102]

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.

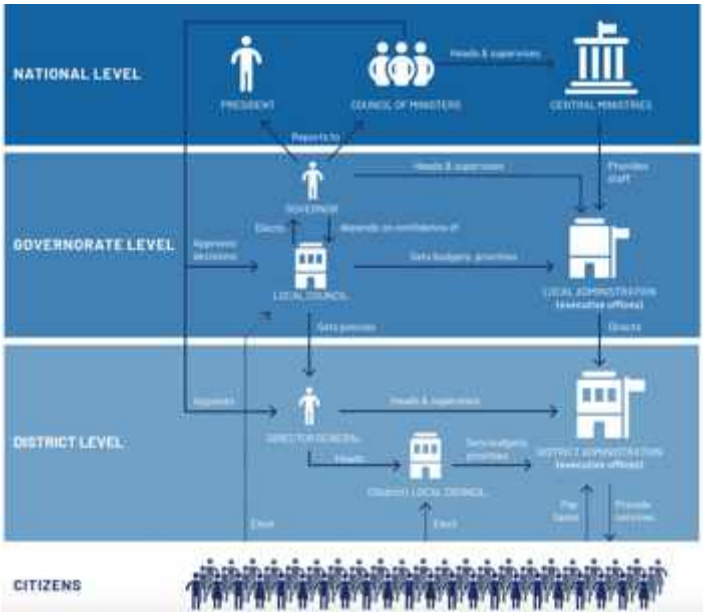


Figure 43. Local Governance Framework in Yemen. UN-Habitat, 2020.

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

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.

Figure 45. The boundaries of the watershed that contributes to flash flooding risk in the Tuban Delta

Figure 46. Major assets and streams in the Tuban Delta

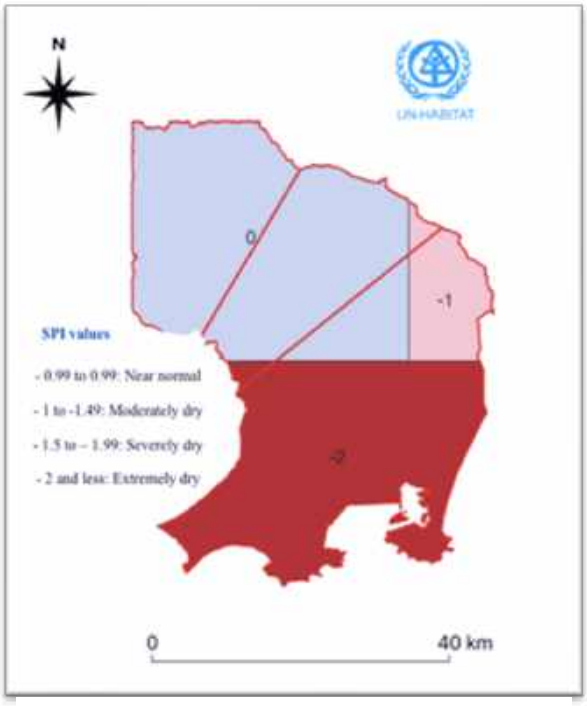


Figure 44 SPI drought index by region

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

The hydrology study also mapped the assets throughout the Tuban Delta alongside 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.

Specific risks and vulnerabilities by each region are outlined below.

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 EN	Site Name AR	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	الرباط الغربي	LR	High risk
Lahj	Tuban	Al Hawtah - Tuban	مخيم عطيرة	LR	High risk
Lahj	Radfan	al Habilin	المحوى الأعلى	LR	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).

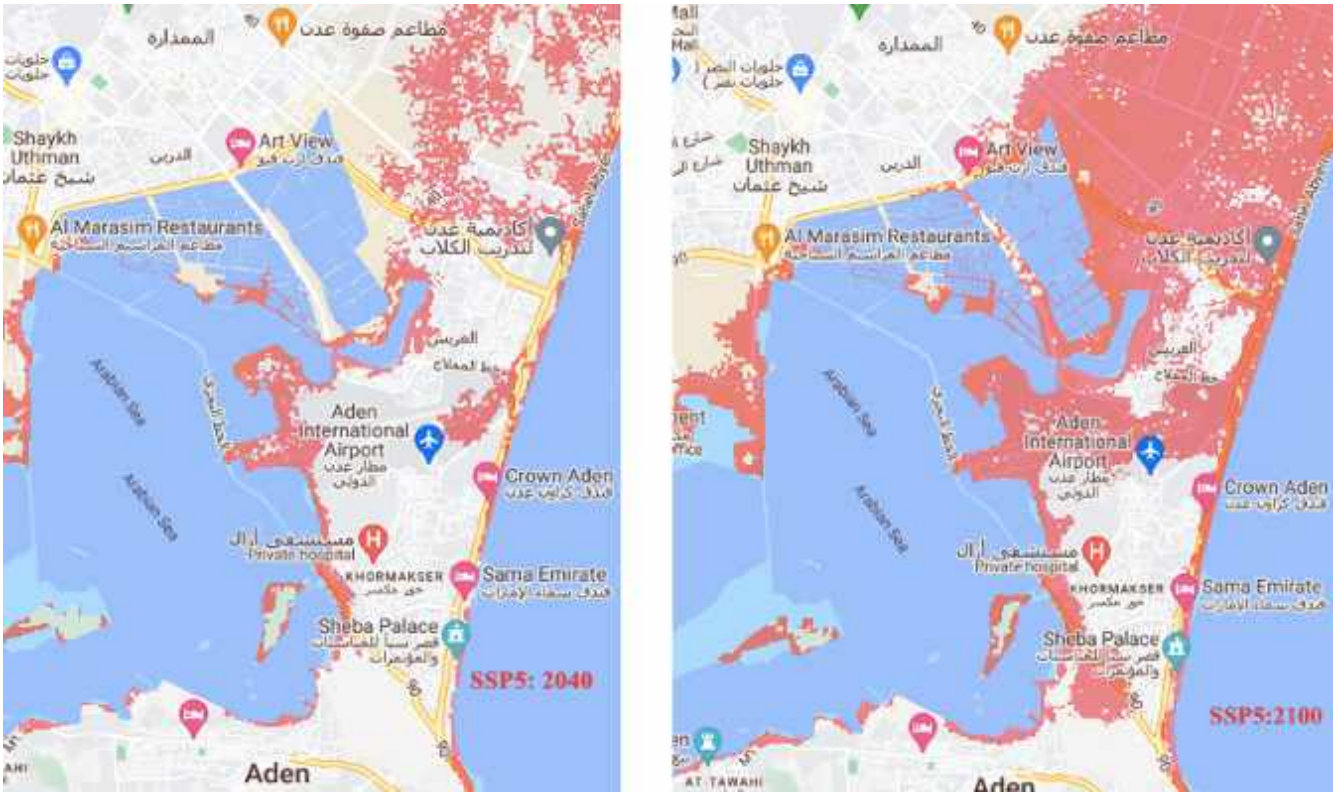


Figure 47. Extent of sea level rise in Aden in 2040 and 2100 based on a high emission scenario

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

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 EN	Site Name AR	Regions	Flood risk
Lahj	Tuban	Al Hawtah - Tuban	المخشابة	MR	High risk
Lahj	Tuban	Al Hawtah - Tuban	سد فالج	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	Natural channel Encroachment and Degradation	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.

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

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 EN	Site Name AR	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

Utilizing the scoring system, this yields a vulnerability to flooding level of Medium, with a score of 15.

	Exposure	Sensitivity	Adaptive Capacity	
Infrastructure	1	2	3	Knowledge
People	1	2	2	Plans
Ecosystems	1	1	2	Financial Assistance
Total	3	5	7	15

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

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

Annex 2: A study of the hydrology of Tuban Delta in Yemen and the impacts of climate change

1. Introduction

1.1. Water scarcity

Yemen has enough water resources to meet its drinking water needs, but a significant portion of the population suffers from acute water shortages, and 90% of those resources are primarily used for irrigation using traditional methods (UNDP 2021). In addition to conventional irrigation methods, water resources in Yemen face other challenges including climate change, water management practices, overexploitation of water resources and population growth. These factors have led to socioeconomic instability and caused water-related conflicts, which are sadly not monitored and are frequently too complex to be resolved by sheikhs or the legal system alone in Yemen (Huntjens et al., 2014). On the other hand, the ten years of war has increased water scarcity and groundwater depletion leading to saltwater intrusion, which may cause food and water insecurity. In this regard, Tuban Delta is one of the most water scarce basins in Yemen that includes Aden one of the most populated cities. The increased population, overexploitation of groundwater and climate change have impacted the area and highlighted the needs for studying these challenges. Thus, hydrological research is required to evaluate the hydrological conditions and potential climatic risks facing Tuban Delta, which can help addressing these challenges in other water basins and communities in Yemen.

1.2. Water quality

Most of the surface waters are used in the upper and middle regions. These resources suffer from agriculture-based pollution fertilizers and chemical products and untreated wastewater that is discharged directly to the streams and canals. On. The other hand, groundwater quality has not been studied in detail in terms of its suitability as irrigation or drinking water. Here are the most important sources of groundwater pollution:

- Natural radioactivity: Groundwater in Aden, like many areas globally, may contain naturally occurring radionuclides such as radium, uranium, and thorium. These substances can enter groundwater from geological formations and rocks. Harb et al. (2013) collected and tested a total of 37 groundwater samples from four areas in Aden governorate, namely Beer Ahmed area, Beer Fadle area, Daar-saad area, and Al-Masabian. The results showed that the annual obtained dose was about 5-10 times higher than the recommended value of (0.1 mSv/year) for drinking water as recommended by WHO. Moreover, Abdurabu et al. (2016), tested the radioactivity of groundwater in Juban District, Yemen and found that the high radionuclide concentrations were found mainly in water from wells in the basement aquifer. The study found that the mean annual effective dose for infants is almost twenty times the WHO guideline level for drinking water. Therefore, it is recommended to investigate this issue that requires collaboration between local authorities, environmental agencies, health departments, and scientific institutions to ensure the provision of safe and potable groundwater to the community while minimizing health risks associated with radioactivity.
- Salinity: According to Yemeni drinking water standards, EC for drinking water is preferred to be less than 1000 µS/cm and the maximum allowed limit can reach 2500 µS/cm (Saleh et. al. 2017). However, testing many samples in the lower region indicated high EC values (more than 2000 µS/cm and in some wells more the 3000 µS/cm. Some of this salinity is based on aquifer characteristics (natural salinity), while the rest are due to saltwater intrusion, especially in the coastal areas. After analysing available data from 2007 and 2021, there is an increase in average EC mainly in the LR, which exceeds the Yemeni standards for drinking water, but it can still be used for other uses 5526.42µS/cm and 4629µS/cm. The wells in the MR and the UR still have drinkable water with EC concentrations about 2113.28 µS /cm in 2021.
- Nitrate: The concentrations of nitrate in Bir Ahmed and Bir Naser were 75 and 58 mg/l, which exceed the Yemeni standard of 50 mg/litter.
- Wastewater: Cities and industries discharge untreated domestic and industrial wastewater in peri-urban areas. While the dangers of pollution produced by urban wastewater are more visible, there is also a potential pollution hazard to aquifers from untreated wastewater from rural settlements. To assess groundwater pollution in Bir Nasser and Bir Ahmed waters fields, in Tuban Delta, Saleh and Al-Sallami (2022) collected 20 groundwater samples in the period from February until July 2021. The results showed that most of the physical, chemical, and biological parameters are higher than the permissible limit by WHO. The main reasons for this pollution are the use of cesspits, the closeness of the wells to the agricultural lands that use chemical and animal fertilizers, and the random drilling of wells, and excessive pumping rates (Saleh and Al-Sallami, 2022).

1.3. Climate Scenarios

The Coupled Model Inter-Comparison Projects (CMIP6) estimate the global socioeconomic trends through the Shared Socioeconomic Pathways (SSPs) up to 2100. The SSPs are built on five storylines that describe various socioeconomic processes based on five narratives describing alternative socio-economic developments, including sustainable development (SSP1), regional rivalry (SSP3), inequality (SSP4), fossil-fueled development (SSP5), and middle-of-the-

road development (SSP2) (Riahi et al., 2017). SSP1 and SSP5 are indicators of effective institutions, wise investments in health and education and quick economic expansion. SSP1 is based on sustainable practices, whereas SSP5 is based on a fossil fuel-driven economy (Bassetti, 2022), SSP3 and SSP4 show low investments in health and education in developing nations, a rapidly expanding population, and rising inequality.

SSPs based scenarios further refine the RCPs. Thus, couplings SSPs and RCPs is used to describe possible alternative conditions of human society and nature at the macroscale (Frame et al., 2018) that could shape future society (Hausfather, 2018) as the following:

SSP1: A world that is based on the Sustainable Development Goals (SDGs) (RCP 1.9 and RCP 2.6).
SSP2: “middle of the road” (RCP 4.5).
SSP3: a fragmented world of regional rivalry and resurgent nationalism (RCP7).
SSP4: a world of ever-increasing inequality (RCP6); and
SSP5: A world of rapid and unconstrained growth using fossil fuel development (RCP 8.5).

2. METHODOLOGY

2.1. Study area

Tuban Delta (TD) is the downstream of Wadi Tuban basin. Wadi Tuban has a total area of 7360 Km^2 and consists of seven sub-basins (Saleh et al., 2012), Maytem, Saelah Qataba , Worzan see, Worzan, As-Sodan, Tuban, Al Enteshari and Agreen.

Tuban Delta is located between 44.65° - 45.1° E and 12.7° -13.3° N, its topography ranges from 10 m below sea level to about 800m above sea level. Administratively, TD can be divided into three regions the Upper Region (UR), the Middle Region (MR), and the Lower Region (LR). To delineate the watershed of Tuban Delta, QGIS and HEC-HMS model have been used. The Digital Elevation model for the study area was downloaded from the Shuttle Radar Topography Mission (SRTM) of the United States Geological Survey USGS. Ten break points (outlets) were created, which led to many sub-basins, which had been merged in one administrative watershed as shown in Figure 48. Tuban delta is divided into three regions: The Upper Region (UR) with an area of 450 Km^2 and a population of 36 921 people; the Middle Region (MR) with an area of 570 Km^2 and a population of 85 954 people; and the Lower Region (LR) with an area of 1030 Km^2 and a population of 1 133 013 people.

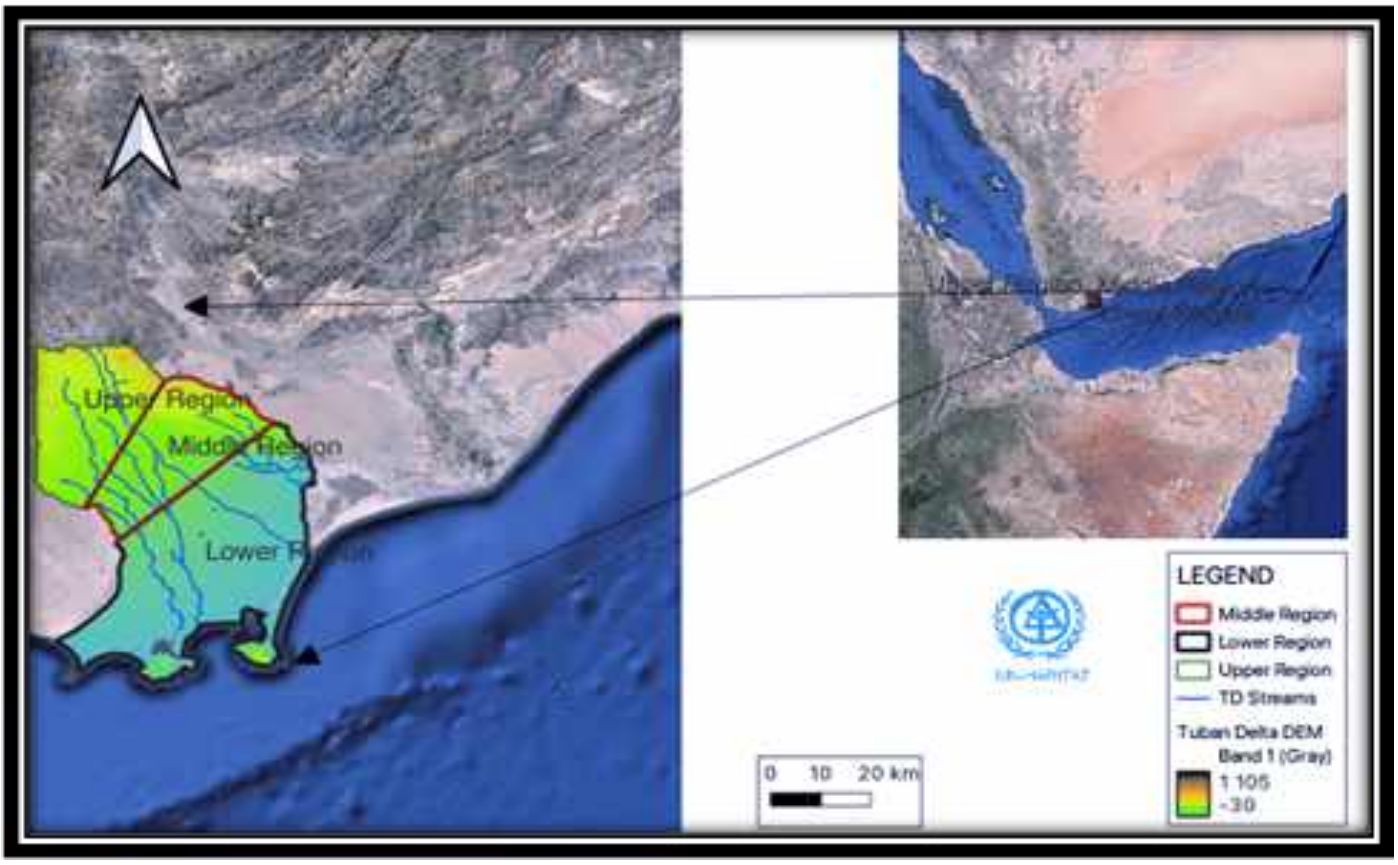


Figure 48 Tuban Delta location (administrative map).

2.2. Data Collection

Consultations

Different sorts of data are required, namely hydrological data, land and water uses, demographic and socioeconomic data and climatic projections to carry out the hydrology study and to carry out the related analysis. Some of the required information has been gathered from open-access websites and earlier studies. However, most of these data were outdated because of the war. Therefor, and in collaboration with the national stakeholders, additional data have been gathered from national authorities. The following national organizations have contributed to the gathering and validating the data: EPA, NWRA, MAIFW, MWE and NWSC. In this context, it is important to note that many hydrological measurements have ceased because of the war, and some equipment has either been stolen or destroyed. Consequently, after 2015, it was difficult to obtain reliable data. As a result, numerous consultation meetings were arranged to correct the data that had been gathered.

Field data

In February 2023, local government officials and representatives of the Water User Associations (WUAs) were interviewed. Then, three field trips were made to the top, middle, and lower parts of Tuban Delta and three Focus Group Discussions (FGDs) were held on each field visit; farmers, men, and women. The following subjects were discussed: Local issues and demographic trends; Institutional structures; Socioeconomic activities (agriculture, water consumption, and use of the land); and Climate-related risk (including sea level rise, drought, saltwater intrusion, and flooding).

To estimate groundwater abstraction and the quality of the discharged water from wells, the local team members conducted several field visits to collect data about agricultural and domestic wells. The data collected included water level, average abstraction rates, temperature and the Electric Conductivity (EC) to compare the collected data with the data of 2007.

Remote sensing data and Climate Scenarios

Because of the war, no rainfall records were measured after 2015. Monthly rainfall rates were thus acquired from Multi-Source Weighted-Ensemble Precipitation (MSWEP), a worldwide precipitation product with a 3 hourly 0.1° resolution that combines gauge, satellite, and reanalysis data to produce the highest quality precipitation estimates. Then, the monthly rainfall rates were processed in QGIS to calculate the annual precipitation in 2022.

The Meteorological Research Institute Earth System Model Version 2.0 (MRI-ESM 2.0) is considered under CMIP6 considering SSP3 (coupled to RCP7) and SSP5 (coupled to RCP8.5) . It is anticipated that MRI-ESM 2.0 will perform better in many of the experiments scheduled for CMIP6 than earlier models that took part in the fifth phase of the Coupled Model Intercomparison Project (CMIP5) (Yukimoto et al., 2019a).

In general, SSP3 and SSP5 represent high emission, high impact scenarios. However, the rate of emission reduction during the last 13 years is not optimistic enough to consider lower emission scenarios such as SSP2.

Some climate projections up to 2100 were obtained by the support of UNESCWA. Other climate projections were brained from different climate services platforms such as Climate Change Knowledge Portal (CCKP), which was created by the World Bank (WB) for development practitioners and policy makers to solve a need. https://climateknowledgeportal.worldbank.org. Moreover, the time frames for the extreme events scenarios have been modified from 2010-2039; 2035-2060; 2060-2089; and 2070-2099 to be 2023-2040; 2041-2060; 2061-2080; and 2081-2100.

Runoff

Runoff water availability can be calculated by subtracting evaporation and infiltration from total rainfall (Dingman 2015). The rational method, Cook's method, or curve number are three basic runoff estimation methods that can be used to estimate runoff and water availability (Juniati et al., 2021). The rational method was utilized in this paper to estimate water availability in Tuban Delta using the following equations (Juniati et al. 2021):

$$C = \Sigma (ci \times Ai) / \Sigma Ai \quad (1)$$

$$R = \Sigma Ri / m \quad (2)$$

$$WA = C \times R \times A \quad (3)$$

where, WA = water availability (MCM/year), C = weighted runoff coefficient, Ci = Land-use coefficient, Ai = Land Area (Km^2), R = average yearly rainfall data (m/year), Ri = Rainfall in station i, m = number of rainfall stations.

Hazard Assessment

Hazard assessment values are determined by multiplying the scores for severity values and the probability together for each recognized risk. Severity is the amount of damage or harm hazard could create and it is often ranked on a four-point scale: 4- Catastrophic; 3- Critical; 2- Marginal; and 1- Negligible. Probability is the likelihood of the hazard

occurring and it is often ranked on a five-point scale: 5- Frequent; 4- Probable; 3-Occasional; 2-Remote; and 1-Improbable. Then hazard values can be categorized into four categories I. Low: II. Medium-Low; III. Medium; IV. Medium-High; and V. High, Figure 49.

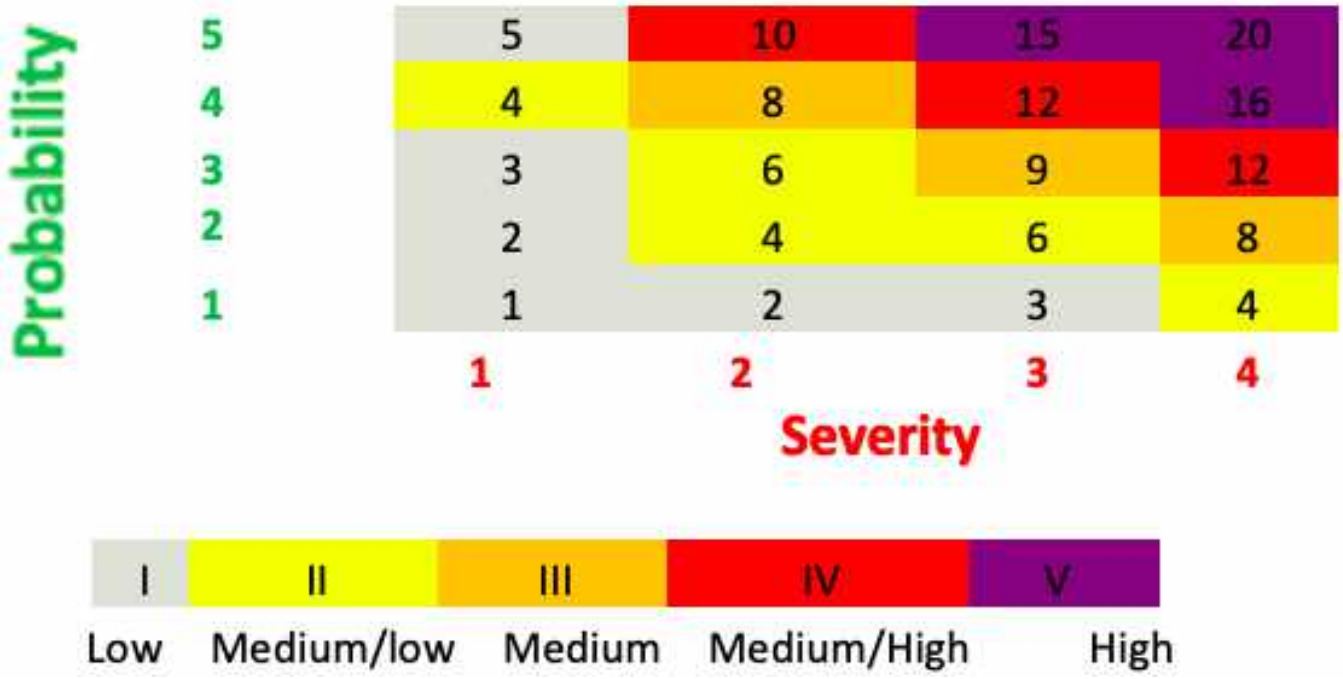


Figure 49 Risk Assessment Values and Categories

WATER BALANCE

WATER RESOURCES

No specific estimates of water resource availability in Tuban Delta (TD) have been made so far. However, there are some estimates for Yemen as a whole or for specific governorates; for example, Haidera and Noaman (2008) assessed Lahj's the potential water resources to be 130 MCM/ year. TD is considered the downstream of Tuban Wadi Basin. As a result, the total renewable water resources in TD will be the sum of inflow from Tuban Wadi's highlands, rainfall/runoff from the three regions, and groundwater flow from the highlands.

- Water Availability from the Highlands: Between 1955 and 1983, the average annual flow at the top of TD was estimated to be 125 MCM, whereas the highest inflow occurred in 1982 with an annual inflow of 350 MCM, which led to a catastrophe flood in March 1982. Due to the lack of recent estimation of the inflow from the highlands and after consultation with the local authorities, the annual inflow from the northern highlands in 2022 is estimated at 125 MCM, which is usually used totally before reaching the ocean as 35% (43.75 MCM) in the upper region, 50% (62.5 MCM) in the middle region, and 15% (18.75 MCM) at the top of the Lower Region (before the city of Aden). This limited flow to the city of Aden has changed soil qualities, enhanced desertification, and forced people to overuse groundwater for agricultural and domestic uses, thus increased saltwater intrusion.

- Water Availability from Runoff: To estimate water availability from local runoff, the rational methods were used, considering the rainfall of 2022. Runoff coefficient Ci depends on soil type, land slope and land cover. According to Saleh et al. (2017), the soil types in Tuban delta clay loam, silt clay, loam, and silty clay loam. However, because silty clay loam and clay loam are the most common soil textures, so average values of silty clay loam and tight clay were chosen. Tuban Delta's slope was calculated in the HEC-HMS model to be about 5%, indicating that the basin is represented by a gentle slope (rolling) (Marifa et al. 2021). As a result, the average runoff coefficients for different land uses in Tuban Delta based on soil texture and slope have estimated as 0.65, 0.45 and 0.6 for agricultural areas, Pastureland, and Populated areas, respectively. Then, the weighted runoff coefficient for each region, the different land uses were estimated using recent google map, QGIS and national documents. Then, the weighted runoff coefficients were estimated. The acquired monthly rainfall MSWEP were processed in QGIS to calculate the annual precipitation for 2022, see Figure 50.

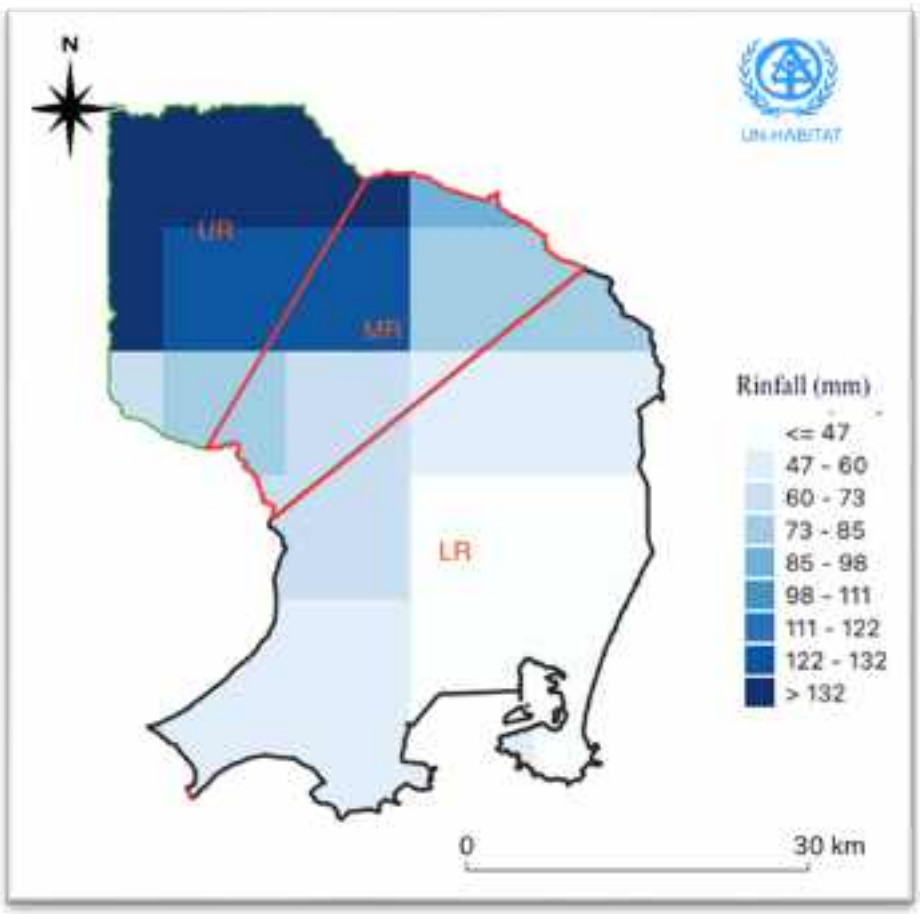


Figure 50 Precipitation in 2022 in Tuban Regions Based on MSWEP Data.

Then, water availability in the three regions have been estimated using the rational method as shown in the table below.

Table 39 Water Availability in Tuban Delta Based on Runoff Estimations.

Regions	UR	MR	LR	Total
Rainfall(m)	0.118	0.084	0.051	
Weighted C	0.466	0.476	0.485	
Area (Km^2)	450	570	1030	
Runoff MCM	25	23	25	73

- Total Renewable Water: Based on groundwater aquifers, limited groundwater flows come from the northern aquifers. Therefore, the groundwater recharge in TD will occur mainly due to local rainfall, check dams and the inflow from the highlands to the streams and canals. According to (Girgirah et al., 2007), 70% of the available water (runoff and inflow from the high lands) supplies groundwater. Thus, the total renewable surface water will be the rest, see table below.

Table 40 Renewable Water Resources in Tuban Delta (MCM).

Regions	UR	MR	LR	Total
Renewable GW	47.9	59.7	31.0	138.6
Renewable SW	20.5	25.6	13.3	59.4
TOTAL	68.5	85.3	44.2	198

Based on the conducted field visits, Tuban Delta has about 3600 wells compared to 350 wells in 1966. Out of these wells, more than 1200 wells are dried out due to climate change and overuse. The conducted field visits show that there are 2200 working wells for agricultural uses, while for domestic uses in Aden there are 107 wells. Comparing the average water level and discharge of 120 wells in 2007 with 2023, shows a decrease in the average water level from 37.1m in 2007 to 49.5 m in 2023, which indicates that the depletion in groundwater reaches 12.4 m during these 16 years (annual groundwater depletion reaches 80 cm). The annual discharge rates for agriculture and domestic uses are estimated at 147.4 and 50.1 MCM, respectively. On the other hand, no change in water quality or Electric Conductivity (EC) was found. The distribution of wells in Tuban Delta was estimated to be 10.2%, 37.5%, and 52.3%, respectively, at the UR, MR, and LR. As a result, groundwater extractions for agriculture are estimated at 15, 55 and 77 MCM from the UR, MR and LR, respectively. While groundwater extractions for domestic uses are estimated at 1.3, 3.2 and 45.5 MCM from the UR, MR and LR, respectively. In this regard, Komex (2001) suggested reducing the extraction rate in the LR to 36.4 MCM to stop saltwater intrusion.

- Non-Conventional Water Resources: The non-conventional water resources (NCWR) include mainly greywater reuse and treated wastewater.

1. Greywater reuse: The reuse of greywater is a good practice that can save up to 30% of the domestic demand if it is used in toilet flushing (Mourad et al., 2011). However, in Yemen, greywater reuse is limited and mainly applied in some mosques, where the greywater is used to irrigate the gardens of the mosques.

2. Treated wastewater: The availability of sewage networks and wastewater treatment plants (WWTPs) determines the availability of treated wastewater. There are seven WWTPs in Tuban Delta (the treatment method is oxidation ponds), three of them at Tuban district (Saber WWTP; Al-Waht WWTP; Al-Hamra WWTP); two at Al-Hwtah District (Tahror WWTP and Al-Fashlah WWTP) and two (Al-Areesh and Al-Mansorah WWTPs)) in Aden. In the lower region, 9 MCM of the treated wastewater is used in the wetlands, while the rest is discharged directly to the ocean. In this regard, a study evaluated secondary effluents and biosolids generated from four sewage treatment plants in Yemen, which revealed that concentrations of faecal coliforms (FCs) were higher than those recommended by WHO (Al-Gheethi et al., 2014). There is only one WWTP in the Middle Region that treats about 1.0 MCM per year. While the upper region's wastewater is not treated or reused.

WATER DEMANDS

Water demands include agricultural, domestic, and industrial. Industrial demand in TD is limited, and environmental demand is unmet because no water flow in the streams towards the ocean. Municipal water networks serve a portion of the community, including commercial and government buildings. While the rest needs are met by privately owned wells.

- Domestic Water Uses: Domestic Water Use (DWU) is mostly met by municipal water supply provided by the Local Water and Sanitation Corporation (LWSC) or by private supply for individuals who are not connected to a public water supply. Around 25% of people in the lower region are not connected to the public water system, whereas 40% of the people in the upper and middle regions are not connected to the public water system. According to Aden's water corporation, half of the produced water is non-revenue water (NRW) and according Lahij water corporation, 40% of the Middle Region's population is not linked to the public water supply system, while the NRW is about 30%. Using the available data indicates that the domestic water uses are about 110, 103, 100 L/capita/day (including the NRW), in the LR, MR, and UR respectively. Thus, DWUs in the LR, MR, and UR are 45.5, 3.2 and 1.3 MCM, respectively.

- Agriculture Water Uses: Agriculture land in Tuban delta is about 18,356 ha. However, due to water shortage, the cultivated areas have been about 60 % of the total cultivated area. There are three types of irrigation in Tuban Delta:

1. Spate irrigation: This approach uses traditional intakes and canals to shift water flow from valleys, rivers, and wadies into farmlands that are lower in elevation than the valley (about 40%).

2. Check basin irrigation: In this approach, soil bunds are built all around the field as a boundary, and then the field is inundated with water (about 55%).

3. Drip irrigation about 5%.

The total Agricultural Water Use (AWU) for each region has been estimated as the sum of groundwater extraction from agricultural wells, the Non-Conventional Water Resources (NCWR) and surface water the 30% of the inflow water from the highlands. The total agricultural water uses in the UR, MR and the LR are 28.1, 74 and 91.8 MCM/year.

UNMET DEMAND ASSESSMENT

In general, the unmet demand in a catchment can be estimated by subtracting total water demands from total water supply. The current estimations based on the collected data show that the Lower region faces a sever water shortage that reaches 84.3 MCM, due to the limited water availability (climate change), over-abstraction of the depleting groundwater and lack of, or insufficient operation and maintenance of water and wastewater systems.

FUTURE PROJECTIONS

- Water Demand Projection: Recently, environmental flow is not considered in national water plans in Yemen, however, it is recommended to include this demand in the future water management plans. An average environmental flow of 10-30 l/s at the basin outlet can contribute to water sustainability in Tuban Delta. Thus, the total demand projections in the three regions have been estimated based on the domestic water demand and agricultural water demand.

1. DWU projection: Domestic water demand projections up to 2100 have been estimated based on average water consumption per capita assuming that NRW will be eliminated by 2040. Thus, domestic water consumption starting from 2040 will be 90, 99 and 96 L/day in the LR, MR and UR, respectively.

On the other hand, the domestic water demand projection depends on population growth. Thus, future population and DWU projections up to 2100 can be estimated based on two scenarios:

a. DWU_n: Normal increase, which means the rate of growth of 3% will stay the same up to 2100 10 using the following equation:

$$P_F = P_p \times (1+R)^n$$

where :

- P_F : future population at time T,
- P_P: present population,
- R: growth rate (3%), and
- n: number of years.

b. DWU_r : Reduction in population growth rate, which means the growth rate of 3% until 2040, 2.5% from 2040 to 2060, 2% from 2060 to 2080, then 1.5% from 2080 to 2100. In this case the Equation 6 is used.

$$P_F = P_p (1+r_1)^{n1}(1+r_2)^{n2}.....$$

where:

- r_1, r_1, … are the growth rates in the specific period,
- n_1, n_2, … are the number of years for each period.

The table below presents future domestic water projections DWU_n *and* DWU_r.

Table 41 DWUn and DWUr Projections.

Year	Lower region		Middle Region		Upper Region		Total DWU (MCM)	
	DWU_n	DWU_r	DWU_n	DWU_r	DWU_n	DWU_r	Normal	Decline
2022	45.5	45.5	3.2	3.2	1.3	1.3	50.1	50.1
2040	77.4	77.4	5.5	5.5	2.3	2.3	85.2	85.2
2060	139.9	126.9	9.9	9.0	4.1	3.8	154.0	139.7
2080	252.6	170.9	17.9	13.4	7.5	5.6	278.1	189.9
2100	456.3	254.0	32.4	18.0	13.5	7.5	502.2	279.5

2. AWU projections: Two scenarios have been assessed as shown in the table below.

a. AWU_a: Constant land and irrigation practices.

b. AWU_b: Constant land, modern irrigation starts with 50% in 2040, 70% in 2060 and 100% in 2080.

Table 42 Agricultural Water Uses Projections under Two Scenarios (MCM).

Year	Lower region		Middle Region		Upper Region		Total	
	AWUa	AWUb	AWUa	AWUb	AWUa	AWUb	AWUa	AWUb
2022	92	92	74	74	28	28	194	194
2040	92	92	74	74	28	28	194	194
2060	92	66	74	53	28	20	194	139
2080	92	51	74	41	28	16	194	108
2100	92	42	74	34	28	13	194	88

Based on the above-mentioned scenarios, two demand scenarios have been considered, see the tabel below.

- Reference Scenario: Constant cultivated lands, constant population growth rates, the same agricultural practices.
- Improved Scenario: Modern irrigation and decreased population growth.

Table 43 Total Water Uses Projections (MCM).

Year	Reference scenario				Improved scenario			
	LR	MR	UR	Total	LR	MR	UR	Total
2022	137.5	77.2	29.3	244.1	137.5	77.2	29.3	244.1
2040	169.4	79.5	30.3	279.2	169.4	79.5	30.3	279.2
2060	231.9	83.9	32.1	348.0	192.9	62.0	23.8	278.7
2080	344.6	91.9	35.5	472.1	221.9	54.4	21.6	297.9
2100	548.3	106.4	41.5	696.2	296.0	52.0	20.5	368.5

The table above shows that Improved irrigation & reduced population growth scenario can contribute to solve water shortage as water saving can reach 20%, 37% and 47% in 2060, 2080, and 2100, respectively. Through fruitful cooperation and active involvement with all concerned stakeholders, new demand scenarios can be developed. However, the developed scenarios should be concrete and based on what can be done in Tuban Delta to save water resources. For example, reusing greywater in toilet flushing can save 35% of the domestic water needs (Mourad et al., 2011). However, this scenario needs social acceptance and involves some private costs.

Water Supply Projections

1. Runoff: The average annual rainfall projections under SSP3 show an increase in rainfall rates after 2040 and it will reach the highest between 2061 and 2080 in the lower region (with 50% certainty), while the annual rainfall rates will start to increase after 2060 in the middle and upper regions. On the other hand, the low rainfall rates before 2040 might lead to more dry years, however, the projections show an increase of the wet years after 2040, see the table below.

Table 44 Average Annual Rainfall Projections (mm) under SSP3 and SSP5.

Years	SSP3			SSP5		
Regions	LR	MR	UR	LR	MR	UR
2022	51	84	118	51	84	118
2023-2040	69.8	69.4	76.3	82.3	79.9	87.8
2041-2060	76.4	68.3	75.1	89.6	90.0	99.0
2061-2080	110.4	106.2	116.8	77.7	74.8	82.3
2081-2100	100.5	94.9	104.4	97.2	84.3	92.7

From the table below, the average change in water availability from runoff compared to 2022 is estimated and presented under SSP3 and SSP5.

Table 45 Average Change Factors in Water Availability under SSP3 and SSP5 Compared to 2022.

Climate	SSP3			SSP5		
Regions	LR	MR	UR	LR	MR	UR
2023-2040	1.37	0.83	0.65	1.61	0.95	0.74
2041-2060	1.50	0.81	0.64	1.76	1.07	0.84
2061-2080	2.16	1.26	0.99	1.52	0.89	0.70
2081-2100	1.97	1.13	0.88	1.91	1.00	0.79

The upper region and the highland are assumed to have the same average change factors in water availability. Then, using the same procedure that was used in estimating water availability from runoff. Under SSP3, the LR is projected to increase its water scarcity due to consecutive dry years lasting for periods of two to four years, especially between 2040 and 2060. While there might be some wet years after 2060 that cause flooding in the UR and MR, which will be combined with wetter year in the UR and MR, which might bring some floods.

NCWR: Non-conventional water resources (NCWR) include treated water (TWW) and desalinated water. Two scenarios are presented here:

a. Reference NCWR ($NCWR_r$): no increase on the current NCWR ;
b. Improved NCWR ($NCWR_i$): The TWW was estimated at 33 % of the domestic water demand. Thus, the same percentages will be applied for future projections (all TWW will be reused). Moreover, a new water supply, a solar-powered desalination plant with a production capacity of 10 MCM/year, can be added every 20 years to the LR starting from 2040.

Table 46 and Table 47 present water supply projections in the three regions considering $NCWR_r$ and $NCWR_i$ under SSP3 and SSP5, respectively.

Table 46 Water Supply Projections under SSP3

Year	UR		MR		LR		Total	
	NCWRr	NCWRi	NCWRr	NCWRi	NCWRr	NCWRi	NCWRr	NCWRi
2022	68.8	68.8	86.5	86.5	52.8	52.8	208.1	208.1
2040	63.0	63.0	60.4	60.7	37.3	46.5	160.7	170.2
2060	66.2	66.2	59.5	60.9	36.8	60.7	162.5	187.8
2080	99.1	99.1	92.0	95.3	52.3	102.6	243.4	297
2100	90.8	90.8	82.0	88.8	47.6	145.7	220.4	325.3

Table 47 Water Supply Projections under SSP5.

Year	UR		MR		LR		Total	
	NCWRr	NCWRi	NCWRr	NCWRi	NCWRr	NCWRi	NCWRr	NCWRi
2022	68.8	68.8	86.5	86.5	52.8	52.8	208.1	208.1
2040	51	62.5	91	91.3	103.6	112.7	245.6	266.5
2060	57.7	65.3	102.8	104.2	112.6	136.4	273.1	305.9
2080	48.1	97.4	85.7	89	98.3	148.6	232.1	335
2100	54.2	87.8	96.5	103.4	119.1	217.2	269.8	408.4

Unmet Demands Projections

Based on water supply projections under SSP3 and SSP5 and water use scenarios, two scenarios for each SSP are assessed:

- Reference Scenario: Reference Demand scenario and NCWR
- Improved Scenario: Improved irrigation & reduced population growth Scenario and $NCWR_i$

Under SSP3

Table 48 presents the projections under SSP3 considering the reference and the improved scenarios. The table shows that the ML and LR will be facing water shortage under the reference scenario up to 2100, which will reach 24 and 501 MCM in 2100 in the MR and the LR, respectively. The projections based on the Improved Scenario, on the other hand show a better situation in Tuban Delta in general after 2060, However, water shortage in the LR will be around 150 MCM in 2100, which highlights the need for more than small water desalination plants in the LR.

Table 48 The Projections of the Unmet Demands under SSP3

Scenario	Reference scenario				Improved scenario			
Region	UR	MR	LR	Total	UR	MR	LR	Total
2022	40	9	-85	-36	40	9	-85	-36
2040	33	-19	-132	-119	33	-19	-123	-109
2060	34	-24	-195	-185	42	-1	-132	-91
2080	64	0	-292	-229	78	41	-119	-1
2100	49	-24	-501	-476	70	37	-150	-43

Under SSP5

The table below presents the projections under SSP5 considering the reference and the improved scenarios. The table shows that the LR will still have a severe water shortage under the refence scenario, while the improved scenario might improve the situation in Tuban Delta by 2060. However, a proper water management and allocation plan are needed to improve the situation in the LR.

Table 49 The Projections of the Unmet Demands (MCM) under SSP5.

Scenario	The Reference scenario				The improved scenario			
Region	UR	MR	LR	Total	UR	MR	LR	Total
2022	40	9	-85	-36	40	9	-85	-36
2040	21	12	-66	-34	32	12	-57	-13
2060	26	19	-119	-75	42	42	-57	27
2080	13	-6	-246	-240	76	35	-73	37
2100	13	-10	-429	-426	67	51	-79	40

4. CLIMATE IMPACTS/RISKS

4.1. Heat Waves

According to the climate model MRI-ESM2-0, the number of hot days per year might increase starting from 2050 to reach 40 days/ year under SSP3, and 70 days/year under SSP5 in 2100. This increase of temperature will increase evapotranspiration rates and water scarcity in Tuban Delta, thus reduce agriculture production (food security) and domestic water supply. Moreover, temperature increase will impact old people and women.

The severity levels of heat waves, in 1 to 4 scale, with 1- Negligible; 2- Marginal; 3- Critical; and 4- Catastrophic, are shown in the table below. The table shows that the LR will have the highest heatwave severity followed by the MR. Therefore, increasing creation and green areas should be included in all urban planning to reduce this impact.

Table 50 The Severity of Heat Wave Risks.

Years/regions	SSP3 (RCP 7)			SSP5 (RCP 8.5)		
	UR	MR	LR	UR	MR	LR
2023-2040	1	1	2	1	1	2
2041-2060	2	2	3	2	2	3
2061-2080	3	3	4	3	4	4
2081-2100	3	4	4	3	4	4

4.2. Saltwater Intrusion

The salinity of groundwater in Tuban Delta was estimated based on the Electric Conductivity (EC). In general, EC concentrations in Tuban Delta have increased in the LR near the coast due to overexploitation and saltwater intrusion.

Moreover, the aquifer type near the coast is semi-confined (Squarespace nd), which allows saltwater intrusion and the movement of the salty water from the brackish aquifer.

On the other hand, there are medium salinity levels in the MR and the UR due to the characteristics of the rocks. According to the Yemeni drinking water standards, EC for drinking water is preferred to be less than 1000 µS/cm and the maximum allowed limit can reach 2500 µS/cm (Saleh et. al. 2017). WHO recommends EC in drinking water to be about 400-800 µS/cm, while water with EC from 800 to 2500 µS/cm can be used for irrigation and livestock (Al-Khashman, 2014). Figure 51 shows Electric Conductivity (EC) concentrations in some wells in Tuban Delta. It shows that all wells that are located near the coast have high EC concentrations especially those that are located at a brackish aquifer.

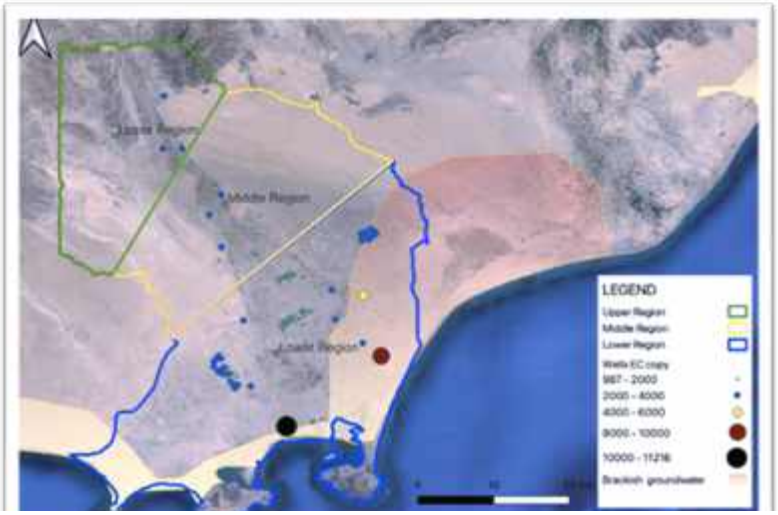


Figure 51 EC Concentrations (µS/cm) in Some Well in Tuban Delta.

In 2023, based on NWSA data of 2019, many wells of Dar Almanasira well field that is located 15 km northern the eastern costal line have high EC concentration (more than 2500 µS/cm), which means brackish water is about 20 m below sea level. Taking an average annual drop in water table of 1 m all wells of Dar Almanasira well field will become brackish after 2040. Thus, discharged water won't be drinkable without a proper purification/treatment via Reverse Osmosis system (RO), for example. However, it can be used to irrigate salinity tolerant crops. In this regard, bio-saline agriculture, which is the production and growth of plants in saline rich groundwater and/or soils, is important because it allows using low quality of water to irrigate some species and to adapt to local climatic conditions (Oumara and El Youssfi 2022). For example, in Morocco, some crop species were tested and showed very high tolerance to salinity, such as Quinoa, Pearl millet, Barley, and Panicum Blue (Hirich et al., 2021).

Only few wells outside of the Bir Ahmed well field that is located 8-14 Km from the coast, have EC less than 2000 µS/cm. These wells are located at low productive aquifer (about 65-70 m below the surface) and above the brackish water, which means these wells are vulnerable to drought and to sea-level rise. The well field is located at 40m above sea level. Thus, in case of drought, people might think of deepen these wells ignoring the possibility of reaching the brackish aquifer. Thus, in case of drought and continuous over abstraction, these well will become brackish after 2080. Abubaker (2012) argued that wells that have a depth of 65 m or more will get brackish water.

Bir Naser well field that is located about 16 km from the coast has fair water quality, based on the Yemeni standards, EC range 1500 to 1800 µS/cm. However, these wells are vulnerable to sea-level rise and overexploitation. Thus, EC concentrations will increase. The statistic water levels (S.W.L) of the wells are about 20-30 m below sea level. These wells will become brackish when S.W.L reaches 80 m below sea level. Thus, in case of drought and continuous over abstraction, these wells might become brackish by 2080.

If these well fields, which are the main drinking water resource in the LR become brackish, people in the LR, mainly Aden, will face water scarcity as domestic water needs will be affected. Moreover, other legal and illegal wells that are used for irrigation at the coastal area will be affected as well. Therefore, new allocation strategies will be needed and looking for new domestic water resource will be a must. The National Authority of Water and Sanitation in Aden suggested drilling new wells with a depth of 300-350 m to cover the increasing demand. However, it is not recommended to deepen wells in the coastal area as it may reach the brackish water. Thus, this might not be a sustainable solution. Constructing solar-powered desalination plants can be a sustainable option to cover the increasing demand in Aden.

Saltwater intrusion will keep increasing due to increase water demand and drought years between 2023 and 2040. After 2040, the probability for the years to be wetter is high however, population increase, and unmonitored pumping might not help in reducing saltwater intrusion. The table below shows saltwater intrusion risks at the main water supply well fields in Aden taking into consideration the continues illegal and unmonitored groundwater withdrawal.

Table 51 The Risk of Saltwater Intrusion in the Coastal Area.

Years/Well fields	Saltwater intrusion		
	Dar Almanasira	Bir Ahmed	Bir Naser
2023-2040	High risk	Low risk	Low risk
2041-2060	Brackish	Medium risk	Medium risk

2061-2080	Brackish	High risk	High risk
2081-2100	Brackish	Brackish	Brackish

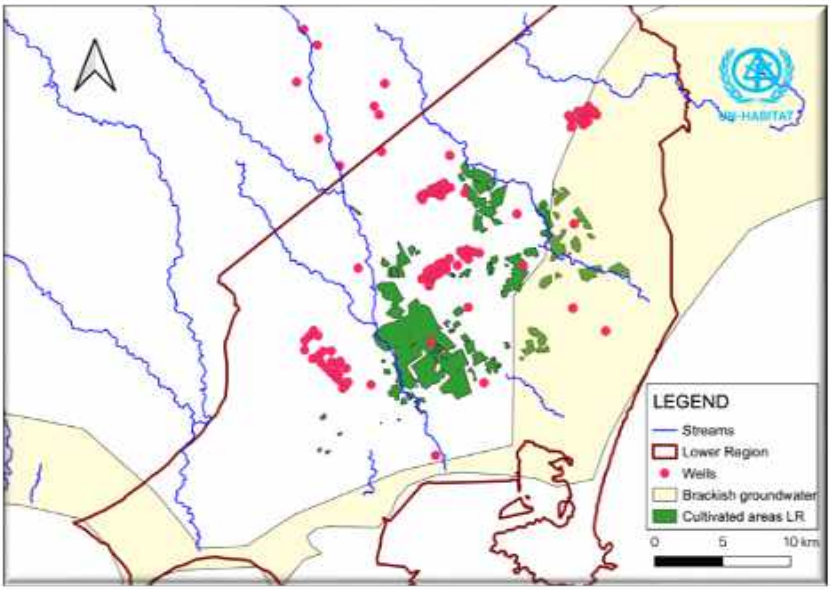


Figure 52 The Impact of Saltwater Intrusion on Agriculture Area in the LR.

On the other hand, saltwater intrusion will impact agriculture yield. Recently, only 2948 ha of the total agricultural land in the Lower Region (8859ha) is cultivated due to climate change (water scarcity). However, about 10% of the cultivated lands are irrigated by brackish water (Figure 52), and this percentage will be about 20% by 2040, which might lead to reduce cultivated areas and impact food security in the area.

4.3. SEA-LEVEL RISE

QGIS has been used to map the affected areas if sea-level rises by 1 meter. Figure 53shows that most of the coastal areas in Aden might be impacted especially the airport. However, visiting the airport area shows that the highways infrastructure around the airport will be impacted and reduce the projected impact on the airport and on the other coastal areas.

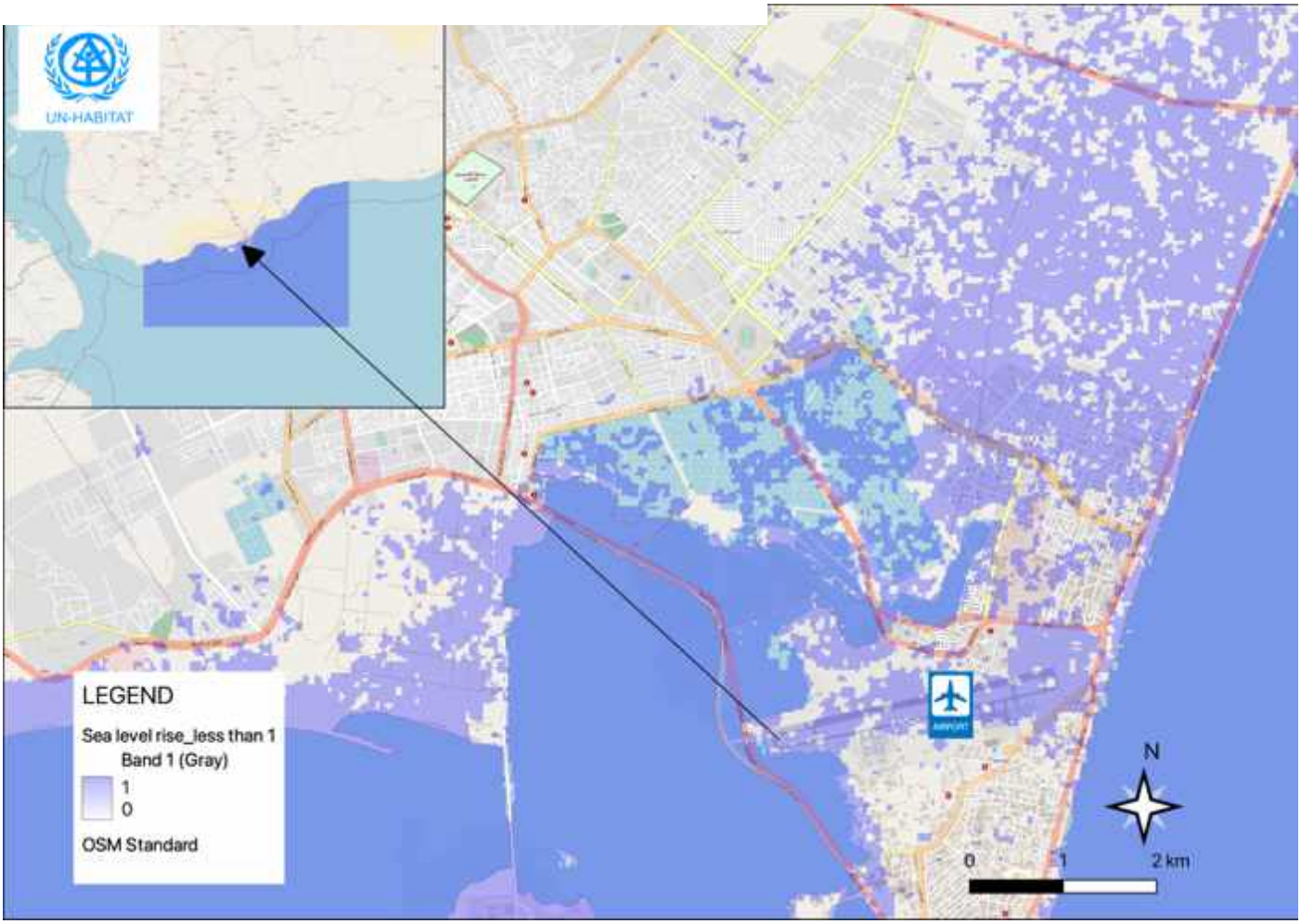


Figure 53 The Impacts of Sea-Level Rise in the Coastal Areas of Aden

.

In this regard, based on Climate Change Knowledge Portal (CCKP), Figure 53 shows sea-level rise from 2008 to 2100 under RCP2.6, RCP4.5 and RCP8.5. While based on the CMIP6, Figure 54 shows projected sea-level rise under SSP5 and SSP4 (Climate Central 2023).

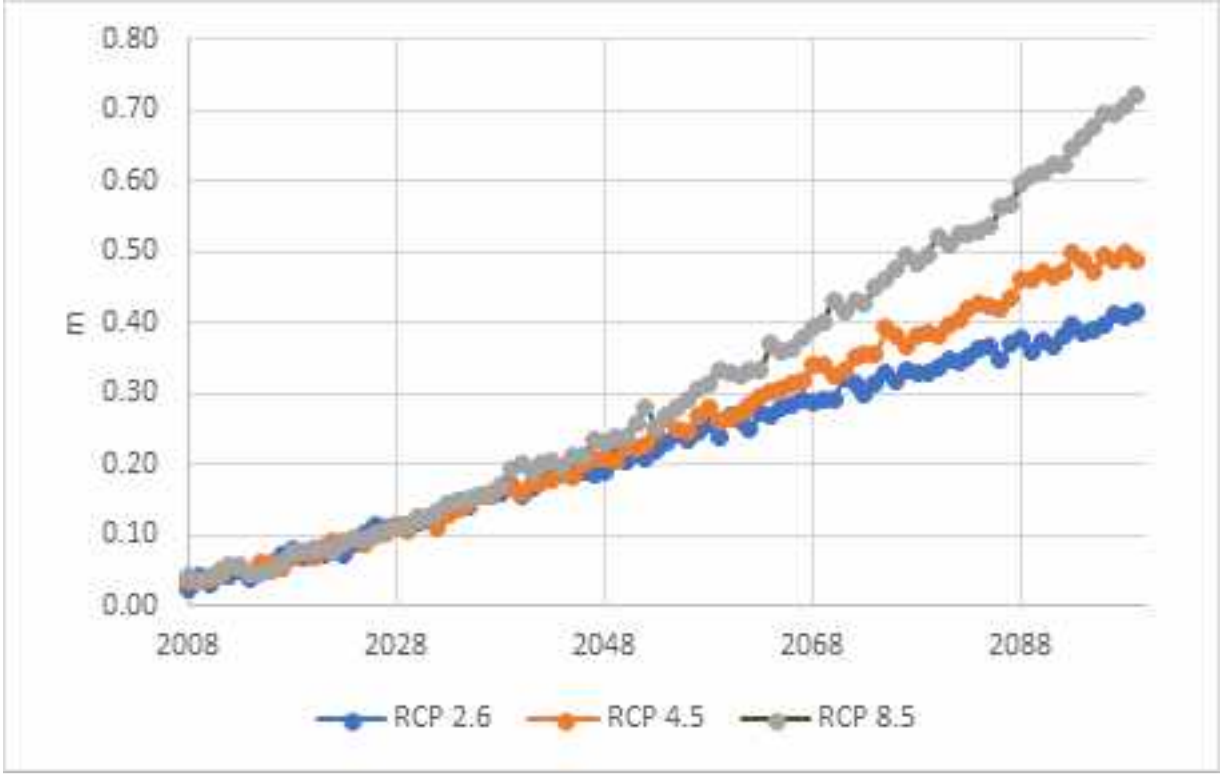


Figure 54 Future Projections of Sea-Level of Coastal Yemen.

Table 52 Projected sea-level rise (m) under CMIP6.

YEAR	SSP5 (RCP 8.5)	SSP3 (RCP 7)
2020	0.05	0.05
2040	0.16	0.16
2060	0.31	0.28
2080	0.51	0.46
2100	0.77	0.67

The impacts of sea-level rise

Sea-level rise might affect most of the building near the coast that has an elevation of zero or below sea level. Mapping sea-level rise under RCP 8.5 shows that the risk will be low in 2040 in the coastal area compared with 2100, by which the airport will be affected if no measures are taken, see Figure 53 (flooded area in puple).

Annex 3: Pre-feasibility assessment of proposed adaptation measures for the AF and GCF proposals

1. Introduction

This pre-feasibility study report," is a part of the Green Climate Fund (GCF) Readiness project called "Strengthen the capacities of sub-national authorities and key actors in the water sector to adapt to climate change in the Tuban delta." The study focuses on the Tuban delta, which is one of the most significant water basins in Yemen. Its objective is to assess potential measures to address the water deficits caused by the impacts of climate change and show the crucial need and feasibility of the seawater desalination plants as an adaptation option for enhancing water resilience against the climate change impacts.

The study encompasses a hydrology analysis of the Tuban delta, a Climate Change Vulnerability Assessment (CCVA), and consultations with stakeholders in the target area. The findings highlight the urgent need to address the water deficits that are projected to worsen due to climate change and population growth. The current water deficit in the Tuban delta stands at 84.4 million cubic meters (MCM), and it is expected to increase to approximately 90 MCM by 2025 and 147 MCM by 2050.

Addressing these water deficits is crucial to avoid the far-reaching implications of water scarcity on various aspects of life, including livelihoods, socioeconomic conditions, and public health. The report emphasizes the importance of developing suitable and sustainable solutions to reduce the heavy reliance on groundwater for water supply in the Tuban delta.

1.1 Background about Tuban Delta

The Tuban Delta is the downstream area of Wadi Tuban basin which is one of the most important water reservoirs in the country. The Wadi Tuban has a total area of 7360 Km^2 and consists of seven sub-basins (Saleh et al., 2012). The Tuban Delta is located between 44.65° - 45.1° E and 12.7° -13.3° N, its topography ranges from 10 below sea level to about 800 above sea level. Based on consultations in country, the Delta was divided into three regions: the Upper Region, the Middle Region, and the Lower Region, represented in Figure 55. The division was chosen because of different physical characteristics, pressures and issues being faced by each region.

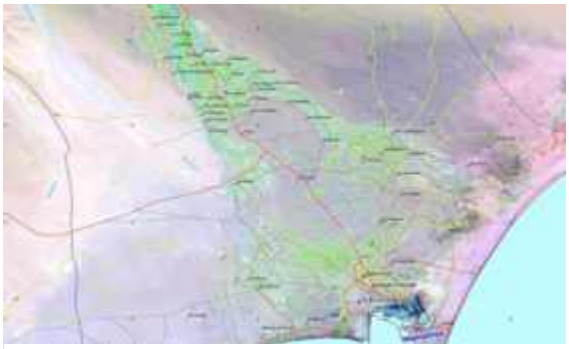


Figure 56 Tuban delta, Yemen

In the Tuban Delta, surface water and groundwater are experiencing several challenges, including overuse, increased evapotranspiration, and a lack of a sustainable water management strategy. These issues have an impact on the growing population, land use, water quality, water quantity, and agricultural systems. Furthermore, the development of several dams and other rainwater harvesting techniques in the upper section of the Tuban watershed (upstream) has decreased the availability of surface water in the Tuban Delta (downstream). As a result, limited water reaches the lower region and no water reaches the ocean, which forces people and farmers to depend mainly on groundwater. The demand for water in the region is due to both domestic and agricultural uses, with total demand in 2022 estimated at 136.4 MCM (million cubic meters) in demand (comprised of 45.5 and 91.9 MCM, for domestic and agriculture, respectively).

Figure 55 Tuban Delta regions with contours and streams delineated, UN-Habitat (2023) Hydrology report for the Tuban Delta

The estimated water supply is however only 53 MCM, resulting in a **total current water deficit of 84.4 MCM.** This deficit will accelerate in the future due to climate change impacts and population growth to be about 90MCM in 2025 and 147 MCM in 2050.

The sensitivity to water insecurity is high not only due to this water shortage but also due to water-intensive crops being cultivated such as sorghum, cotton, and vegetables, and that some households in the region are not linked to the water grid – up to 25% in Aden and 40% in Al-Hawtah. There is also an impact on natural ecosystems with the water withdrawal level so high, the environmental demand is unmet and no water flows to the ocean, disrupting the natural hydrological cycle.

2. Climate change risks, vulnerabilities and adaptation solutions

A climate change vulnerability assessment of the three regions for two key hydrological climate change impacts, flooding and water security, was undertaken. 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.

Table 53 Climate related risks

Climate risks	Upper Tuban Region	Middle Tuban Region	Lower Tuban Region
Water Security	Medium-High	High	High
Flooding	Medium	Medium-High	High

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. 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

This area covers 1030 km^2 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. 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. 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.

2.1 Water-related challenges

Water resources in Tuban Delta, including Aden/Lahj municipalities, face many challenges, including:

- ❑ Climate change risks and impacts
- ❑ Overuse of groundwater / depletion
- ❑ Lack of a sustainable / integrated water management strategy

Main hazards

- ❑ Droughts / Water scarcity
- ❑ Flooding (flash, river, coastal)
- ❑ Sea level rise (and saltwater intrusion)
- ❑ Heat (Heat waves, high nr hot days)

Impacts on water resources

- ❑ Reduced water availability due to the reduction of annual rainfall rates, which have depleted groundwater levels by about 1 m/year, increased saltwater intrusion, and led to land & soil degradation.
- ❑ Increased drought periods have dried out many streams in the lower Tuban region, which led to informal housing near the dried streams, thus exposing these to the risk of flooding.
- ❑ Increased extreme events, for example, a heavy rainfall in March 1981 led to a catastrophic flood.

Water deficit (2022 estimation)

- ❑ Water supplies: 53 MCM
- ❑ Water demand: 137.4 MCM
  - ➢ Domestic: 45.5 MCM
  - ➢ Agricultural 91.9 MCM

- ❑ Total current water deficit: 84.4 MCM. The deficit will increase due to climate change and population growth to about 90 MCM in 2025 and 147 MCM in 2050

CCVA and hydrology studies recomeded several solutions to overcome the identified vulberablity and risks. However, all the available options are not capable to address the water defects in the lower region as shown in *Table 54*. One of the possible measures is the water supply from treated wastewater and efficient irrigation. Both options will be insufficient to satisfy the growing water demand, especially considering future climate change impacts and population growth. Therefore, with the current dependence on depleting groundwater resources, sea-water desalination has become a crucial alternative for providing freshwater and part of a strategy to diversify water supply resources and use renewable water resources.

Table 54 Potential adaptation measures to contribute to addressing water deficit in the Tuban delta.

Potential solutions	Potential contribution to addressing water deficit
Shift to modern / efficient irrigation	45-50%
Wastewater treatment and reuse.	10 %
Greywater treatment and reuse.	5 %
Groundwater recharge from flood water and from the treated wastewater.	5 %
Total	65-70%

Remaining current gap (2023) even if potential solutions mentioned are implemented: at least 30-35 % or 25.3-29.5 MCM.

Remaining solution: increase the water supply through desalination plants which would provide a minimum of 35 MCM (100,000 m3/day) for domestic water use needed in 2024. Adaptation measures focused on a shift to modern irrigation systems and wastewater treatment and reuse will be part of an Adaptation Fund proposal. The next section further assesses all the available potential measures to address the water defeicts.

3. Pre-feasibility assessment of the proposed measures

All the proposed measures identified to address the water deficts were to reduce the high dependency and overuse of the groundwater by finding a new alternative source of water for the agricultural and drinking water pruposes. The aviable options are as follows:

3. Solar-powered desalination plant
4. Greywater reuse from Mosques and schools.
5. The development of the green belt along Aden - Abyan coastal highway.
6. Reuse of treated wastewater for agriculture irrigation and green belt
7. Rehabilitation the irrigation system and improving irrigation methods.
8. Rehabilitating Al-Hswah Thermal Power Plant
9. Re-utilizing the desalinated water from Al-Hswah Thermal Power Plant in artificial ponds for ground water recharge.

3.1 Solar-powered seawater desalination plant

1. Goal and objectives

The primary goals of a new desalination plant are to provide a sustainable, high-quality source of freshwater, address water scarcity, and meet the increasing water needs in the lower region while minimizing environmental impact and ensuring public health and safety, which will enhance water security, and reduce the risk of water shortages during droughts or other crises. The project will also contribute to reducing dependence on groundwater resources, which can reduce groundwater depletion and reduce saltwater intrusion.

2. Site assessment

Based on the consolation with the Ministry of Water, the selected site will be at AL-Haswa, which is 17000 m from the water supply point. All needed measure will be considered in the location to protect the Environment. The Ministry has 70,000 m^2 to construct the desalination plant. However, the solar power plant needs a big area. Each m^3 of desalinated water needs 4 Kwh, which needs 12 m^2 of solar panels. Thus, to produce 20,000 m^3/day, 240,000 m^2 of solar panels are needed + 24000 m^2 spaces between them and before the fence. N the other hand, the average solar radiation in Yemen is 450-550 cal/cm2 /day. The annual average of daily sunshine hours is between 7.3 and 9.1 hours/day.

3. Activities and related costs

The cost of any water desalination plant depends mainly on the production rate (desalinated water).for example, To produce 60,000 m³/ day (21.9 MCM/year), Al Khafji Solar Saline Water Reverse Osmosis (Solar SWRO) Desalination Plant costed 130 million USD (Link). Based on the hydrology study, the LR has a water deficit of 84 MCM in 2022. To stop using groundwater for drinking water purposes, 40MCM of desalinated water is needed (assuming the daily water per capita is about 100 litter), which will cost a lot (about 200 million USD). The proposed desalination plant can produce 20,000 m^3/day. The table below presents the breakdown activities and costs.

Table 55. Breakdown activities and related costs of construction a solar-powered seawater RO desalination plant.

Materials,	**Quantities**	**Dimensions**	**Budget**
A new 20,000m3/day seawater reverse osmosis desalination plant will cover 20% of current water deficit need, benefitting 812,206 people			
Offshore Seawater intake HDPE pipe (to get 50,000 m^3/day)	1	600m long, 1.5m diameter	6000000
Onshore intake water pump	1	0.58 m^3/sec	300000
Pretreatment Quartz sand filter/Mechanical filter	3	50X5 M	1500000
Activated carbon filter	3	50X5	1500000
High pressure centrifugal Pump			400000
Energy Recovery device			100000
Reverse Osmosis systes	1000	1.1 m, 8 inch	1500000
Water supply pipes		17 km	1000000
Water supply pump	2	0.23 m^3/sec	400000
Outlet HDPE pipe (to get 30,000 m^3/day)	1	2 Km X 0.5 m diameter with nozzles	10000000
Buildings , auxiliary and Service Facilities (with solar energy)			2000000
Waste and solid handling			1000000
O&M			5000000
A new solar photovoltaic (PV) plant (60 Mwh = 35 ha)			
Land	1	35 ha	1000000
Solar panels	13640	2.3X1.13	2500000
Solar inverter	18	3mw inverter	1500000
Bearing structures			10000000
Cables and lines			200000
Electrical substation equipment	1		500000
Electricity storage (batteries)	3	3000000	9000000
Fences and security measures			100000
Camera and security measures			500000
Labor and management			1500000
A climate change, WASH awareness program			
Capacity development with local and national government on resilient water management			1500000
Business management plan			500000
Capacity building courses/programs			1500000
workshops (the costs including posters and consultants)	200	50 people in each workshop	2000000
Integrated water-land resources management plan			2000000
TOTAL			65,000,000

4. Technical feasibility

In general, solar-powered desalination is a viable and increasingly popular option for addressing water scarcity in regions with ample sunlight. The table below presents some key considerations of the technical feasibility of constructing a solar-powered desalination plant.

Table 56. The technical feasibility factors of constructing a new desalination plant.

Factors	Description	Local/actual situation
Solar Resource Availability	7.3-.3-9.1 hours/day	Feasible
Desalination Technology	Several desalination technologies can be integrated with solar power, including reverse osmosis and solar stills.	Feasible
System Design	Consider the capacity of the solar panels or solar concentrators.	Feasible
Energy Storage	To supply during cloudy days or at night.	Feasible
Water Source	Seawater	Feasible
Water Demand	Can the plant meet the planned water needs effectively?	YES
Land and Infrastructure	The availability of suitable land for the plant, access to the coast (if applicable), and proximity to water distribution infrastructure	Feasible
O&M	monitoring, maintenance of solar panels, and equipment upkeep.	Feasible
Technological Advancements	Keep abreast of technological advancements in solar panels, energy storage, and desalination methods	Feasible

In summary, the construction of the proposed solar-powered desalination plant in Aden is feasible. However, a comprehensive feasibility study that considers all the above factors is essential to ensure a successful project.

5. Socioeconomic impacts

The construction and operation of a solar-powered desalination plant can have various socioeconomic impacts on the surrounding community and region. These impacts can be both positive and negative, depending on factors such as location, scale, and community engagement. Here are some of the socioeconomic impacts to consider:

- Job Creation: The construction and operation of the project can generate employment opportunities in various sectors, including project development, engineering, construction, and operations. This can reduce local unemployment rates and provide stable job opportunities.
- Increased Access to Freshwater: By providing a reliable source of freshwater in regions facing water scarcity, the desalination plant can support local communities, agriculture, and industry. This can enhance overall well-being, improve living standards, and stimulate economic growth.
- Agricultural Benefits: Access to desalinated water can enable agricultural activities in arid or water-scarce regions, leading to increased crop yields and the development of new agricultural ventures. This can boost the local economy and improve food security.
- Revenue Generation: The operation of the desalination plant can generate revenue for the local government through taxes, permits, and fees. This revenue can be reinvested in the community's infrastructure and services.
- Technological Advancements: The adoption of solar-powered desalination technology can stimulate innovation in renewable energy and water desalination fields, potentially creating opportunities for local businesses and research institutions.
- Community Development: The presence of the plant may attract new businesses and services to the area, leading to improved infrastructure, healthcare facilities, and educational opportunities.

6. Environmental impacts

- Reduction in Greenhouse Gas Emissions: Solar-powered desalination relies on renewable energy sources (solar panels). Thus, reducing the reliance on fossil fuels, which can help lower greenhouse gas emissions and combat climate change.
- Conservation of groundwater resources: Producing freshwater from seawater will reduce the pressure on the overexploited groundwater, which will help protect natural ecosystems/biodiversity, and groundwater (quality and quantity), which will reduce saltwater intrusion and improve soil properties.
- Sustainable Brine Disposal: Environmentally responsible desalination plants can employ innovative methods for brine disposal, such as dilution, deep ocean discharge, or resource recovery, minimizing the impact on marine ecosystems.

7. Coast effectiveness.

The new desalination plant will meet the increasing drinking water demand in the populated Aden. given the *availability of solar hours and solar panels in Yemen and* considering the LEC (0.036), solar-powered desalination is the most environmental and cost-effective desalination option.

8. Possible alternatives

Solar-powered desalination is a sustainable and environmentally friendly approach to producing freshwater from saline sources. However, there are alternative energy sources methods to compare based on their feasibility and the Levelized Energy Costs (LEC), which reflects all the costs including initial capital, return on investment, continuous operation, fuel, and maintenance, as well as the time required to build a plant and its expected lifetime, see the table below.

Table 57:. Possible clean energy sources to power the desalination plant.

Alternatives		Description	Possibility in the Tuban Delta	**LEC ($/kW-hr)**
Solar PV		The use of solar panels to generate electricity.	*Sun hours in Yemen between 7.3 and 9.1 hours, which makes it a feasible source.*	*0.036*
Wind energy	onshore	Wind energy can be harnessed to power desalination processes. Wind turbines generate electricity that can be used directly or to drive desalination systems.	*Aden doesn't have* consistent wind resources. *Moreover, wind turbines have more negative environmental impacts compared with the solar one in addition to operation and maintenance costs.*	0.038
	Offshore			0.106
Geothermal-Powered Desalination		In areas with access to geothermal energy sources, such as hot springs or geothermal reservoirs, heat from the Earth's interior can be used.	This approach is efficient and can be cost-effective. However, it is not applicable in the Tuban Delta.	0.04

Hybrid Systems	Combining multiple renewable energy sources, such as solar and thermal energy. Hybrid systems are designed to mitigate intermittency and fluctuations in energy production	Hybrid systems *needs more expertise for maintenance and operation works, which might be an issue in Yemen.*	0.165
Tidal and Wave Energy	Coastal regions with strong tidal and wave energy potential can harness these natural forces to generate electricity for desalination.	Tidal and wave energy devices can provide a stable power source. *However, this technology might not work well in some developing countries in their post-conflict phase such as Yemen.*	0.2-0.3
Biomass and Biofuels	In some regions, agricultural or forestry waste can be converted into biofuels, which can power desalination plants.	*This option is based on a good waste management system that can provide* organic waste, which is not in the case of Aden.	*0.09*
Nuclear Desalination	Nuclear power can be used to generate high-temperature heat for desalination.	*It is a consistent and powerful energy source; however, it raises concerns related to safety and radioactive waste.*	*0.093*
Fossil Fuels with carbon capture and sequestration (CCS)	Although not environmentally ideal, desalination can be powered by fossil fuels with carbon capture and storage technologies to mitigate greenhouse gas emissions.	*This approach can be considered in areas with limited access to renewable energy sources due to the extra cost of capturing carbon.*	*0.13*
Hydropower	Generating electricity from rivers	*It is not feasible in ´Tuban Delta*	*0.039*

Each alternative has its advantages and drawbacks, depending on the local conditions and environmental considerations however given the *availability of solar hours and solar panels in Yemen and* considering the LEC (0.036), solar-powered desalination is the most environmental and cost-effective desalination option.

3.2 Greywater reuse from Mosques and schools

1. Goal and objectives

Greywater refers to the wastewater generated from household activities like bathing, laundry, and washing dishes. The project aims at reusing greywater from schools and mosques to be used later after treatment for irrigation purposes. Reusing greywater from for irrigation in nearby areas can be a sustainable and cost-effective approach to water conservation. The project will contribute to increased water security by tapping into a new water source and reducing reliance on groundwater for irrigation and increasing the green areas around the selected locations. Moreover, reusing greywater will contribute to reducing groundwater depletion thus saltwater intrusion in the coastal area.

2. Site assessment

Many schools do not have proper water and sanitation systems, which means no greywater will be generated from these schools. Rehabilitation of some selected schools may raise the question 'what about the other schools?' Big mosques are in Aden. However, the water used for Wadu is salty, thus the treatment might not be economic or only salt-resistant plant will be irrigated. Moreover, most mosques and schools are built in dense urban areas with limited gardens/land around them. Therefore, the selection of the mosques and schools should be based on available area to use the treated greywater and to avoid addition costs regarding transferring the treated water to other locations to be used for irrigation. Maintenance will be the responsibility of the authorized people in schools/mosques. However, they need some training. 10 female schools and 20 Mosques from the lower region will be considered as it is more vulnerable to water scarcity compared to the middle and upper regions of the Tuban Delta. The selection will be based on land availability and the number of served people. In general, mosques and schools in the lower region are bigger and have more students/attendees.

3. Activities and related costs

All activities and the related costs are presented in the table below.

Table 58. The activities of the greywater reuse project.

Activities	Costs related to	Costs (USD)
Renovate sanitation systems in schools (some schools don't have a proper sanitation facility)	Plumbing (labor)	3000
	Construction work and materials	5000
	Pipes and tanks	4000
Greywater Collection and Storage System (installation of a greywater collection system)	Plumbing (labor)	2000
	Pipes, and	3000
	Storage tanks	4000
Greywater Treatment	Graywater system	120000
Irrigation System (to irrigate nearby irrigation areas)	Pipes and pumps	3000
	Labor	3000
	Others	3000
Irrigation Infrastructure	Installing as drip irrigation	9000
Monitoring and Maintenance	cleaning filters, pumps, and storage tanks.	9000
Raise awareness among students, staff, and the community about greywater reuse.	20 Workshops at schools and mosques	40000
	100 posters	1000
	2000 Brochures /Training material	5000

Administrative Costs	Project planning, Coordination and Reporting	10000
TOTAL		224000

4. Technical feasibility

Assessing the technical feasibility of treating and reusing greywater from schools and mosques for irrigation involves evaluating several key factors related to infrastructure, water quality, and sustainability. Greywater reuse can be an environmentally friendly and cost-effective way to conserve water and support irrigation needs. The table below presents the primary technical considerations.

Table 59. The technical feasibility factors of the Greywater reuse projects.

Factors	Description	Local/actual situation
Greywater Generation and Collection	Estimate the volume of greywater generated by schools and mosques (0.33 l/students/day and 2 l/mosque attendee/day)	The generated greywater from schools (825 m^3/year), while the generated greywater from mosques will be about (7300 m^3/year).
Greywater Treatment	Selecting the treatment technologies based on the quality of greywater	Feasible
Water quality	Determine the treatment capacity required to meet quality standards.	Feasible
Distribution System:	Pipes, pumps, and irrigation methods to optimize water use and minimize wastage.	Feasible
Storage Facilities	Plan for storage facilities to hold the treated greywater	Feasible
Maintenance and Monitoring:	Develop a maintenance plan for treatment systems, tanks, and distribution infra.	Feasible
Health and Safety Measures	Implement health and safety measures & Educate all users	Feasible
Regulatory Compliance	Ensure compliance with national regulations	Feasible
Community Engagement	Engage with the school and mosque communities.	Feasible
Sustainability	Developing a long-term O&M plan.	Not feasible without funds

Assessing the technical feasibility of treating and reusing greywater from schools and mosques for irrigation requires a site-specific evaluation and consideration of local conditions. Collaboration with water treatment experts, engineers, and local authorities is essential for designing and implementing a successful greywater reuse system.

5. Socioeconomic impacts

- The lower region faces water scarcity and greywater reuse is a good option for water savings and reducing the reliance on freshwater sources for irrigation.
- In general, using greywater for irrigation increases crop yields and farm income. However, some communities don't accept irrigating edible crops with treated wastewater/greywater. Therefore, awareness and training will be needed.
- The installation, maintenance, and operation of greywater treatment systems can create job opportunities in the water treatment and plumbing sectors. For this project at least two workers and two drivers will be employed to monitor the systems and to transfer the treated greywater to proposed places.
- The rehabilitation of the water and sanitation systems in female schools can ensure their active attendance all schooldays.
- Investment in greywater treatment technologies can drive innovation, potentially leading to more efficient and affordable systems. Aden University for example can be involved by which, master students and professors may develop local treatment systems.
- This project will promote awareness among communities about water scarcity and greywater reuse, which can empower individuals and organizations to make sustainable water management choices.
- The involvement of different stakeholders in this project can play and an important role in creating national regulations and policies governing greywater reuse.
- Due to water salinity, additional treatments might be needed, which will increase the costs of the project.

6. Environmental impacts

Reusing treated greywater for irrigation can have several environmental impacts, both positive and negative, depending on how it is managed.

- Water conservation: Reusing greywater reduces the demand for freshwater resources (groundwater discharge), which is especially important due to water scarcity in Yemen.
- Improving soil health and the ecosystem: the irrigated plants will lead to better soil retention, reduced erosion, increased habitat, and positive effects on the local ecosystem.
- Reducing wastewater loads by diverting greywater away from the sewage system. This can lead to cost savings and energy reductions associated with wastewater treatment.

7. Cost effectiveness

The measure will serve 15,000 students (females), and 10,000 mosque attendees. The generated greywater from schools will be about 0.5 litter per students per day for about 200 days; while for the mosques, it will be about 2 litter per attendee per day (365 days). Thus, the total annual produced greywater can be 1500 m^3 from schools and 7300 m^3 from mosques. Thus, mosques will generate more greywater compared with schools. Therefore, it will be more cost-effective for mosques. The total treated greywater can irrigate 2-3 ha, which means the generated greywater can contribute to irrigate 30 small farms, about 180 people. Thus, cost-effectiveness will be about 1245 USD/capita.

8. Possible alternative

The treated greywater can be used for toilet flushing. In this case, each location will need a pump, more pipes, and a high tank that can be located on the roof. Then, the cost effectiveness will higher be due to saving drinking water. However, reusing greywater in toilet flushing needs raising awareness activities to be accepted by the society.

3.3 The development of the green belt along Aden-Abyn costal road

1. Goal and Objectives

This project seeks plantation of green belt along Aden-Abyn costal road and using the treated wastewater from Al-Areesh WWTP to irrigate the belt. The reuse of treated wastewater will contribute to water security, reduce groundwater depletion and improved water management as the risks of decreased water security due to climate change have increased.

2. Site assessment

Green areas such as the green belt contribute to the aesthetic appeal and quality of life in Aden. Aden, like many other urban areas, faces various challenges related to pollution, inadequate green spaces, and a lack of recreational opportunities. Establishing green areas can help address these issues and bring about positive changes to the city's socioeconomic landscape. Moreover, the creation of green space in Aden increases resilience to urban heat island effect and reduces some climate change impacts such as erosion and flooding risks from sea level rise. Besides, the green belt will reduce the impacts of sandy storms at the coastal area.

Keeping these areas lush and healthy through irrigation with treated wastewater helps create pleasant and functional spaces for recreation and relaxation. However, it's important to note that the successful implementation of green areas in Aden will depend on careful planning, sustainable maintenance, and community involvement, which are the main challenges at this time.

3. Activities and related costs

The table below presents the related activities and costs of the green belt.

Table 60. Breakdown activities and related costs of the green belt.

Activities	Costs related to	Costs (USD)
Trees	Purchasing the trees	10000
	Labor and to plant the trees	20000
	machinery for excavation works	40000
	First irrigation (by trucks)	10000
Irrigation system	Water storage tank(s)	10000
	Pipes with drippers	50000
	Solar-powered Pump(s)	20000
	Labor	20000
Awareness	Workshop and posters	20000
O&M	3-4 years of maintenance work	100000
Total costs		300,000

4. Technical feasibility

Assessing the technical feasibility of planting a green belt in Aden, Yemen, involves evaluating several key factors related to environmental conditions, resources, and infrastructure. Establishing a green belt can have numerous environmental and social benefits, including improved air quality, biodiversity, and aesthetics. The table below presents the primary technical considerations:

Table 61. Technical feasibility factors of the green belt project component.

Factors	Description	Local/ actual situation
Site Selection	Identify suitable locations for the green belt based on local climate, soil conditions, and topography.	Feasible
Soil Quality	Assess the quality of the soil in the selected sites to determine its suitability for plant growth.	Feasible
Plant Selection	Choose native or drought-resistant plant species that can thrive in Aden's climate and soil conditions.	Feasible

Water Supply	Ensure a reliable and sustainable water source for irrigation, especially in arid regions like Aden.	Water will be provided from Al-Areesh WWTP
Irrigation System	Design an efficient irrigation system that minimizes water wastage and ensures proper distribution.	Feasible
Maintenance Plan	Comprehensive maintenance plan (regular watering, pruning, weeding, and pest control).	Feasible only at the beginning of the project when funding is available.
Climate Resilience	Select plant species that can withstand the region's climate variability (heatwaves and droughts)	Feasible
Community Engagement	Raise awareness , Involve local communities and stakeholders in the planning and implementation	Feasible only at the beginning of the project when funding is available.
Infrastructure and Resources	Assess the availability of infrastructure such as roads, fencing, and irrigation infrastructure.	Feasible
Regulatory Compliance	Obtain any necessary permits and approvals from local and national authorities for land use and environmental impact	Feasible
Biodiversity and Habitat Enhancement	Design the green belt to promote biodiversity and create habitat for local wildlife.	Feasible
Regulatory Compliance	Consider the use of native plants that support local fauna.	Feasible
Monitoring and Evaluation	Implement a monitoring system to assess the health and growth of planted vegetation.	This might not be feasible without continuous funding
	Evaluate the project's success in meeting its environmental and social objectives.	This might not be feasible without continuous funding
Sustainability and Long-Term Vision	Plan for the long-term sustainability of the green belt, including community involvement and financial sustainability.	Without continuous funding, the project will fail as no authority can operate/maintain it without funding

Establishing a green belt in Aden can contribute significantly to the city's environmental quality and overall well-being. However, based on national consultation, the project had failed before due to funding challenges and the conflict, which means funding is needed for continuous operation/maintenance. Otherwise, the project won't succeed. *Thus, it is not recommended to fund this project under the current post-conflict situation.*

5. Socioeconomic impacts

- Improved Health and Well-being: the green belt can improve environmental conditions thus reducing healthcare costs associated with pollution-related illnesses. Moreover, access to green areas can reduce stress and improve mental well-being, which can lead to increased productivity and job satisfaction.
- Tourism and Recreation: Green areas can become attractive destinations for tourists and residents, boosting the local tourism industry.
- Job Creation: The establishment and maintenance of green areas require skilled labor, offering employment opportunities in landscaping, horticulture, and park maintenance. Moreover, the development of recreational facilities and events in these areas can create jobs and generate income for local businesses.
- Increased Property Values: Properties located near green belt tend to have higher values, which can benefit homeowners and generate more property tax revenue for the city. Moreover, developers may be more inclined to invest in and develop areas around the green belt, leading to economic growth.
- Community Engagement and Social Cohesion: Community involvement in the planning and maintenance of the green belt can create a sense of ownership and responsibility among residents.
- Education and Research: The green belt can be used for educational purposes, such as environmental awareness programs and research projects, enhancing the knowledge and skills of residents. Moreover, educational and research institutions can collaborate with the city to conduct studies related to green spaces and their impacts.
- Cultural and Aesthetic Value: If the green belt is designed to reflect the local culture and heritage, it will promote a sense of identity and pride among residents. Moreover, Aesthetic improvements in the city can attract cultural events and art installations, stimulating the creative economy.

6. Environmental impacts

- If the green belt receives adequate treated wastewater, Aden can play a role in addressing climate change and creating more sustainable urban environments, which can help in reducing the risks of sandstorms, land degradation, erosion, and floods.
- The presence of green areas can help mitigate environmental issues, such as air and water pollution, and contribute to climate change adaptation by reducing heat island effects and providing shade.

7. Cost effectiveness

It is not clear to estimate the beneficiaries of such projects as it involves the people living near the belt and the people who travel using the nearby highway. The total cost of the green belt is estimated at 300,000 USD. About 5% of Aden

population (50,000 people) might benefit from the belt due to living nearby the area or using the nearby highway. Thus, the cost-effectiveness of this project can be 6 USD.

8. Possible Alternatives

The green belt or increase trees plantation in Aden can be performed with the help of local people and NGO, by which drought-tolerant trees can be provided to local people and the associated NGO to take care of plantation and maintenance.

The other option can be providing people with some productive trees, which can increase their income and the green areas in Aden at the same time.

3.4 Rehabilitating two WWTPs and the water system

1. Goal and Objectives

The goal of this projects to rehabilitate two WWTPs (Tahror and Saber) and and install three vertical pumping units using solar energy for the re-pumping station (Magrs nagy wellfield – Al-Hwtah). The project tackles water scarcity problem, which is one of the main climate change impacts in the Tuban Delta, by which the treated water will be used for irrigation and thus reducing depleting the vulnerable groundwater resources in the Delta.

2. Site assessment

The project proposes rehabilitating of two Wastewater treatment plants (Tahror and Saber WWTPs) and install three vertical pumping units using solar energy for the re-pumping station (Magrs nagy wellfield – Al-Hwtah) with all required accessories:

1. Tahror WWTP is located at Al-Hwtah District – Lahj Governorate (WWTP1), the closest residential area is about 50 m from the plant. The plant serves 26830 people from Al-Hwtah City and Al-Duba village. The plant consists of: an anaerobic Pond; length 54 m, width 39 m, depth 2.8 + 0.5 m), and a Facultative Pond: length 139 m, width 99 m, depth 1.25 + 1 m. No flow measurement device, no previous records. However, based on number of people served, the estimated daily flow is 1,880 m3/day. Based on size of Anaerobic Pond, the estimated capacity might be 960 m3/day. Most of the sludge are not removed yet. The rehabilitation works will not increase the plant capacity. When it comes to wastewater quality, the performed visits revealed that wastewater quality it not acceptable (Visually) as there are no regular tests to evaluate treatment efficiency or previous quality records. Thus, the plant has the following socioenvironmental impacts: Bad smell, mosquito spread, disease prevalence in areas near final discharge (Tahror and Kod Al-Zagbari villages). he treated wastewater benefits 29 farmers by irrigating 12 ha (Fodder only for livestock). No upgrade/extension can be done to the plant due to limited area. The rehabilitation works required are: Remove the sludge from the ponds; Remove tailings and trees from the plant and the ponds; Install flow measuring device; Establish a laboratory to inspect and evaluate the treatment efficiency (central laboratory in LWSC-Lahj); Supply emergency pumping unite, and Install fence around the plant.

2. Saber WWTP: This plant serves the Western part of Saber City (6900 people), the closest residential area is about 50 m from the plant. The plant consists of: One anaerobic pond: 30m length, 27m width, 2.5 + 2.2 depth; a facultative pond: length 53 m, width 43 m, depth 2.2 + 2.95m, and a maturation Pond: length 72.5 m, width 53 m, depth 1.2 + 3.1m.No flow measurement device, no previous records. However, based on number of people served, the estimated daily flow is 490 m3/day. Based on size of Anaerobic Pond, the estimated capacity might be 227 m3/day. The sludge is usually removed to the desert. However, socioenvironmental impacts include bad smell, mosquito spread, disease prevalence in areas near the plant. No upgrade/extension can be done to the plant due to limited area. The required rehabilitation works include Install flow measuring device, establish a laboratory to inspect and evaluate the treatment efficiency (central laboratory in LWSC-Lahj); Supply emergency pumping unite, install discharge pipe from the plant; and Rehabilitate guard room pumping house.

3. Activities and related costs

Rehabilitating a wastewater treatment plant involves a range of activities and related costs to upgrade the facility to its intended or improved operational condition. The specific activities and costs can vary widely depending on the size of the plant, its current condition, the extent of rehabilitation needed, and other factors. The table below presents the breakdown activities and the related costs.

Table 62: Breakdown activities / costs of rehabilitating the WWTPs.

Activities	Costs related to	Costs (USD)
Improving drinking water supply	Rehabilitation of buildings and accessories of the pumping station for Al-Waht City.	40000
	Construction of Ground Tank made of RCC/stone masonry with capacity of 300 m3, including the pipings and pups and solar energy	75000
	Supply and install tree vertical pumping units for re-pumping station (Magrs nagy wellfield to Al-Hwtah) with all required accessories	103600
Sub total		318600
Rehabilitation and upgrade of **Tahror WWTP** and reuse	Remove the sludge and trees from the ponds & the plant.	30000
	Install flow measuring device at the inlet chanel	4000

the treated wastewater for irrigation	Supply emergency pumping unite	12000
	Supply and Install steel coated mesh fence around the plant including concrete foundation, steel columns and main steel door.	33000
	Construction of Ground Tank made of RCC/stone masonry with capacity of 1000 m3	65000
	connection pipes and irrigation channels	25000
Sub total		169000
Rehabilitation and upgrade of **Saber WWTP**, and reuse the treated wastewater for irrigation.	Install flow measuring device at the inlet channel	4 000
	Supply emergency pumping unite	25 000
	Supply and Install discharge pipe	44 000
	Rehabilitate guard room	2 000
	Rehabilitate pumping house.	3 000
	Construction of Ground Tank made of RCC/stone masonry with capacity of 1000 m3	60000
	connection pipes and irrigation channels	20000
Sub total		158000
Total		645600

4. Technical feasibility

Assessing the technical feasibility of rehabilitating the WWTPs for irrigation involves a multidisciplinary approach, with input from engineers, water quality experts, agronomists, and environmental specialists. Collaboration with relevant authorities, local communities, and stakeholders is crucial to the success of the project. Proper planning and rigorous monitoring are essential to ensure the safe and sustainable use of treated wastewater in agriculture. This type of project can have significant environmental and economic benefits but requires careful planning and evaluation to ensure its technical feasibility, as presented in the table below.

Table 63. Technical feasibility factors of the WWTPs projects

Factors	Description	Actual situation
Water Quality Standards:	Ensure that the treated wastewater meets local and national water quality standards and regulations for irrigation use.	Feasible
Treatment Plant Capacity	Determine the treatment plant's capacity to meet the irrigation water demand and assess expansion needs.	Feasible
Water Quality Monitoring	Implement a continuous water quality monitoring to ensure that the treated wastewater meets irrigation standards.	Feasible
Pathogen Reduction	If required, install additional treatment processes to reduce pathogens to safe levels for irrigation.	Feasible
Nutrient Management:	Implement nutrient management strategies to prevent over-fertilization and minimize nutrient runoff.	Feasible
Community Acceptance:	Engage with local communities and stakeholders	Feasible
Regulatory Compliance:	Compliance with local, regional, and national regulations	Feasible
Training and Capacity Building	Provide training to wastewater treatment plant operators, irrigation system managers, and farmers	Feasible
Long-Term Maintenance:	Establish a long-term maintenance plan for both the wastewater treatment plant and the irrigation system.	Feasible

5. Socioeconomic impacts

- The project will Increase the irrigated areas, thus Increase water productivity and food production.
- Economic Benefits: Treating wastewater for irrigation can be more cost-effective than treating it to the higher standards required for drinking water. It can also reduce the costs associated with purchasing and transporting freshwater for irrigation purposes. Moreover, treated wastewater contains nutrients like nitrogen and phosphorus, which can act as fertilizers for plants. When used for irrigation, it can enhance plant growth and reduce the need for chemical fertilizers.
- Some people might not accept buying edible crops that were irrigated by treated wastewater.
- Using treated water in irrigation will increase the green areas, thus improve the local climate and reduce the risks of heatwaves and floods, which benefit most people of the society especially women and old people.

6. Environmental impacts

- Water conservation: using treated wastewater for irrigation will conserve groundwater resources. Thus, reducing the demand for potable water, which is typically of higher quality and better suited for drinking and other essential purposes. This helps to ensure a sustainable water supply in the study areas.
- Waste reduction: Instead of discharging treated wastewater into the ocean, which can still carry some pollutants, using it for irrigation puts the water to beneficial use. This reduces the environmental impact of wastewater disposal. Moreover, properly managed treated wastewater can help in protecting natural water bodies from pollution caused by excess nutrient runoff.

- ❑ Drought resilience: In Yemen, water resources are scarce, thus using treated wastewater can provide a reliable and sustainable source of water for maintaining green spaces. This contributes to the resilience the green areas during water shortages.
- ❑ Mitigating climate change: Green areas contribute to carbon sequestration and help mitigating the urban heat island effect.

7. Cost effectiveness

Table 64 Cost-effectiveness of proposed measures

Project components	Costs $	Beneficiaries		Cost effectiveness	
		Direct	Indirect	Direct	Indirect
Upgrading Tahror WWTP	169000	525	750	322	252
Upgrading Sabe WWTP:	158000	280	400	564	395
Developing efficient water supply	318600	89000	-	4	

8. Possible alternatives

For wastewater treatment, there are two options:

- ❑ New WWTPs: Constructing new WWTPs can be considered an option. However, this option needs more time and high capital cost.
- ❑ Septic tanks: Septic tanks are good option in rural areas. However, due to its cost, people in Yemen have constructed it without considering engineering standards or environmental impacts, which have led to groundwater pollution. This option requires responsible authorities to supervise/monitor the work and emptying the septic tanks, which will increase the capital and the private operation costs. Providing funding for some houses to construct such well-designed septic tanks can impact social equity principles.

For agriculture water needs, the following options can be considered:

- ❑ Rainwater Harvesting: Collecting rainwater and storing it for irrigation can help reduce the demand on treated water supplies.
- ❑ Water Conservation: Promoting water conservation practices and awareness can help reduce overall water demand. This can include public education campaigns, regulatory measures, and incentives for water-saving technologies.
- ❑ Alternative Water Sources: Depending on the local conditions, alternative water sources like fog harvesting, condensation, or atmospheric water generation may be explored for specific applications.
- ❑ Artificial Recharge: Recharge of aquifers with excess flooding water during wet periods can help store water for later use. Managed aquifer recharge can be an effective way to replenish groundwater resources.
- ❑ Greywater Recycling: Greywater, wastewater from non-toilet fixtures, can be treated and reused individually for irrigation and toilet flushing.

3.5 Rehabilitating the irrigation canals and installing drip

1. Goal and Objectives

The existed irrigation system faces many problems that reduce water use efficiency and pose flooding risks to the people, cultivated lands and infrastructure. Therefore, this project aims at rehabilitating the irrigation systems canals and installing drip irrigation system to deliver water in the stream effectively, increase water use efficiency and reduce flooding risks. *Thus, the project addresses the two main climate risks in the Tuban delta water scarcity and flooding.*

2. Site assessment

The irrigation system to be rehabilitated is based on 3 wadies the great wadi Al-Wadi Al-A'adhm (WA), the big wadi: Al-Wadi Al-Kabeer (WK), and small wadi: Al-Wadi Al-Sageer (WS), **Error! Reference source not found.**. The system consists of 14 weirs and serves 44604 people. The system irrigates 28540 acre (11 550 ha), 28% of which are irrigated by flood irrigation. Farmers cultivate cereals, onions, tomatoes, watermelons, melons, and other vegetables. There are 12000 farmers (30% women, 15% are IDPs farmers, 20% youth farmers), 70% of whom working on their own farms. Women farmers. The conducted field visits in October 2023 show that the system faces the following problems: Erosion of canal embankment, canals and control structures are full of sands, plants and sedimentation in the canal, damages of intakes structure of sub-canals, and damage of some gates and their lifting system. Therefore, rehabilitating these canals will increase the irrigated/cultivated area by 50%, which means creating new job opportunities for 6000 farmers.

3. Activities and related costs

The total cost of the project is estimated at (3,783,100 USD), as per the table below.

Table 65. Breakdown activities / costs of rehabilitation the irrigation canals.

Proposed Interventions	Estimated Cost ($)
Concrete works for canal intake structure, diversions, culvert and protection works.	837500

Supply and install lifting system + steel gates for intakes of main canals & diversions.	77500
Repair and maintenance of the lifting system and steel gates and steel handrails over the intakes of canals.	21600
Removal of deposited soil from canal intake and along the canal and earth works	183500
Construction of stone-gabions works for protection of irrigation canals, agriculture lands and Al-what city from flashing floods.	1203000
Support farmers' with modern irrigation techniques and system (Urban and Rural Areas) using bubbler irrigation techniques	1200000
Construct, supply and install automatic wadi flow gauging station at Dukeim	70000
Consultancy for detailed engineering study and tender documents for the project	60000
Technical staff to execute / supervise activities	621027
	4274127

4. Technical feasibility

In general, assessing the technical feasibility of rehabilitating and protecting irrigation systems is a complex process that requires careful planning, engineering expertise, and a holistic approach that considers environmental, social, and economic factors. Collaboration among relevant stakeholders, including government agencies, local communities, and technical experts, is essential to ensure the successful implementation of such projects.

Assessing the technical feasibility of rehabilitating and protecting an irrigation system involves an evaluation of various technical factors as presented in the table below.

Table 66.The technical feasibility of rehabilitating and protecting irrigation systems.

Factors	Description	Feasibility
Infrastructure Condition Assessment	Evaluate the current condition of the irrigation system, including canals, pipelines, pumps, and control structures.	Feasible
Water Source Sustainability	Analyze the availability and sustainability of water sources that supply the irrigation system.	Feasible
Hydraulic Design and Efficiency	Ensure that the hydraulic design of the system is efficient and meets the current and future demands of agriculture.	Feasible
Protection from Environmental Hazards	Implement protective measures, such as erosion control structures and sedimentation basins, to safeguard the system.	Feasible
Technological Upgrades	The use of environmentally friendly machinery	No
	The use of solar power pumps and control systems.	Feasible
M&O	Develop a comprehensive maintenance plan	Feasible
Community Engagement	Engage with local communities and stakeholders to gather their input and ensure that the rehabilitation efforts meet their needs.	Included in the activities

5. Socioeconomic impacts

The project will benefit 73317 people, of whom 72000 people will benefit from the irrigations systems and 1245 people will be protected from floods. Other socioeconomic benefits include:

- Improving water supply and distribution will lead to (20-30%) increase in food production, which can contribute to food security by increasing the availability of food crops and reducing the need for food imports, potentially lowering food prices.
- Rehabilitation will lead to an increase in land values in the affected area by 20-30%.
- Improving the irrigation systems can help reduce the reliance on rain-fed agriculture, making farming more predictable and stable and encourage farmers to keep their farms.
- The project will increase employment opportunities in the construction and maintenance phases, in addition to the farming opportunities.
- The project will support 350 poor farmers with drip irrigation systems, which will increase their income.
- This project will develop the area allowing to new infrastructure and encourage education.
- Average costs of flood damage which would be avoided as the result of the rehabilitation.

6. Environmental impacts

- *Improved Water Efficiency (*reduce water wastage through leaks and evaporation):
- Canal rehabilitation can lead to reduced water wastage through leaks and seepage, improving water use efficiency and reducing the overall demand for freshwater resources. Moreover, the project will improve water-use efficiency in agriculture and will save 50% of the used water. Thus, water consumption will be less and the stress on water resources will be reduced. Moreover, Rehabilitating the canals will allow more water to reach farmers thus will reduce groundwater discharge.
- Reduce groundwater depletion: Farmers who get water from the canals will reduce their dependency of groundwater resources. Thus, reducing groundwater depletion.

- Energy Consumption: Energy-efficient technologies will be considered such as solar pumps or water-efficient distribution methods.
- *Habitat Restoration*: Proper canal rehabilitation provides opportunities for habitat restoration and enhancement. This includes planting native vegetation along canal banks and creating or restoring wetlands, which can support biodiversity.
- *Reduced Erosion*: Properly rehabilitated canals control soil erosion by managing water flow and preventing sediment from entering natural water bodies.
- *Aquatic Ecosystem Health*: Improved canal management leads to better water quality and flow patterns, which can benefit aquatic ecosystems and the species they support.
- *Sustainable Agriculture*: Enhanced irrigation systems can support sustainable agriculture by ensuring a reliable water supply, which can reduce the pressure on natural water sources like rivers and lakes.

10. Cost effectiveness:

The project will have two aims:

- For improving agriculture practices, the total cost is estimated at 1483024 USD and the total direct beneficiaries will be 72000 people, thus cost effectiveness is 21 USD/person.
- For flood protection, is estimated at 1475000 USD and the total direct beneficiaries 50140 person. Thus, cost effectiveness is 29 USD/person.

11. Possible alternatives

If the flow in the channels is very low, maintaining these channels can be done by the local authorities and there will be no need for rehabilitation. In this case, the focus can be on installing modern irrigation system, which might not be the focus of UN Habitat.

3.6 Rehabilitating Al-Hswah Thermal Power Plant

1. Goal and Objectives

The objective aims to rehabilitate Al-Hswah power plant, by which the produced electricity and water will increase. The project contributes to water security by providing an additional water resource by utilizing the condensed desalinated water.

1. Site assessment

The rehabilitation works will increase desalinated water, which will be 1400-2600 m^3/day. This water will be mixed with the water coming from Bir Ahmed (Tuban Delta) wellfield to be used for drinking purposes through the network.

2. Activities and related costs

Table 67 Breakdown activities/costs of the artificial ponds for rehabilitating the power plant.

1	Rehabilitation of the existing desalination units +A3:F8	BoQ	**1 000 000**
2	Rehabilitation of existing pumping, storage, pipeing and connections	LS	**200 000**
3	Detailed engineering study & tender	LS	**50 000**
4	O & M	36 Months	**72 000**
5	Technical staff	LS	**15000**
TOTAL			**1337 000**

3. Technical feasibility

Despite the local team's expertise in running the plant and their clear understanding of the needed actions, rehabilitating the facility is simply not feasible. The power plant's outdated system has reached a point of critical deterioration. Furthermore, any attempt to intervene in this intricate system carries a high risk of causing catastrophic failures. Therefore, rehabilitation efforts are not feasible. On a brighter note, if alternative solutions emerge to address the energy shortage, the plant might be decommissioned and dismantled.

4. Socioeconomic impacts

Rehabilitating the plant will increase water production by 2600 m^3/ day of desalinated water, which will improve the quality of the water in the networks and can serve 26000 people. However, this needs a good cooperation between the ministry of water and the Ministry of Power.

5. Environmental Impact

The main environmental impact is CO2 emission. However, considering the situation in Yemen, it will be better to increase water supply and sustain electricity from the existed resources.

6. Cost effectiveness

The rehabilitating work will directly serve 26000 people and indirectly 786204 people. Thus, cost effectiveness will be 51 and 2 USD/person considering direct and indirect beneficiaries, respectively.

7. Possible alternatives

Solar energy is the best possible electricity resources for areas like the city of Aden. However, due to post conflict challenges and the lack of expertise, installing a big solar plant to serve a million people is not feasible currently.

3.7 Constructing an artificial pond/lake for groundwater recharge

1. Goal and Objectives

The objective of this project is to use the desalinated water that are produced in the power plant to recharge groundwater instead of discharging it to the ocean. The project aims at constructing an artificial pond, which can serve as a creation area that supports biodiversity, reduce heatwaves, recharge the depleted groundwater and the extra water can be used for irrigation. Thus, the project is an adaption measure that can reduce climate risks such as water scarcity, biodiversity loss and groundwater depletion.

2. Site assessment

Now a day, the power plant discharges the desalinated water, 1,400 m^3/day, to the ocean. This water can be used for groundwater recharge by transferring it to appropriate artificial ponds. This option involves some risks regarding the possibility of illegal use of the water before reaching the pond and the high evaporation rates. The evaporation rate in Yemen is about 1.25 m/year. Thus, to reduce the evaporated amounts, the constructed ponds should have small surface areas. The daily water production is estimated at 1400 m^3/day, which leads to an annual storage of 0.5 MCM. However, to design a pond for a 30 days flow, 42000 m^3, we can assume the depth to be 3 meter thus the surface area will be 14000 m^2 (100X140 m^2) , which means the evaporation will be about 1500 m^3 per month and the same amount will infiltrate. Thus, the remaining water will be 39000 m^3. The first two days from the next month can fill the pond and any extra water can be used for irrigation.

At the end for the same pond size (140*100*3 m^3), the water will be divided into 42000,18000, 18000, & 433000 m^3 for filling the pond, evaporation, infiltration and irrigation, respectively.

3. Activities and related costs

Constructing artificial ponds or lakes for groundwater recharge is a water management technique used to replenish and enhance groundwater resources. The activities and costs associated with such projects can vary depending on the location, size, and specific goals of the recharge facility, the table below present most of the activities and its related costs. However, it is essential to note that the costs associated with constructing artificial ponds or lakes for groundwater recharge can vary widely based on local conditions, project size, and specific project goals. To get an accurate cost estimate for a particular project, it's advisable to work with experts, conduct a detailed feasibility study, and solicit bids from contractors. Additionally, consider funding sources, which may include government grants, private investment, or a combination of both.

Table 68. Breakdown activities/costs of the artificial ponds for groundwater recharge.

Activities	Costs related to	Costs (USD)
engineering Study	hiring experts	80000
Excavation and Earthwork	Excavation Works	126000
Embankment Construction	Engineering work and supervision	120000
Irrigation canals/pipes	Design,Excavation and Distribution	90000
Water Supply from the thermal power plant	Pipelines, pumps, excavation works, labor & material	1280000
Vegetation / creation area	Planting native vegetation	50000
O&M	Regular maintenance (36 months)	72000
Community engagement	Posters , workshops and meetings	10000
Total		1828,000

4. Technical feasibility

Assessing the technical feasibility of constructing artificial ponds or lakes for groundwater recharge involves considering several critical factors and conducting a thorough evaluation of the project's viability. It's essential to conduct a site-specific feasibility study and engage with hydrogeologists, engineers, environmental experts, and relevant stakeholders to assess the technical feasibility of constructing artificial ponds or lakes for groundwater recharge. However, based on national consultations, the design and the implementation of this project is feasible. However, good monitoring plan should be in place to make sure that the sustainability of the project and prevent illegal pumping of the water from the lake.

5. Socioeconomic impacts

The rehabilitating works and the planned activities can create job opportunities, potentially benefiting the local community.
Providing communities with reliable water sources can improve their overall quality of life, health, and well-being.

- ❑ The project needs proper monitoring and maintenance activities. Otherwise, all installed equipment will be lost.
- ❑ The rehabilitating works and the planned activities can create job opportunities, potentially benefiting the local community.
- ❑ Rehabilitating the power plant and increasing water distribution can stimulate economic growth and development in the region.
- ❑ Providing communities with reliable water sources can improve their overall quality of life, health, and well-being.
- ❑ The project needs proper monitoring and maintenance activities. Otherwise, all installed equipment will be lost.

6. Environmental impacts

- ❑ Increased Freshwater Supply: Desalinated water can help meet freshwater demands in arid regions where water scarcity is a significant concern. This can reduce pressure on local freshwater sources, including rivers and aquifers.
- ❑ Groundwater recharge: Desalinated water will recharge groundwater, it will help mitigate the depletion of aquifers and can help combat saltwater intrusion, which are the main issues in the lower region of the Tuban Delta.

7. Cost effectiveness:

The plant produces 1400 m^3/day (511,000 m^3 /year), 5% of which will evaporate, 10 % will recharge the groundwater, and the rest will be used for irrigation. The benefits include supply drinking water for 1400 people and irrigating 450 ha (supporting 450 farmers), which means the cost effectiveness is about 988 USD per capita.

8. Possible alternatives

- ❑ The desalinated water can be delivered with low cost to the water company by which it can be mixed with Aden's water network and supply 14000 people.
- ❑ Groundwater recharge can be done using treated wastewater, treated greywater and flooding water, which are be cost-effective options.

4. Conclusions and recommendations

This report assessed the proposed interventions tackling water security and flooding risks in the Tuban Delta. The table below summarizes the interventions, costs, beneficiaries, cost per beneficiary, and the related AF's environmental and social principles of the proposed interventions.

Table 69. The costs, beneficiaries, and cost-effectiveness of the options

Interventions	Outcome	Target commune	Costs (USD)	Beneficiaries *	Cost effectiveness (USD/person)	AF Environmental & Social Principle Triggered
Seawater Desalination plant	Securing drinking water	Aden	65000000	812,206	80	1-5
Greywater reuse from Mosques/ schools	reusing greywater in irrigation	10 mosques and 20 schools	224000	180	1245	1, 4, 10,11
Rehabilitating Tahror WWTP	Increase the efficiency and the quantity of the treated WW	Al-Hwtah District and Sabr City	169000	1275	133**	1,10,11,14
Rehabilitating Saber WWTP			158000	680	232**	
The green belt	16 km long of trees near the coast	Aden	300,000	50,000	6	1,2,5,9,14
Early warning Systems & risk management plans	An EWS will be installed, and a risk management plan will be prepared	Tuban Delta	2800000	1,000,000	3	1-5, 8.9,11
Uppgrading of Alheswa power plant (screened-out by ministry)	2600 m^3/day of water	Aden	1337000	26000	51	1-5
Artificial pond for groundwater recharge	Creation area & groundwater recharge	The Lower region	4020000	1850	988	1-5,9,10
Rehabilitating the Irrigation systems	Water use efficiency, And Flood protection	Tuban Delta	4274127	73317	58	1-5,10,11,14

*About 66% of the Beneficiaries are kids/youths, 17% are men & 17% women. ** including direct and indirect beneficiaries.

On the other hand, each of the intervention plays a role in saving/producing water and reducing the current water deficit as show in the table below.

Table 70. Saved water from the proposed interventions.

Interventions	Saved water MCM (m^3/day)	Deficit reduction %
Seawater Desalination plant	7.3 (20000 m^3/day)	9
Rehabilitation of the irrigation canals	0.8	0.9
Artificial groundwater recharge from the power plant	0.5 (1400 m^3/day)	0.6
Rehabilitating the Power plan and using the desalinated water for drinking purposes	1.46 (4000 m3/day)	1.7
Rehabilitating the WWTPs	0.3 (700 m^3/day)	0.3
Greywater reuse from Mosques/schools	0.0088 (22 m^3/day)	0.01
Greywater reuse in toilet flushing	4.5	5

Based on this pre-feasiblity assessment and the previous CCVA and hydrology study, the following projects are feasible and can be considered:

a. Constructing solar-powered seawater desalination plant is feasible as it reduces water insecurity and groundwater depletion in the Tuban Delta.
b. Rehabilitating the irrigation canals is feasible as it reduces flooding risks and support water security.
c. Rehabilitating WWTPs is feasible as it produces more water to be used for irrigation thus reducing the pressure over the depleted groundwater resources.

To conclude, the three proposed measures should be implemented in integrated and inclusive way in order to enhance the climate-resleient of the Tuban Delat as the main water source of millions of people in Aden and Lahj. Therefore, the government of Yemen is intended to implement all the proposed interventions through GCF and Adaptation Fund as follows:

Table 71 Proposed measures for the GCF and AF proposals

GCF	AF
- Constructing solar-powered seawater desalination plant	- Rehabilitating the irrigation canals
	- Rehabilitating WWTPs

Annex 4: ESIA-ESMP, including social inclusion plan

Public Consultation / disclosure notice[103]

Public Consultation/Disclosure Notice

Date: **XXXX**

The United Nations Human Settlement Porgramme (UN-Habitat) and the Environment Protection Authority (EPA) are requesting feedback on this draft Environmental and Social Impact Assessment and associated Environmental and Social risks Management Plan for this project.

Comments and questions can be sent to the following address:

United Nations Human Settlement Porgramme
Email: unhabitat-yemen@un.org
Website: https://www.unhabitat.org
The last date for receiving of comments is XXXX

This document and its content have been prepared and are intended for UN-Habitat's, AF's and Yemen government information and use in relation to the project 'increase climate change resilience to water scarcity and flooding in the Tuban Delta.' The report was prepared by UN-Habitat and reviewed by the Environment Protection Authority (EPA), the AF Designated Authority (DA) in Yemen.

[103] In line with standard practice and requirement for UN-Habitat projects that seek support from the Adaptation Fund (AF), UN-Habitat discloses the proposed project ESMP before the AF Board consideration of the project proposal on the relevant UN-Habitat website in both English and the local language(s).

1. ENVIRONMENTAL AND SOCIAL RISKS AND IMPACTS ASSESSMENT (ESIA)

Executive summary and key recommendations

In short

- Project is categorized as category B project.
- A detailed ESIA-ESMP[104] has been prepared for the project with a focus on the proposed concrete interventions, which include:
- Rehabilitation of the irrigation system activities (outputs 2.1.; 2.2.; 2.3.) and modern irrigation system (output 4.1)
- Activities related to (re)use of (treated) (waste)water (outputs 3.1.; 3.2.; 3.3.; 3.4)
- Activities related to awareness raising, capacity strengthening and planning have been screened as well in Table 84.
- As long as the proposed follow-up actions are taken, and the main proposed risks mitigation measures are fully implemented, any potential environmental and social risks and impacts will be site-specific and localized.

Project categorization

Based on the risks screening against the 15 AF safeguard areas, the project has been categorized as a "B" category project in terms of the environmental and social risks it poses.

Main outcomes of the environmental and social risks screening and impact assessment

- Potential risks and impacts have been identified in related to AF principles:
  - 1: compliance with the law
  - 2: access and equity
  - 3: vulnerable and marginalized groups
  - 6: core labour rights:
  - 12: pollution and resource efficiency:
  - 13: public health
- No risks and impacts were identified in relation to:
  - 4: human rights:
  - 5: gender equality and women's empowerment:
  - 7: indigenous people:
  - 8: involuntary resettlement:
  - 9: protection of natural habitats:
  - 10: conserving biodiversity:
  - 11: climate change:
  - 14: physical and cultural heritage:
  - 15: land and soil erosion:
- Mitigation measures are in place to avoid or reduce any of above potential risks and impacts.

Key recommendations

- This ESIA-ESMP should be approved by the Yemen government no later than the project inception phase.
- All project beneficiary groups will be consulted again during the inception phase to verify and further identify all specific needs and concerns of groups.
- The project will ensure equal opportunities in participation and decision-making of women, youth and other vulnerable groups by using quotas and by agreeing on representation in decision-making processes through the use of ToRs, agreements, etc. Quotas and a targeting strategy will be applied for meetings, workshops, and trainings.
- A Grievance and Redress Mechanism will be strictly applied.
- The project follows ILO core labor standards. Looking at the conventions and protocols not ratified, the project will be particularly attentive to any health and safety and inspections.
- Employment and working conditions following core labour standards to which the project activity will need to comply will be included in all legal agreements with all sub-contractors, including steps and responsibilities to comply.
- A waste management plan will be prepared. Reference to the waste management plan to which the project activity will need to comply will be included in all legal agreements with all sub-contractors, including steps

[104] Environmental and Social Impact Assessment and Environmental and Social risks Management Plan.

and responsibilities to comply. It will be ensured treated wastewater is only used for appropriate crops (through coordination with farmer/water user associations and authorities and related monitoring), while complying with (international) standards for water quality.

Purpose, scope, and methodology of ESIA-ESMP

Social and environmental policies are essential tools to prevent and / or mitigate undue harm of projects and project activities to people and their environment. In line with the Adaptation Fund's Environmental and Social Policy (ESP) and UN-Habitats safeguards system, UN-Habitat is required to categorize the risk of the project as a whole and to identify and manage any potential environmental and social risks and impacts. This Environmental and Social Impact Assessment (ESIA) and Environmental, Social Risks Management Plan (ESMP) has been prepared by UN-Habitat.

The purpose of the ESIA-ESMP document is to demonstrate how this project complies to the AF ESP. The document shows what potential environmental and social risks and co-benefits and opportunities have been identified per project activity, the potential impacts of the risks and how these will be managed / mitigated.

To ensure compliance with the AF ESP, all proposed project activities have been screened against the 15 AF principles (i.e., safeguards) to identify potential environmental and social risks and to assess related potential impacts. Where risks have been identified, the significance of impacts have been assessed and where needed, measures to avoid or mitigate risks and impact identified (+ monitoring arrangements). Analyses are based on collected disaggregated data focused on identification of climate change related needs, limitations, constraints, and requirements specific for marginalized and vulnerable groups, especially of women and youth. Activity prioritization has been done in consultations with project beneficiary groups. The executing entities and other contractors will also comply to the ESMP.

Socio-economic and environmental context of the Tuban delta

The Tuban Delta region is highly vulnerable to water insecurity, with the highest level of vulnerability in the Lower Region which includes Aden and the middle region which includes Al-Hawtah. The area is vulnerable due to the high level of exposure of assets and people, the sensitivity of the existing systems including agriculture, natural resources, and health systems and low levels of adaptive capacity.

The city of Aden, located in the Tuban Delta, has grown from 589,419 in 2004 to an estimated 1,051,000 in 2021, in part due to in-migration of Internally Displaced Persons fleeing conflict in the north. Yemen, including Aden and the Tuban Delta, experiences extreme water scarcity due to its climate and overexploitation of groundwater which will be exacerbated by increased heat and unpredictable precipitation patterns as a result it is necessary for Yemen to increase water supply through innovative methods which is why the development of a desalination plant is the proposed intervention.

In terms of exposure, there are over one million people in Aden, and an additional 100,000 plus in the region, that are potentially water insecure due to higher water demand than supply and the climate hazards such as drought and evapotranspiration from heat which could further reduce water supply. In addition, despite the high levels of urbanization there are over 9,000 hectares of agricultural land in the surrounding area, the majority of which do not have modern irrigation methods.

Water scarcity has profound socioeconomic impacts in arid areas like the Tuban Delta. The limited availability of water severely affects agriculture, leading to reduced crop yields, livestock losses, food insecurity, unemployment, and poverty. Inadequate water supply and sanitation facilities contribute to health issues, as clean water access decreases and waterborne diseases become more prevalent. Education is also affected, as children, especially girls, must spend significant time fetching water instead of attending school, and educational institutions struggle to provide clean water and sanitation facilities. Water scarcity hampers economic productivity, particularly in water-intensive industries, leading to decreased production, job losses, and hindered economic growth. Additionally, water scarcity can fuel migration and conflicts as competition for limited water resources arises, disrupting social cohesion and straining resources. Comprehensive strategies focusing on water management, infrastructure development, and socio-economic interventions are necessary to address water scarcity and promote sustainable socio-economic development in areas like Aden.

Climate change vulnerability assessment of the Tuban delta

A Climate Change Vulnerability Assessment (CCVA) was prepared as part of the GCF readiness project (for more details see annex 1 on 72). The CCVA, together with the hydrology study, form the basis for identifying adaptation options for the water sector.

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 insecurity and flooding, which is largely due to the higher number of people and assets exposed and sensitive to these hazards. Besides sea-level rise is a risk, which may also negatively affects water security and flood impacts.. 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.

Increased temperature and variations in precipitation patterns are beginning to affect Yemen and expected to intensify in coming decades with impacts on extreme events, sea level rise, and water and food security. This project is concentrated on the water security issues faced by the Tuban Delta, including Aden, as a result of climate change while recognizing that other climatic hazards will also impact on the overall resilience and development of Yemen and the Tuban Delta.

Looking from a water security lens, the potential **temperature increases** of as high as +3.5 to +4.0ºC along the Red Sea and Arabian Sea coastline by the end-century (2070-2099) and approximately +2.0 ºC by mid-century (2050). Further modeling shows that an increase of 30 additional hot days (>40ºC) per year by mid-century under a medium emission scenario (RCP 7).[105] This will **increase evapotranspiration**, thereby decreasing water supply for households and agriculture while also potentially simultaneously increasing water demand as a coping mechanism.

In addition, the number of dry days per year is expected to increase along the western Arabian Sea coastline as well as towards the Highlands by approximately 2 to 6 additional days/yr. under the low-emission scenario (RCP 2.6) and by 8 to 14 days/yr. under the high emission scenario (RCP 8.5.).[106] Further the lower Tuban Delta region, which includes Aden, is likely to have more **drought periods** than the rest of the Tuban Delta.

Sea-level rise (30 cm by mid-century and up to 77 cm by the late 21st century) will continue to exacerbate shoreline erosion, as well as accelerate **saltwater intrusion** into groundwater which is already being observed as a result of increased water demand and drought years.

Serious and severe flooding in all regions of the Tuban Delta is likely to increase from 2040 under both medium and high emission scenarios due to increased heavy precipitation.[107]

In summary, major climatic threats for the Tuban Delta include (i) higher intensity and frequency of floods in exposed areas, (ii) prolonged droughts due to increasingly erratic rainfall and temperature (iii) increasing water stresses due to higher evapotranspiration rates from heat, increasing pressure on water resources and sea-level rise

These climatic threats combined with the current depleted water supply (outlined below) and growing demand for water in the region due to population and economic growth results in an untenable situation in which reduced water supply, exacerbated by climate change, can not meet the demands necessary for the region. This has implications for agricultural productivity and subsequently food security and livelihoods security for thousands of families in the Tuban Delta.

[105] GCF Country Programme Yemen 2023 (in draft)
[106] Ibid
[107] UN-Habitat (2023) Hydrology Study of the Tuban Delta

Hydrology study of the Tuban delta

Water resources in Tuban Delta face many challenges, including climate change, overuse, and lack of a sustainable water management strategy. Climate change impacts on water resources include:

- Reduce water availability due to the reduction of annual rainfall rates during the last decades, which have depleted groundwater levels by about 1 m/year, increased saltwater intrusion, and led to land & soil degradation.
- Increase drought periods has dried out many streams in the LR, which encouraged illegal housing near the dried streams, thus exposing them to the risk of intense flooding.
- Increase extreme events, for example, a heavy rainfall in March 1981 led to a catastrophic flood.

These issues have affected the growing population, land use, water quality, water quantity and agricultural systems. The 2022 estimation of water supplies include renewable surface water, renewable groundwater water and non-conventional water resources, which have been estimated at 59, 139, and 10 MCM, respectively. While the water uses include 194 MCM for agricultural uses and 50 MCM for domestic uses, which means agricultural water represents 80% of the total water use. This results in a total water deficit of 36 MCM. Furthermore, the development of several dams and other rainwater harvesting techniques and the overuse of surface water in the upper section of Tuban watershed (upstream) have decreased the risk of floods but decreased the availability of surface water in Tuban Delta (downstream). As a result, limited water reaches the lower region and no water reaches the ocean, which has forced people and farmers to depend mainly on groundwater using renewable energy leading to a big water deficit. These factors coupled with climate change have increased saltwater intrusion to groundwater aquifers, desertification, increased groundwater depletion, led many well to run dry and deteriorated the fertile soils in the lower region of Tuban Delta.

Possible options to reduce this deficit include:

- Shifting from traditional surface irrigation to drip irrigation (if all agricultural lands use drip irrigation, 45-50% of the deficit will be covered).
- Wastewater treatment and reuse: Most people in the Tuban Delta use septic tanks. The available wastewater that can be treated can cover about 10% of the deficit.
- Greywater treatment and reuse: can be used in the nearby areas, however, if it is used in toilet flushing, it can cover 5% of the deficit, which is not applicable at this time.
- Groundwater recharge from flooding water and from the treated wastewater can cover 5%.
- Monitoring groundwater resources and preventing unauthorized extraction activities. This option should be used to reduce illegal groundwater recharge, thus reduce groundwater depletion and saltwater intrusion.

However, the mentioned above options will be insufficient to satisfy the growing water demand in Aden, especially considering future climate change impacts and population growth. Therefore, with the current dependence on depleting groundwater resources, sea-water desalination has become a crucial alternative for providing fresh water and is part of a strategy to diversify water supply resources and use renewable water resources.

Future projections: The MRI-ESM2-0 climate model and QGIS have been used to analyze future water availability under two Shared Socioeconomic Pathways (SSP3: RCP 7) and (SSP5: RCP 8.5). Two main scenarios have been assessed, the first is the reference scenario where all activities and population growth stay the same, while the second one is the improve scenario, which considers modern irrigation, decreasing in the population growth rates and increase the use of treated wastewater. The results reveal a wide range in water availability estimates up to 2100 in the three regions. Under the reference scenario, water deficit might be more than 400 MCM in 2100 under both climatic pathways (SSP3 and SSP5). However, examining the improved scenarios show a better situation in Tuban Delta. However, the water shortage might not be more than 43 and 10 MCM in 2100 under SSP3 and SSP5, respectively. On the other hand, the LR will experience the greatest water scarcity due to rising demands brought on by traditional irrigation methods and population growth as all these scenarios predict severe water shortages in the LR, which might range from 60 to 80 MCM under the improved scenarios. Therefore, the LR will need extra water resources such as a 50 MCM solar pumped sea-water desalination plant as soon as possible, then other 10 MCM plants every 5-10 years.

Examining the improved scenario shows show a better situation in Tuban Delta, by which the water deficit might not be more than 40MCM. However, the LR will not recover its water deficit, because all these scenarios predict severe water shortages in the lower region, which might range from 60 to 80 MCM under the IDS. Therefore, the LR needs extra water resources such as a 50 MCM solar-powered seawater desalination plant as soon as possible, then other 10 MCM plants every 5-10 years. On the other hand, groundwater recourses are depleting.

Tuban Delta is one of the critical basins in Yemen where most of the illegal rigs/wells are found. The assessment of 2023 shows that there are 3600 wells, 1200 of which have gone dry, and the average annual drop of groundwater levels reaches one meter due to the imbalance between discharge and recharge rate. If this imbalance continues as it is in 2022, the projections show that most of the wells will go dry or become brackish in the LR by 2060.

Future climate risks: The three regions can be affected by drought and flooding in the future. For instance, under SSP3 and SSP5, extremely high rainfall rates might cause flooding between 2060 and 2063, and between 2074 and 2076, respectively, while drought might occur between 2029 and 2034, and between 2069 and 2072. The LR, on the other hand, is the most susceptible to the effects of climate change since it is impacted by four main climate hazards namely flooding, drought, sea-level rise, and saltwater intrusion, which will have an impact on water supply systems and coastal infrastructure. Moreover, the LR faced severe meteorological and socioeconomic droughts in 2022, and unfortunately the socioeconomic drought will last the coming years until finding a new water resource.

Management and climate adaptation options: The study area has been divided into three regions revealed management shortcomings and the requirement for a sustainable water management strategy to distribute the existing water resources under climatic and socioeconomic challenges. The study reveals a need for new sustainable solutions to meet the rising water demand in the lower region and to reduce saltwater intrusion. Different adaptation options have been discussed and ranked with national stakeholders through consultation and workshops including:

- Rehabilitating irrigation canals and improve the current irrigation system to be drip irrigation.
- Rehabilitating some of the wastewater treatment plants to reuse the treated wastewater and the sludge to improve agricultural productivity.
- Groundwater recharge; and floodwater harvesting.
- Installing solar-powered seawater desalination plants to meet the rising demand in Aden.
- Disaster management plan coupled to an early warning system is required at the head of Tuban Delta to alert residents of flooding dangers if water flow surpasses 150 m3/sec combined by a proper disaster management plan to reduce the risk of flooding. In this light, it is important to note that a devastating flood in Tuban Delta in 1982 was brought on by a water flow of 225 MCM from the top of the Tuban Delta (Wadi Tuban upstream).
- Yemen, meanwhile, has both a water law and a water policy. They are inactive, nevertheless, and were unable to address Yemen's water sector's problems. To conserve the natural resources, particularly groundwater and to enhance human welfare, new versions are therefore required that address climate-related hazards, water management methods, roles and responsibilities. However, these might take long time to be adapted and approved. Therefore, an Integrated Water Resources Management strategy for Tuban Delta is urgently needed.

Policy & legal framework and safeguarding requirements

By Yemen government

Policy & legal framework

Table 72 Relevant policies and strategies

Policy / Document	Year
National Adaptation Programme of Action (NAPA)	2008
Initial National Communication INC)	2001
Second National Communication (SNC)	2013
Intended National Designated Contribution (INDC)	2015
Third National Communication (TNC)	2018
Technical Needs Assessment (TNA)	2023
National Adaptation Plan (NAP)	Forthcoming
Fourth National Communication	Forthcoming
Nationally Determined Contributions	Forthcoming
The 4th Socio-Economic Development Plan for Poverty Reduction	2002
National Environmental Action Plan (NEAP)	2005
National Strategy for Environmental Sustainability (NSES)	2005
National water sector Strategy and investment programme	2004
National Food Security Strategy	2010
National Agriculture Sector Strategy (NASS) 2012-2016	2012
National Action Plan to Combat Desertification	2000
National Biodiversity Strategy and Action Plan (NBSAP)	2017
Yemen's Sixth National Report to Convention On Biological Diversity (CBD)	2019

Yemen Aden Master Plan	2005-2025

Table 73 Relevant national laws and standards

Law / standard	Year
Republican Resolution on Law No. 25 of 1992 on the appropriation of land for public benefit	1992
The primary civil law governing land is the Law of Land and Real. Estate No. 21 of 1995	1995
Law No: 26 / 1995 EPL Environmental Protection Law.	1995
Environmental Impact Assessment Policy for the Republic of Yemen 1996	1996
Republican Resolution No. 170 of 1996 issuing the Implementing Regulation for Law No. 21 of 1995 on lands and real estate of the State	1996
Law No. 20 of 1998 on seeds and agricultural fertilizers	1998
Yemeni Standards for Water, Water Used for Irrigation 1999	1999
Law No. 39 of 1999 on the hygiene and environmental health.	1999
Evaluation of Future Development of the EIA System in Yemen 2001	2001
Water Law No. 33 of 2002, and its executive regulations	2002
Law No. 41 of 2006 amending some articles of Water Law No. 33 of 2002	2006
Law No.13 of 2006 approving the Convention on Wetlands of International Importance especially as Waterflow Habitat	2006
Public Health Law, Law No: 04 / 2009	2009

Table 74 Yemen ratification of international conventions / agreements

International conventions / agreements	Year
Climate and Atmosphere	
Civil Responsibility for Damage from Oil Pollution	1979
The Montreal Protocol on Substances that Deplete the Ozone Layer and its amendments	1987
United-Nations Framework Convention on Climate Change (UNFCCC)	1994
Vienna Convention for the Protection of the Ozone Layer	1994
Stockholm Convention on Persistent Organic Pollutants (i.e. a global treaty to protect human health and the environment from chemicals that remain intact in the environment for long periods, become widely distributed geographically and accumulate in the fatty tissue of humans and wildlife).	2001; 2004
Kyoto Protocol to the UNFCC	1997; 2005
Paris Agreement	2016
Land and Physical Cultural Resources	
The Convention on the Protection of World Cultural and Natural Heritage	1982
Biodiversity and Natural Habitats	
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	1997; 1979
Ramsar Convention on Wetlands of International Importance, especially as Waterfowl Habitats	2000
Convention on Biological Diversity (CBD)	2005
Convention on the Conservation of Migratory Species of Wild Animals CMS) à (P#100)	2006
Others	
Environmental Modification Hazardous Wastes Law of the Sea The Rio Declaration on Environment and Development	

Safeguarding / Environmental Impact Assessment requirements

7. In Yemen, the following mechanism is in place to obtain environmental approval for projects:
8. Screening (list all positive and negative impacts); If the negative impacts are not serious, no need to continue.
9. Scoping (optional): This step should be based on consultations with the local people and national experts after listing the impacts.
10. Impact assessment
11. Develop possible mitigation measures (for the negative impacts)
12. Writing all in an Environmental Impact Assessment (EIA) report
13. Send the EIA report to EPA and MWE to be approved.

Screening

The process is based on contents of EIA by-law which clearly states:

> Which areas are considered of high value, requiring a (preliminary) EIA for any activity in that area;
> Which activities are considered potentially harmful to the environment and therefore requiring and EIA;
> Below what capacity or size the requirement for an EIA for any particular activity can be dispensed with.
> EIA should also be obligatory for existing facilities with plans for major expansions (e.g. 25% of capacity), if a new facility of this kind would be eligible for EIA.

Sensitive areas: There is specific requirement formulated for protected areas. The EPL provides for the formulation of a list of special environmentally sensitive areas and locations by the cabinet. Projects with likely

effects to such areas as historical and archaeological places, wetlands, coral islands, natural protected areas, and public parks require full EIA. (Confirm with EPA.)

Timeline: Within 24 working days after receipt of necessary information. In case of the need for additional information, the screening procedure starts when this additional information is received.

Scoping
Scoping is advised, but not mandatory. MPE and EPA in collaboration with specialists and responsible authority prepare a scoping report (incl. Terms of Reference), which is submitted to the competent authority. Communication between project proponent and MWE and EPA does not occur directly but goes through the competent authority, unless MWE and EPA requires specified information about the project.

Timeline: between six weeks and three months.

Impact assessment
The impact assessment is based on the scoping report (including the Terms of Reference). The EPA distributes free copies of the EIA to stakeholders. The report is available to the public for printing at their own costs. Governments must respond with comments to the EPA, otherwise it is assumed that they agree. The EIA can be returned to the project proponent with additional advice and comments. Consequently, the final EIA is drawn.

The main points discussed in the ToR are a) the description of the proposed project, b) description of the surrounding environment, c) description of the social and cultural environment, d) regulatory legal considerations, e) identification of negative and positive environmental impacts, f) potential alternatives to the proposed project, g) preparation of a plan to manage and mitigation of negative impacts, h) preparation of a plan for monitoring and follow-up, i) coordinating with other parties and involving communities and non-governmental organizations.

The EIA report is presented in a concise manner and focuses on important environmental points such as the results of studies, conclusions, and recommendations, supported by summaries of the data collected and references, these data presented as separated attachment from the main report along with the other documents that were used.

Contents of the EIA report

Description of the proposed activity, including a map of the location; the use of the neighbouring lands; the project's requirements of water, energy, drainage, and roads; description of manufacturing operations of the project raw materials handling incidents and risk and safety methods and measures of waste.
Description of the environment that potentially might be affected.
Description of alternatives to proposed project (e.g., using materials of least pollution).
Evaluation and assessment of the probable environmental impact and effects of the proposed activity and the alternatives, including those direct and indirect effects, and short- and long-term accumulations contains (potable water quality, wastewater quality for agriculture, solid and liquid waste, gas emission, ambient air quality, land uses, noise levels, biodiversity, protected areas and socioeconomic factors).
The extent to which areas outside the national sovereignty may be affected by the proposed activity.
Monitoring plan
Example: 1) Introduction 1.1: background, 1.2: description, 1.3: location, 1.4: environment management plan, 2) Impacts 2.1: introduction, 2.2: impacts of the project (main components and their impacts) for example for the artificial lake (the pumping facilities, the pipes, the digging, and the planting and construction within the lake). 3) Mitigation 3.1: introduction, 3.2: mitigation measures (same as 2.2 for each component), 4) Conclusion 4.1: main conclusions, 4.2: monitoring plan, 5) Annex: 5.1: review lists (same as 2.2 for each project components), 5.2: inspection check list (during construction), 5:3: community participation. The report can differ in its structure but should contain the main issues (description, impacts, measures)

Accreditation of consultants: MWE and EPA are responsible for maintaining a data base of consultants and consulting firms that may be contracted for EIA studies. Information and activities of these consultants have to be part of the data base. MWE and EPA advises project proponents on the consultants for their projects (EIA policy).

Review process: MWE and EPA receives the EIS from the proponent (or consultant). It then reviews the report and consults relevant stakeholders including the public. If satisfied, either approves the EIS or sends it back to the project proponent with comments. If not accepted, the EIA must be improved and submitted again for review.

The report copied to EPA consultants (EIA committee), they review if the data provided is enough, good quality and complete, also the relevant environmental standards, effectiveness of the measures suggested in the report

Review expertise: The EIA is sent back to the initial contributors of comments to review. This also include the public, in which case MWE and EPA are responsible for ensuring the public are invited for comments. There is also the possibility for external review by experts from other concerned ministries. The public can be involved through field visit to the community benefiting or impacting by the project and discussed with them or through local association.

Timeline Review: Between six months and one year (EIA policy).

Integration of EIA into decision-making: The competent agencies that give permits are co-operating agencies in EIA and, in this way; EIA is integrated into other existing consent procedures. The licensing Agency gives the final permission for the proposal.

The MWE and EPA in conjunction with other relevant government ministry or authority decides if, or under what conditions, the proposed activity is environmentally acceptable. Accordingly, the MoWE issue clearance letter which may include conditions and mitigating measures (changes in design or location), to monitoring requirements or to requirements for operation and maintenance.

Decision justification: Decisions are justified in writing. The competent authority must prepare a document in which the justification of the decision is elaborated upon, including:

The decision of approval or rejection of the project is based upon the EIS. The competent authority may decide upon the proposed project or can select one of the alternatives. The competent authority does not necessarily follow the outcomes of the EIS review but may take a different decision. This does however not mean that the EIA outcome can be omitted.

The competent authority must provide the MWE and EPA with a copy of the decision report. There is no mentioning of publication of the decision towards civil society and other actors that are not directly involved.

The ESIA policy is part of environmental protection authority law. The Environmental Protection Authority (EPA) is the public agency with overall responsibility for ESIA. It coordinates with sectoral ministries with the purpose of implementing & supervising ESIAs.

By the Adaptation Fund

This document intends to be in line with the AF Environmental and Social Policy (ESP) and Gender Policy (GP) and related guidance documents for the ESP and GP.

Risks screening has been conducted against the 15 AF safeguard areas below:

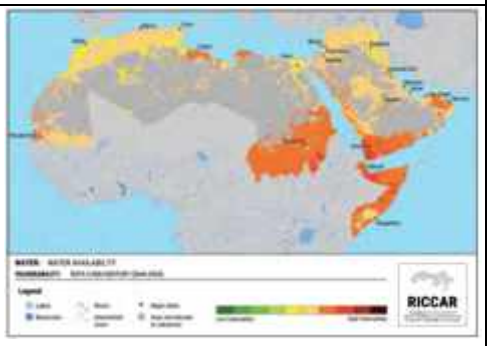
1) Compliance with the Law
2) Access and Equity
3) Marginalized and Vulnerable Groups
4) Human Rights
5) Gender Equity and Women's Empowerment
6) Core Labour Rights
7) Indigenous Peoples
8) Involuntary Resettlement
9) Protection of Natural Habitats
10) Conservation of Biological Diversity
11) Climate Change
12) Pollution Prevention and Resource Efficiency
13) Public Health
14) Physical and Cultural Heritage
15) Lands and Soil Conservation

Project description

Table 75 project description

<table>
<tr><td colspan="2">Project introduction and problem description and need statement</td></tr>
<tr><td>1. Name / title proposed adaptation measure / intervention</td><td>Increase climate change resilience to water scarcity and flooding in the Tuban Delta</td></tr>
<tr><td>2. Name Country, town, community</td><td>Yemen, Tuban delta</td></tr>
<tr><td>3. Introduction</td><td>Water-related challenges
Water resources in Tuban Delta, including Aden/Lahj face many challenges, including:
❑ Climate change risks and impacts
❑ Overuse of water / depletion
❑ Lack of a sustainable / integrated water management strategy

Main hazards Tuban delta
❑ Droughts / Water scarcity
❑ Flooding (flash, river, coastal)
❑ Sea level rise (and saltwater intrusion)
❑ Heat (Heat waves, high nr hot days)

Impacts on water resources in Tuban delta
❑ Reduced water availability due to the reduction of annual rainfall rates, which have depleted groundwater levels by about 1 m/year, increased saltwater intrusion, and led to land & soil degradation.
❑ Increased drought periods have dried out many streams in the lower Tuban region, which led to informal housing near the dried streams, thus exposing these to the risk of flooding.
❑ Increased extreme events, for example, a heavy rainfall in March 1981 led to a catastrophic flood.

Water deficit (2022 estimation)
❑ Water supplies: 53 MCM
❑ Water demand: 137.4 MCM
➢ Domestic: 45.5 MCM
➢ Agricultural 91.9 MCM
❑ Total current water deficit: 84.4 MCM.
The deficit will increase due to climate change and population growth to about 90 MCM in 2025 and 147 MCM in 2050</td></tr>
<tr><td>4. Problem description and need statement</td><td>Problem description: droughts and mismanagement of water resources in the Tuban delta are increasing water scarcity issues, while flooding risks are also increasing.

Needs statement: to address water scarcity and flood risks issues, water resources need to be management sustainably while considering future climate change impacts.

<table>
<tr><th>Potential solutions to address water scarcity issues</th><th>Potential contribution to addressing water deficit</th></tr>
<tr><td>❑ Shift to modern / efficient irrigation</td><td>45-50%</td></tr>
<tr><td>❑ Wastewater treatment and reuse.</td><td>10 %</td></tr>
<tr><td>❑ Greywater treatment and reuse.</td><td>5 %</td></tr>
<tr><td>❑ Groundwater recharge from flood water and from the treated wastewater.</td><td>5 %</td></tr>
<tr><td>Total</td><td>65-70%</td></tr>
<tr><td>❑ Seawater desalination (as last resort)</td><td>30-35 %</td></tr>
</table></td></tr>
<tr><td>5. Adaptation action (how will the measure(s) address problems and needs)</td><td>The project will support:

❑ Integrated and inclusive natural resource management
❑ Shift to modern / efficient irrigation
❑ Reduce flood risks
❑ Reuse of treated wastewater

The existed irrigation system in Tuban Delta faces many problems that reduce water use efficiency and pose flooding risks to people, cultivated lands and infrastructure. Therefore, this project aims at rehabilitating the irrigation systems canals and installing drip irrigation system to deliver water in the stream effectively, increase water use efficiency and reduce flooding risks. Thus, the project addresses the two main climate risks in Tuban delta, namely water scarcity and flooding.

Besides that, reuse of treated wastewater is limited. The project will support the required treatment and measures for reuse for plants where feasible.</td></tr>
</table>

<table>
<tr><td colspan="2">Project location</td></tr>
<tr><td>6. Location (map, showing issues and response action)</td><td>Component 2 interventions site assessment: the irrigation system to be rehabilitated is in 3 wadies: the great wadi Al-Wadi Al-A'adhm, the big wadi: Al-Wadi Al-Kabeer, and small wadi: Al-Wadi Al-Sageer. The system consists of 14 weirs and irrigates 28540 acre (11 550 ha), 28 per cent of which are irrigated by flood irrigation. The conducted field visits in October 2023 showed that the system faces the following problems:
▪ Erosion of canal embankment.
▪ Some canals and control structures are blocked with sands, plants, and sedimentation.
▪ Some intakes structures of sub-canals are damaged.</td></tr>
</table>

- Some gates and their lifting system are damaged.

These problems have made the system a source of flooding risk and caused damages and displacement to the local communities during heavy rainfall periods.

The gabion work will be located at the sides of the wadi and in critical locations where there is a risk of floods on villages, canals, and agricultural lands. The total area for the agricultural lands to be protected by gabion works is around 1,440 hectares. The total residents in the cities and villages proposed to be protected by gabion works is around 41,500 people.

Figure 57 Overview map of rehabilitation interventions main irrigation system (component 2)

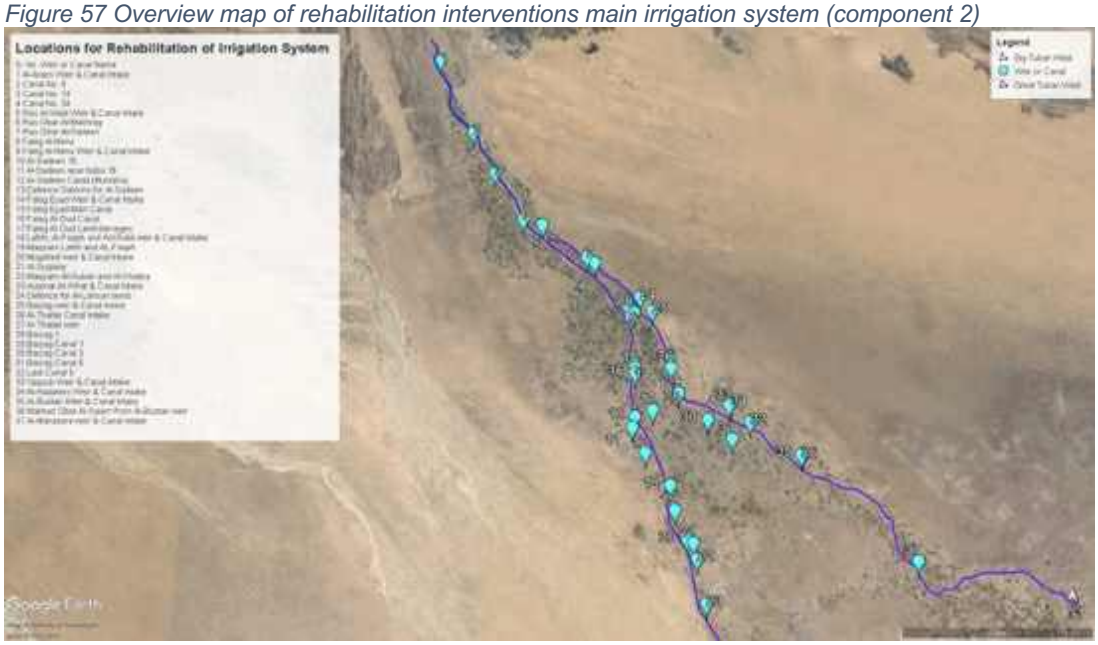
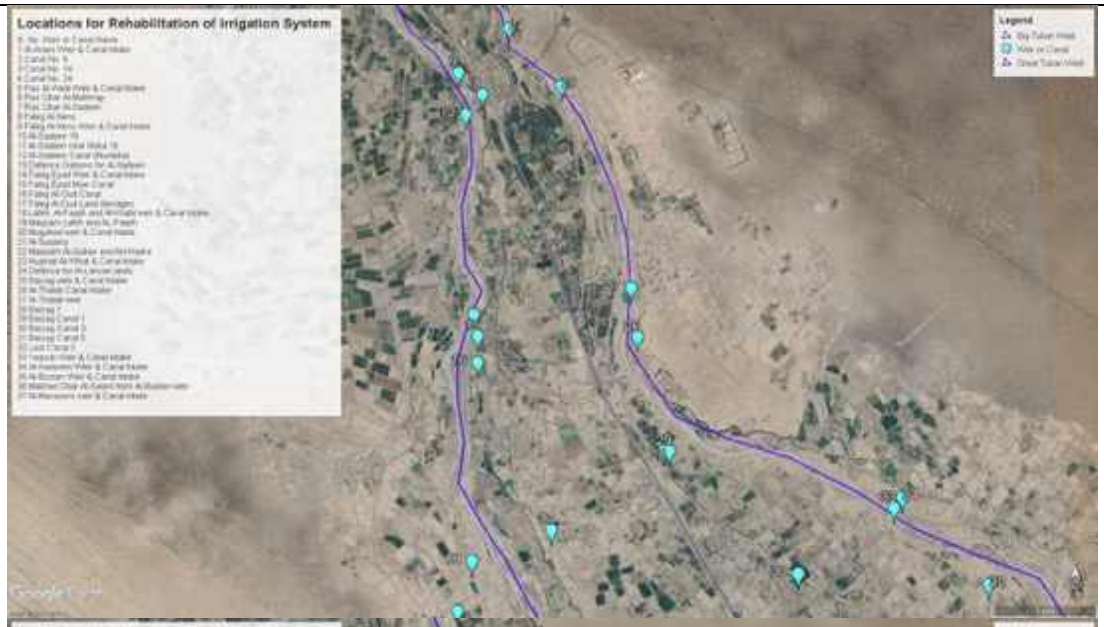


Figure 58 Detailed maps of rehabilitation interventions of the main irrigation system


Locations for Rehabilitation of Irrigation System
Legend


Locations for Rehabilitation of Irrigation System
Legend
Google Earth

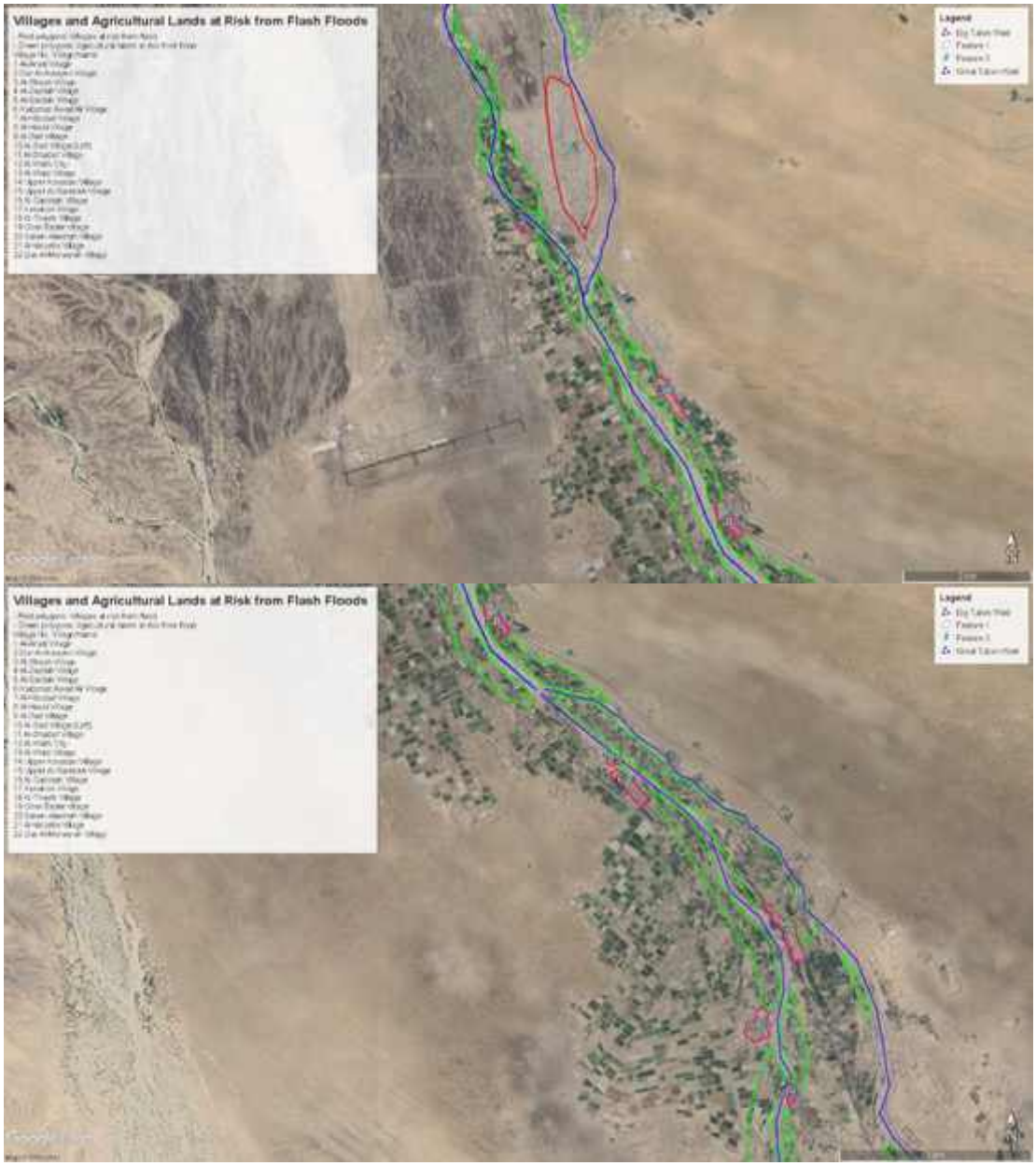

Locations for Rehabilitation of Irrigation System
Legend

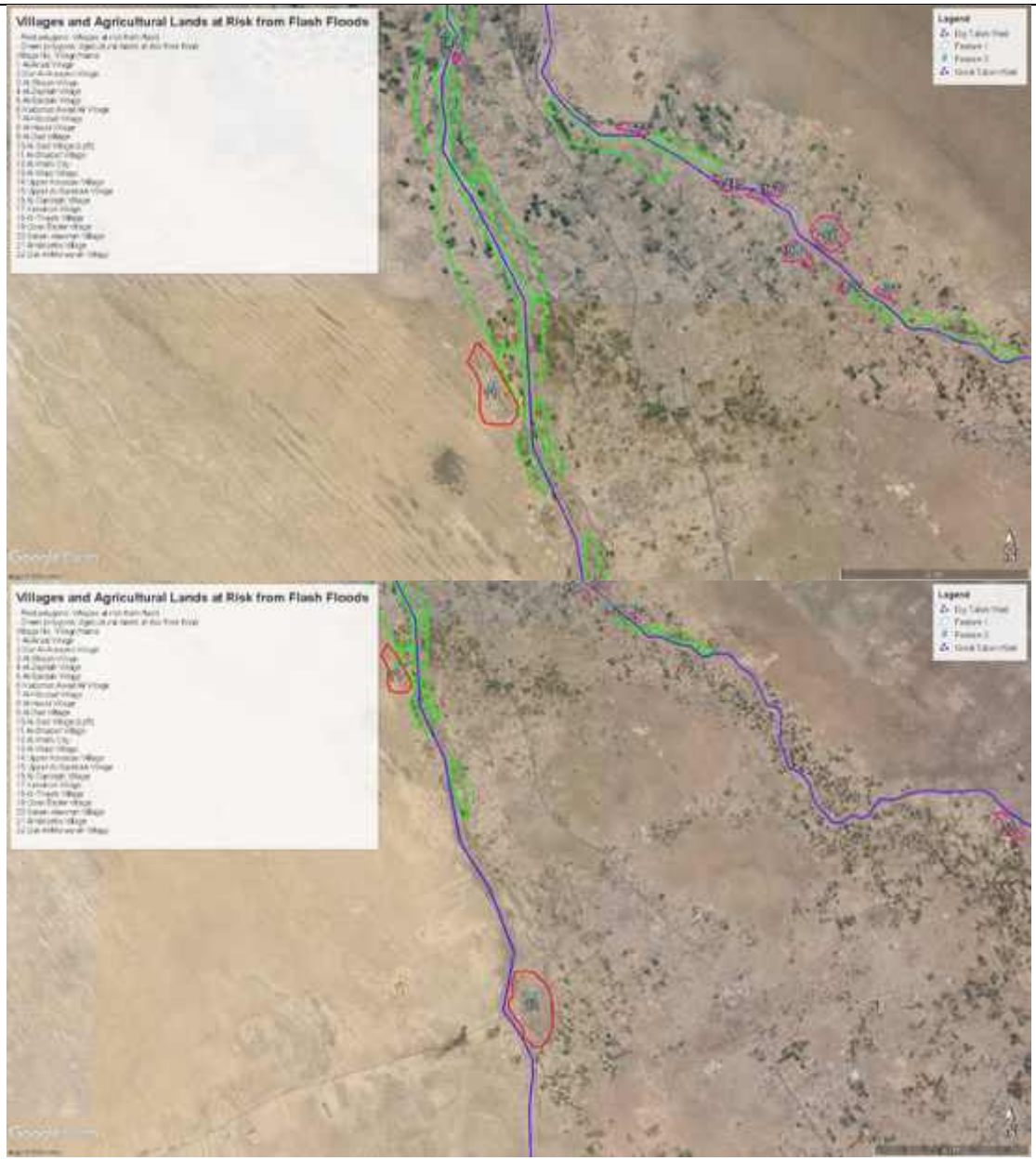

Locations for Rehabilitation of Irrigation System
Legend


Locations for Rehabilitation of Irrigation System
Legend


Locations for Rehabilitation of Irrigation System
Legend

Figure 59 Detailed maps of areas at risk of floods and proposed locations of gabions


Villages and Agricultural Lands at Risk from Flash Floods
Legend
Villages and Agricultural Lands at Risk from Flash Floods
Legend



Component 3 interventions site assessment: Al-What and Al-Hawtah villages are in Tuban district Lahj. Al-What has a dry area in the west and agricultural fields in the east, north and south. Al Hawtah has agriculture fields around.

The WWTPs (Tahror and Saber) are surrounded by agricultural land. The lands towards the west are mostly affected by drought and sand encroachment. These lands will benefit from the project intervention.

Alheswa is located on the coast of Aden. The area consists of the Alheswah wastewater treatment plant, Alheswa nature reserve, Alheswa power plant and some residential areas. The proposed location is 3km west or Alheswa nature reserve and within the Alheswa power plant area. In the north of the location there is Alsha'ab city and in the northwest, there is Bir ahmed with more open areas and agricultural land, which could benefit from the project intervention

Figure 60 Al-Waht city and location of water supply pumping station

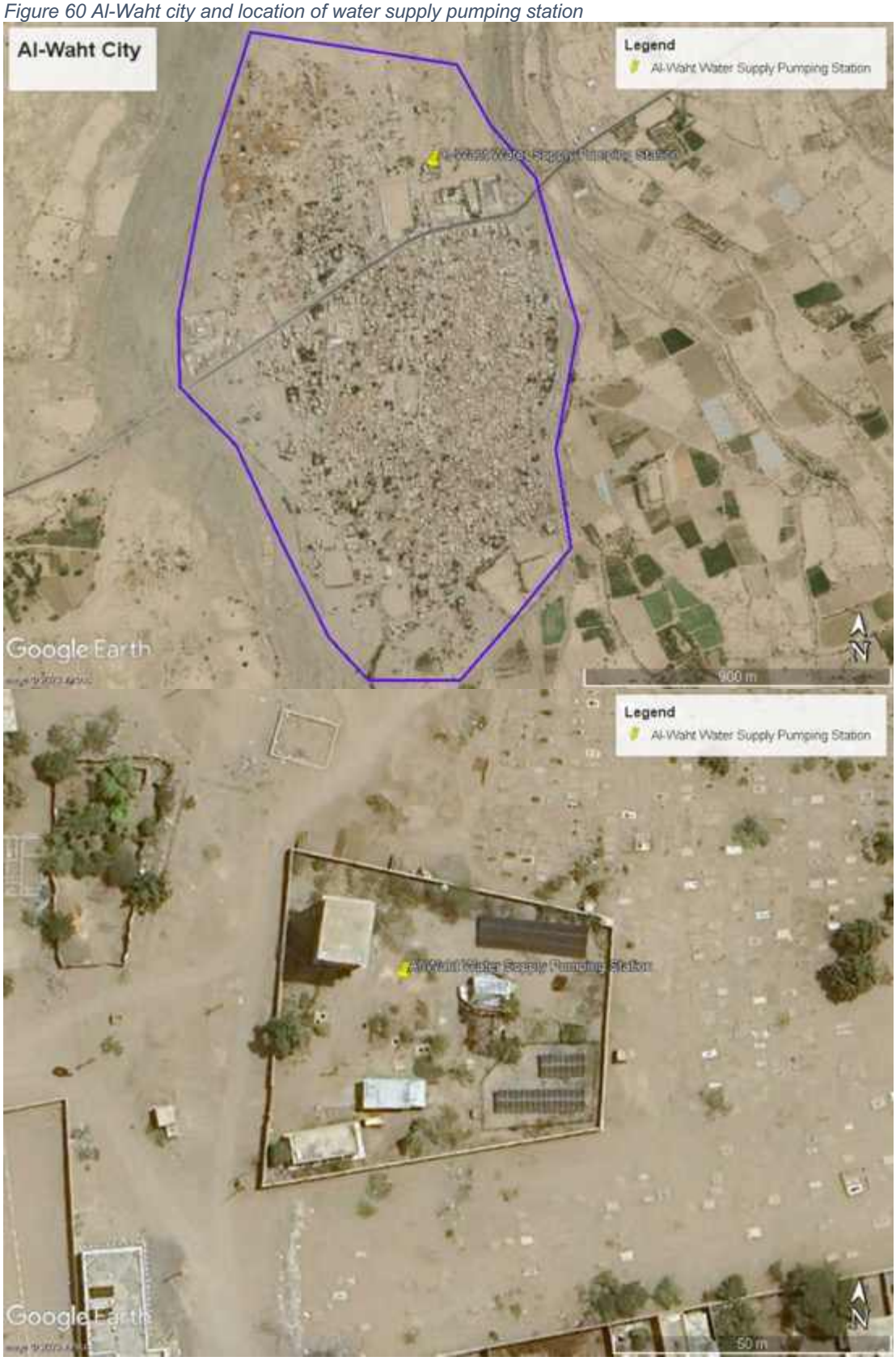
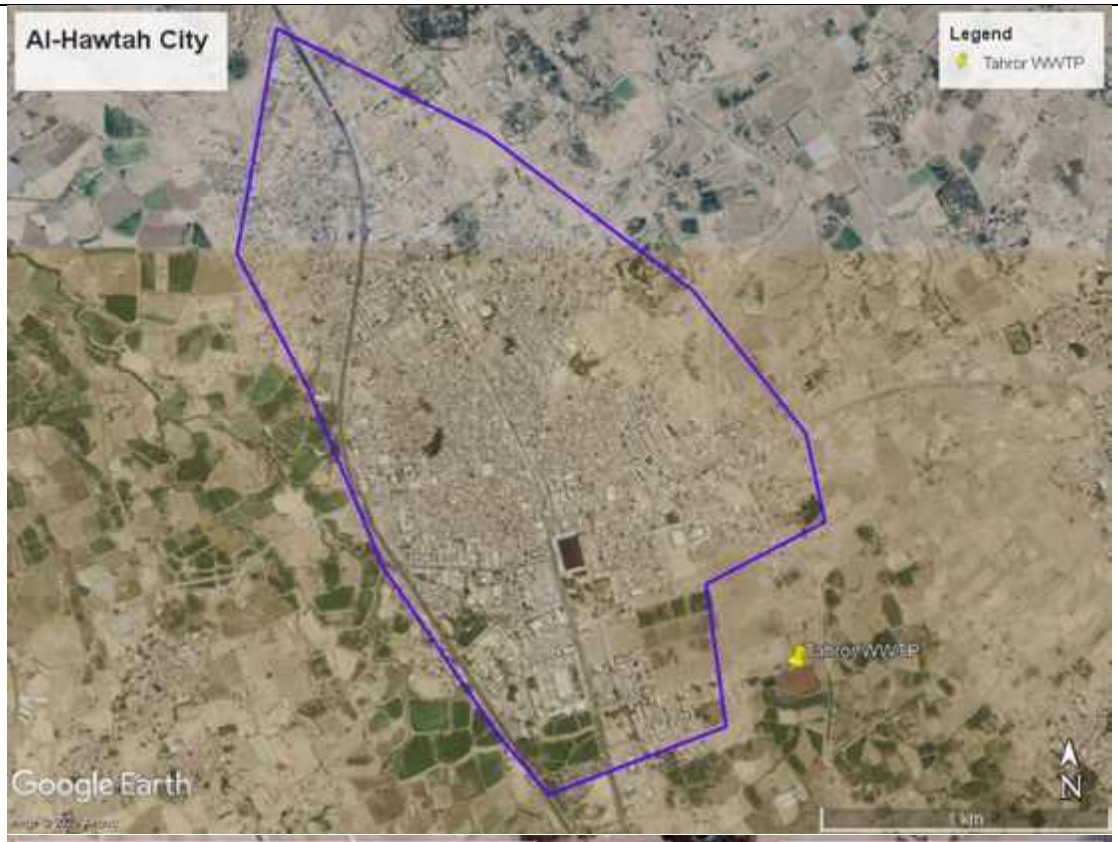
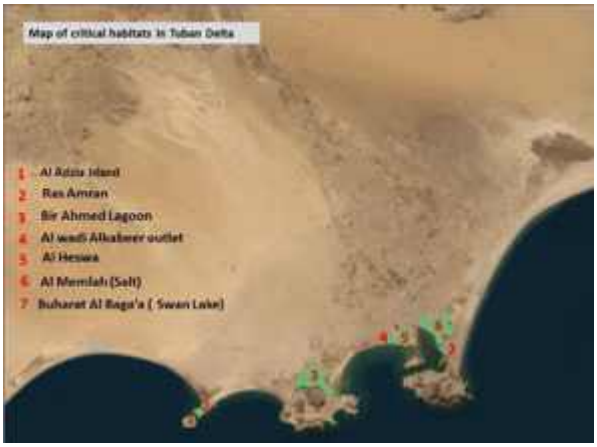
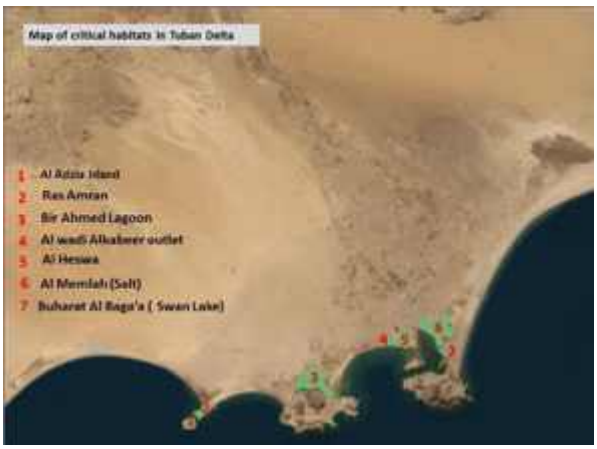
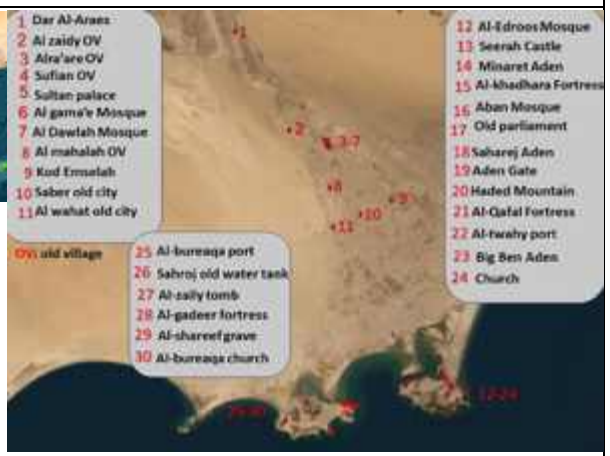


Figure 61 Al-Hawtah city and water supply pumping station


Al-Hawtah City
Legend
Tahror WWTP
Tahror WWTP
Google Earth
1 km
N


Water Supply Station for Al-Hawtah City
Legend
Magrs Nagi Wellfield Pumping Station
Google Earth
40 m
N

		Figure 62 Saber WWTP and reuse of treated wastewater interventions and beneficiary areas  *Figure 63 Tahror WWTP and reuse of treated wastewater interventions and beneficiary area* 
7.	Has land ownership (private; public) been identified, as well as land use (also informally and consent with intervention given?	❑ Shift to modern / efficient irrigation o Rehabilitation of main irrigation channel activities is on public land and on locations where irrigation infra already exists. Supporting modern irrigation techniques will be on private land (farmers, but only with the consent of farmers. ❑ Reduce flood risks o Gabions will be placed in the wadi on public land and where no people live or have livelihood activities ❑ Reuse of treated wastewater o The treatment activities are on plant locations already existing and existing irrigation channels will be used

8.	Are there vulnerable / critical natural habitats in or close to the target area. If so, describe	❑ No vulnerable / critical natural habitats in the Tuban delta as per the Convention on Wetlands (Ramsar, Iran, 1971)[108] ❑ No vulnerable / critical natural habitats in the Tuban delta as per the UNESCO Man and the Biosphere Programme.[109] There are two protected biospheres in Yemen (Socotra Archipelago and Bura'a Archipelago), but these are not located in the Tuban delta area. ❑ According to government information, Aden wetlands is an ecosystem that provides a breeding and feeding site for more than 100 migratory bird species, including flamingos. As a result, the Aden wetlands are among the most important wetland ecosystems in Yemen and in the entire region. Aden wetlands protected areas comprise of five sites: Al-Heswa, Al-Memlah, Al-Wady Al-Kabeer, Swan Lake, and Khour bir Ahmad. In addition to birds, the sites host several plant and aquatic animal species, such as turtles in AlAzizia island and Ras Amran and coral reefs, seaweeds, halophytes and algae. The ecosystems also provides several services, including protection of coastal areas and support marine habitats and consist lagoons, marshes and beaches. 
9.	Is there vulnerable biodiversity in or close to the target area. If so, describe	❑ As per the IUCN Red List of Threated Species[110], there may be some endangered birds in the Tuban delta, including the Egyptian vulture, Saker falcon and Slender-billed curlew. These may be in scrublands, grasslands, wetlands and Marine areas. However, these will not be impacted by the proposed interventions. ❑ According to government information, the Aden Coastal Wetlands are considered to be one of the most important sites for migratory birds and regularly host over 10,000 waterfowl, including three globally threatened and 12 regionally important species populations. The site meets the conditions of the International Ramsar site and Bonn Conventions. Among the most significant species found in the area are Lesser Flamingo (Phoenicopterus minor) with 9200 birds counted on the last census (in 1996), the largest concentration anywhere in the Middle East. Other important species include Great Spotted Eagle (Aquila clanga), Imperial Eagle (Aquila heliaca), and Crab Plover (Dromas ardeola). Aden wetlands host rich marine biodiversity such as sea grasses 6 species, 13 species green and brown algae,19 species of crustaceans and 67 species of mollusks. There are recorded of 24 species of fish from 18 families in Aden wetlands Pas and hard corals were presented as patches in Khor Bir Ahmed. Sea crabs were reported; Soldier crab Charybdis natator and Fiddler crabs Uca sp are common in Khor Bir Ahmed. sea cucumber was recorded includes Halothuria atra, Halothuria edulis, Halothuria scabra and Actinopyga echinites. 
10.	Are there heritage sites in or close to the target area? If so describe	❑ There are no heritage acknowledged by UNESCO[111] in the Tuban delta. UNESCO acknowledged the following sites in Yemen: **Cultural** (4) - Historic Town of Zabid (1993) - Landmarks of the Ancient Kingdom of Saba, Marib (2023) - Old City of Sana'a (1986) - Old Walled City of Shibam (1982) **Natural** (1) - Socotra Archipelago (2008) ☐ According to government information, local heritage sites in the Tubn Delta include mostly single buildings: buildings of ancient mosques, palaces, castles, and forts, in addition to water facilities such as the Aden natural water tanks (Saharej), as well as some facilities from the British colonial period, such as the Big Ben Aden, as well as some ancient cemeteries and tombs. All the identified sites are not in or close to proposed project interventions.  
11.	Are there any fragile soils in the target area? If so, describe	☐ Soils on the margin of a desert area: The tuban delta has desert areas, but there will be no project interventions in these areas. ☐ Coastal soils: no vulnerable coastal soils ☐ Soils located on steep slopes, rocky areas with very thin soils; no

[108] https://www.ramsar.org/wetland/yemen
[109] https://en.unesco.org/biosphere/arab-states#yemen
[110] https://www.iucnredlist.org/search?landRegions=YE&searchType=species
[111] https://whc.unesco.org/en/statesparties/ye

12. Are there lands that provide ecosystem services in the target area?	☐ The Tuban delta is an agriculture area, so the main ecosystem is agroecosystem with agriculture lands (crops, fruits, and ornamental shrubs) and windbreaks trees. Other ecosystems include wadies, bare land and sand dunes with plant species such as Acacia sp., Senna sp., these ecosystem is important for shepherds.

Project measures, budget and specifics

13. Adaptation measure / intervention description and budget

Output / measure	Budget USD
1.1. Capacity development with national and sub-national authorities on effective water management, including project oversight, development, and implementation of integrated management plans.	188.800
1.2. Establishment of laboratory for wastewater quality testing and water supply quality testing.	299.720
1.3. Integrated and inclusive natural resource and climate change risk management process convened bringing together government and community stakeholders	422.440
2.1. Assessment and verification / technical specification and engineering studies, including surveys required for improved irrigation canals and water intake systems	60.000
2.2. Rehabilitated Irrigation canals to improve water access for agricultural purposes in the Tuban.	1.665.216
2.3. Improved water intake structures to increase water supply in the irrigation canals.	88.500
2.4. Stone-gabions constructed to reinforce canals and protect agriculture lands and Al-what city from flashing floods.	1.572.350
3.1. Assessment and verification / technical specification and engineering studies, including surveys required, for water supply alternatives options outlined below	45.000
3.2. Developing efficient and safe water supply alternatives for Al-What, Al-Hawtah, Saber cities and surrounding villages.	1.569.400
3.3. Upgrade Tahror WWTP to treat wastewater for use in irrigation.	400.020
3.4. Upgrade Saber WWTP to treat wastewater for use in irrigation.	360.490
4.1. Support farmers with modern irrigation techniques and system (Urban and Rural Areas)	854.721
4.2. Develop maintenance plans for canals, irrigation system and wastewater treatment plants and KM of all components.	155.760
4.3. Strengthen water user associations for improved monitoring, maintenance and dissemination of information on irrigation techniques and skills development	292.640
4.4. Skills development with women and youth on water management and climate change adaptation	141.600
4.5. Capacity development for communities with a focus on women and youth civil society organizations on integrated and inclusive natural resource management plans	94.400
4.6. Awareness raising with local communities on water conservation and climate change in Aden and the Tuban Delta	129.000
4.7.	

14. Materials to be used

15. Dimension and other technical specifications (length, size, etc.)

Output / measures	Materials to be used	Quantities / size
1.2. Establishment of laboratory for wastewater quality testing and water supply quality testing.	- Instruments, tools and furnisher for two labs	- 2
2.1. Rehabilitated Irrigation canals to improve water access for agricultural purposes in the Tuban	- Small box culvert and protection materials - Lifting system + steel gates	- 2135m3 - 35
2.2. Improved water intake structures to increase water supply in the irrigation canals	- Automatic wadi flow gauging station	- 1
2.3. Stone-gabions constructed to reinforce canals and protect agriculture lands and Al-what city from flashing floods	- Stone-gabions	- 20.500m3
3.2. Developing efficient and safe water supply alternatives for Al-What, Al-Hawtah cities and surrounding villages	- Accessories of the pumping station - Ground Tank - vertical pumping units - PV system	 - 4000m3 - 3 - 33 KwH
3.3. Upgrade Tahror WWTP to treat wastewater for use in irrigation	- Flow measuring device - Emergency pumping unit - Steel coated mesh fence, incl. concrete foundation, steel columns and main steel door. - Ground Tank - Connection pipes and irrigation channels	- 1 - 1 - 600ml - 1000m3 - 2000 m
3.4. Upgrade Saber WWTP to treat wastewater for use in irrigation	- Flow measuring device - Emergency pumping unit - Discharge pipe - Rehabilitate guard room - Rehabilitate pumping house. - Ground Tank - Connection pipes and irrigation channels	- 1 - 1 - 1 - 1 - 1 - 1000m3 - 1000 m
4.1. Support farmers with modern irrigation techniques and system (Urban and Rural Areas)	- Modern irrigation system using bubbler irrigation techniques	- 150 ha
4.2.		

16. Does the intervention result in extra energy use. If so, describe

Modern irrigation requires pumps or elevated tanks. Using solar-powered pumps will not result in additional energy use.

	Additional energy use due to project	Compensation
3.2. Developing efficient and safe water supply alternatives for Al-What, Al-Hawtat cities and surrounding villages.	33 Kwh / day	100 solar panel 550 watt each

3.3. Upgrade Tahror WWTP to treat wastewater for use in irrigation.	NA		
3.4. Upgrade Saber WWTP to treat wastewater for use in irrigation.	NA		
4.1. Support farmers with modern irrigation techniques and system (Urban and Rural Areas)	268 KwH / day	67 horizontal solar pumps (4 KwH each)	

17. Start and end date of activity / works

Output / measure	Nr. months
1.1. Capacity development with national and sub-national authorities on effective water management, including project oversight, development, and implementation of integrated management plans.	42
1.2. Establishment of laboratory for wastewater quality testing and water supply quality testing.	16
1.3. Integarted and inclusive natural resource and climate change risk management process convened bringing together government and community stakeholders	42
2.1. Assessment and verification / technical specification and engineering studies, including surveys required for improved irrigation canals and water intake systems	6
2.2. Rehabilitated Irrigation canals to improve water access for agricultural purposes in the Tuban.	24
2.3. Improved water intake structures to increase water supply in the irrigation canals.	9
2.4. Stone-gabions constructed to reinforce canals and protect agriculture lands and Al-what city from flashing floods.	18
3.1. Assessment and verification / technical specification and engineering studies, including surveys required for improved irrigation canals and water intake systems	6
3.2. Developing efficient and safe water supply alternatives for Al-What, Al-Hawtah cities and surrounding villages.	18
3.3. Upgrade Tahror WWTP to treat wastewater for use in irrigation.	12
3.4. Upgrade Saber WWTP to treat wastewater for use in irrigation.	12
4.1. Support farmers with modern irrigation techniques and system (Urban and Rural Areas)	30
4.2. Develop maintenance plans for canals, irrigation system and wastewater treatment plants and KM of all components.	42
4.3. Strengthen water users' associations for improved monitoring, maintenance and dissemination of information on irrigation techniques and skills development	42
4.4. Skills development with women and youth on water management and climate change adaptation	42
4.5. Capacity development for communities with a focus on women and youth civil society organizations on integrated and inclusive natural resource management plans	42
4.6. Awareness raising with local communities on water conservation and climate change in Aden and the Tuban Delta	42

Project beneficiaries and benefits

18. Beneficiaries (type and number, disaggregated)

Output / measure	Number	
	Total	Women
1.1. Capacity development with national and sub-national authorities on effective water management, including project oversight, development, and implementation of integrated management plans.	300	30%
1.2. Establishment of laboratory for wastewater quality testing and water supply quality testing.		
1.3. Integrated and inclusive natural resource management planning to support the efficient, sustainable and CC resilient use of water in the Tuban, Aden, Abyan Basin.	1,255,888	50 %
2.1. Assessment and verification / technical specification and engineering studies, including surveys required for improved irrigation canals and water intake systems		
2.2. Rehabilitated Irrigation canals to improve water access for agricultural purposes in the Tuban.	72,000	50 %
2.3. Improved water intake structures to increase water supply in the irrigation canals.		
2.4. Stone-gabions constructed to reinforce canals and protect agriculture lands and Al-what city from flashing floods.	50,140	50 %
3.1. Assessment and verification / technical specification and engineering studies, including surveys required for improved irrigation canals and water intake systems		
3.2. Developing efficient and safe water supply alternatives for Al-What, Al-Hawtah, Saber cities and surrounding villages.	89,000	50 %
3.3. Upgrade Tahror WWTP to treat wastewater for use in irrigation.	525	50 %
3.4. Upgrade Saber WWTP to treat wastewater for use in irrigation.	280	50 %
4.1. Support farmers with modern irrigation techniques and system (Urban and Rural Areas)	514	30 %
4.2. Develop maintenance plans for canals, irrigation system and wastewater treatment plants and KM of all components.		
4.3. Strengthen water users associations for improved monitoring, maintenance and dissemination of information on irrigation techniques and skills development		
4.4. Skills development with women and youth on water management and climate change adaptation	250	30 %
4.5. Capacity development for communities with a focus on women and youth civil society organizations on integrated and inclusive natural resource management plans	166	30 %
4.6. Awareness raising with local communities on water conservation and climate change in Aden and the Tuban Delta		

19. How will equal access / benefits be ensured?

☐ Through participative planning and implementation approach with quotas.

20. What are the economic, social and environmental benefits of proposed measures to the community, marginalized and vulnerable groups and women and youth?	☐ Improving water supply and distribution will lead to (20-30%) increase in food production, which can contribute to food security by increasing the availability of food crops and reducing the need for food imports, potentially lowering food prices. ☐ Rehabilitation will lead to an increase in land values in the affected area by 20-30%. ☐ Improving the irrigation systems can help reduce the reliance on rain-fed agriculture, making farming more predictable and stable and encourage farmers to keep their farms. ☐ The project will increase employment opportunities in the construction and maintenance phases, in addition to the farming opportunities. ☐ The project will support 350 poor farmers with drip irrigation systems, which will increase their income. ☐ This project will develop the area allowing to new infrastructure and encourage education. ☐ Average costs of flood damage which would be avoided as the result of the rehabilitation. ☐ Create new job opportunities for 6000 farmers. ☐ Improved Water Efficiency (reduce water wastage through leaks and evaporation). ☐ Reduce groundwater depletion: Farmers who get water from the canals will reduce their dependency of groundwater resources. Thus, reducing groundwater depletion. ☐ Canal rehabilitation provides opportunities for habitat restoration and enhancement. This includes planting native vegetation along canal banks and creating or restoring wetlands, which can support biodiversity. ☐ Rehabilitated canals control soil erosion by managing water flow and preventing sediment from entering natural water bodies. ☐ Improved canal management leads to better water quality and flow patterns, which can benefit aquatic ecosystems and the species they support. ☐ Enhanced irrigation systems support sustainable agriculture by ensuring a reliable water supply, which will reduce the pressure on natural water sources like rivers and lakes.
21. How have beneficiary communities and groups been consulted	☐ Through woprkshops and field consultations, also separate for women, youth and farners. Focus: specific needs and potential concerns
22. Have relevant local authorities (and national government) been consulted and how will they be engaged in the future?	☐ Through woprkshops and bilateral. Focus on needs / priorities and potnetial issues.
Data and monitoring	
23. What data is needed to measures the effectiveness of the proposed measure?	☐ Additional water supply ☐ Water consumption per ha ☐ Irrigated areas and crops.
24. Any data / consultations missing? How to get it?	☐ Consultaties wit hall beneficiary groups have been completed

Environmental and social context	
25. Is an EIAs required by national law? If yes, has this been conducted / will it be conducted? Have outcomes been shared publicly?	In Yemen, the following mechanism is in place to obtain environmental approval for projects: ☐ Screening (list all positive and negative impacts); If the negative impacts are not serious, no need to continue. ☐ Scoping (optional): This step should be based on consultations with the local people and national experts after listing the impacts. ☐ Impact assessment ☐ Develop possible mitigation measures (for the negative impacts) ☐ Writing all in an Environmental Impact Assessment (EIA) report ☐ **Send the EIA report to the MWE and EPA to be approved.** The process is at the last step in bold above
26. Description of gender and youth situation. Are there any unions, organisations in the area? How will these be involved?	Principal areas of concern ☐ Yemen ranked second last in the Gender Gap Index in 2021, just before Afghanistan[112] ☐ Yemen ranks last in the Gender Inequality Index[113] ☐ The CEDAW committee reviewing the 2007 Yemen CEDAW report (their 6th periodic report) noted among other concerns a very low rate of representation of women in decision-making positions in Parliament (0.3 per cent), in the Government (1.82 per cent of commissioned ministers) and in the judiciary (1.65 per cent), low rates of girls' education, women's paid employment, and the legalization of girl marriage below age 15.[114] This has been exacerbated by the war since the last review.

[112] Resourcewatch gender gap index
[113] UNDP GII
[114] Draft UN Women country gender equality brief Yemen (March 2023)

	☐ Deterioration of the rule of law and massive internal displacement have exacerbated women's and girls' vulnerability to violence, including sexual violence, child and forced marriages, and arbitrary detentions and enforced disappearance perpetrated by all parties to the conflict. [115] ☐ More than 77 per cent of internally displaced persons in Yemen are women and children, and at least 26 per cent of displaced households are now female headed, a significant increase from pre-war level.[116] ☐ Lack of representation of women in the political / leadership sphere[117] ☐ Prevailing traditional gender norms in Yemen, including that Yemen has one of the world's lowest female labour force participation rates (estimated at 7 percent).[118] Existing associations and organizations in the project target area: ☐ Women organizations: 15 ☐ Youth organizations: 7 ☐ Water user associations: 22 ☐ Community organizations (leaders): 13 Women and youth organizations in the target area will be involved in awareness and capacity strengthening activities, as well as in natural resource management planning. The activities will be tailored to the needs (and concerns) of women and youth. Quotas will be set for women participation in the project steering committee and technical committee, as well as for workshops and trainings.

Environmental and social risks screening and impacts

Risks screening and impacts assessments have been conducted in detail for concrete project interventions, namely:

- ☐ Rehabilitation of the irrigation system activities (outputs 2.1.; 2.2.; 2.3.) and modern irrigation system (output 4.1)
- ☐ Activities related to (re)use of (treated) (waste)water (outputs 3.1.; 3.2.; 3.3.; 3.4)

Activities related to awareness raising, capacity strengthening and planning have been screened as well in Table 84

As required by the Yemen government.

Table 76 Risks screening of rehabilitation of the irrigation system activities (outputs 2.1.; 2.2.; 2.3.) and modern irrigation system (output 4.1)

Positive impacts	Potential environmental and social risks categories	Item	Impact assessment	Mitigation measures
- Increase agricultural productivity: farmers will gain access to a reliable and efficient water supply for their crops leading to increased agricultural productivity and higher crop yields. - Water Conservation: The measure will minimise water losses through leaks or evaporation, leading to more efficient water use and conservation of this valuable resource. - Enhanced Water Distribution and Equity: These upgrades help ensure more equitable water	Protection of the environment	Emissions and dust	Some activities may release dust and emission, which impact labour and neighbouring communities	- Use to the extent possible, vehicles in appropriate technical conditions. - Ensure that vehicle engines and equipment on site are not left running unnecessarily. - Best practice to ensure minimization of dust emissions during dry and windy conditions (e.g. proper stockpiling, watering etc.). - Exact project-related energy use to be determined during project inception phase. 'Extra' energy use to be compensated through installation of solar PV
		Noise and vibrations	Some activities may release noise and vibrations, which impact labour and neighbouring communities	- Avoid operations and vehicle movements at night. - Set traffic speed limits for construction and operation-related traffic - Position equipment as far as possible from sensitive areas (neighboring communities)
		Waste management	The activities might produce some solid wastes	- Identify waste management facilities and ensure disposal through treatment/removal/recycling of each of the waste types. - Ensure that all wastes produced are properly collected, segregated, stored, transported and treated - Minimize the waste production to the extent possible. - Document all waste related operations (type of wastes, quantities produced etc.). - Appropriate and safe storage of fuels, construction materials, wastes and any

[115] Idem
[116] USAID. September 2022. Yemen: Complex Emergency Fact Sheet #11.
[117] OHCHR
[118] YEMEN Women's economic empowerment in the Yemeni context

distribution among farmers, reducing disparities in access to water resources. - Environmental Benefits: Efficient water use reduces the strain on the depleted groundwater, helps control soil erosion and reduces sediment runoff into the streams. - Rehabilitating irrigation systems will lead to increased agricultural production (food security), stimulating economic growth and development. It creates job opportunities in farming, processing, and related industries, contributing to rural livelihoods and overall economic well-being. - Rehabilitating irrigation systems can help farmers adapt to the impacts of climate variability and protect the local communities and the infrastructure from flooding.				materials that can cause spills (e.g. batteries from energy generators).
		Land uses (land degradation)	Some activities where machineries are used may lead to soil / land degradation in the area around the canals	- The contractor will fix any degradation after rehabilitating the canals for example, no trees should be cut, and no soil should be removed. Trees will be replanted.
		Biodiversity	Machineries and rehabilitation work might impact the local habitat and vegetation	- In cooperation with local authorities, the activities will be planned to avoid sensitive periods for breeding or migration of wildlife and any affected native vegetation will be replanted in new locations. Moreover, low-impact construction techniques and equipment will be used to minimize soil erosion, habitat destruction, and noise disturbance.
	Worker health and safety	Occupational Health and Safety Plan	In addition to noise, CO2 and dust emission, workers might be exposed to work-related health and safety risks	Develop an Occupational Health and Safety (H & S) Plan
		Incident reporting		Ensure all H&S related incidents (e.g. observations, accidents) on site are recorded and followed up properly.
		Personal protective equipment		Ensure the provision of Personal Protective Equipment (PPE) for workers (hardhats, masks, safety glasses, safety boots etc. depending on project type).
		UXO/ Damaged structure clearance		Ensure UXO clearance/damaged structure clearance obtained prior to start of works
		First-aid		Provide one trained first aiders per 50 employees and adequate amount of first aid kits on site.
		Access to health care		- Ensure the workforce has access to primary healthcare on site, providing prescriptions and vaccinations where necessary/applicable - In case more than 35 workers are present on site, ensure that a hospital, medical clinic or a health centre can be reached within a period of 45 minutes.
	Community health and safety	Vulnerable Groups	Due to lack of funding, only poor farmers will install modern irrigation. This might raise questions regarding inequity and reduce the trust in the authorities.	- Ensure all vulnerable groups are consulted during inception phase and continually throughout project cycle to verify and further identify all specific needs, limitations and constraints. Final decisions on who will benefit will be made with communities and water-user associations

Table 77 Risks screening of activities related to (re)use of (treated) wastewater (outputs 3.1.; 3.2.; 3.3.; 3.4)

Positive impacts	Potential environmental and social risks categories		Impact assessment	Mitigation measures
- Water Conservation: Reusing treated wastewater for irrigation, will conserve groundwater resources (efficient water use). - By utilizing treated wastewater, farmers have	Protection of the environment	Emissions and dust	Some activities may release dust and emission, which impact labour and neighbouring communities	- Use to the extent possible, vehicles in appropriate technical conditions. - Ensure that vehicle engines and equipment on site are not left running unnecessarily. - Best practice to ensure minimization of dust emissions during dry and windy conditions (e.g. proper stockpiling, watering etc.).
		Noise and vibrations	Some activities may release noise and vibrations, which impact labour and neighbouring communities	- Avoid operations and vehicle movements at night. - Set traffic speed limits for construction and operation-related traffic - Position equipment as far as possible from sensitive areas (neighboring communities)

access to a reliable water source, even during periods of water scarcity. - Using treated wastewater for irrigation leads to recycling nutrients, thus reducing the need for synthetic fertilizers, and minimizing the environmental impact associated with their production and use - Treated wastewater often contains organic matter and beneficial microorganisms that can enhance soil fertility and improve its structure, which will lead to increased crop productivity and better soil sustainability. - Reusing treated wastewater offers cost savings for farmers and municipalities including cost-effective irrigation and wastewater disposal. - Treating wastewater removes harmful pollutants and contaminants thus, protecting the environment and public health. - Reusing treated wastewater for irrigation can enhance the resilience of agricultural systems to climate-related challenges.		Waste management	The activities might produce some solid wastes	- Identify waste management facilities and ensure disposal through treatment/removal/recycling of each of the waste types. - Ensure that all wastes produced are properly collected, segregated, stored, transported and treated - Minimize the waste production to the extent possible. - Document all waste related operations (type of wastes, quantities produced etc.). - Appropriate and safe storage of fuels, construction materials, wastes and any materials that can cause spills (e.g. batteries from energy generators).
		Pollution prevention	If wastewater is not treated well, this will lead to negative impacts on human health and the ecosystem.	- Ensure all works carried out minimize pollution risk (e.g. liquid effluents, air quality and emissions, noise and vibration management, vehicle and equipment maintenance and selection, fuel, oil and chemical storage and handling) including the whole duration of the Project. - The local authorities and the wastewater companies will monitor the quality of the outflow to be used for irrigation
			Contaminant Residues in Soil and Crops; Treated wastewater may contain residual contaminants such as heavy metals, pharmaceuticals, pathogens, and other pollutants. Continued irrigation with wastewater can lead to the accumulation of these contaminants in the soil, affecting soil quality and potentially entering the food chain through crops.	- A comprehensive water quality monitoring program to assess the content of nutrients, heavy metals, pathogens, and other contaminants in the treated wastewater.
			Soil Salinity and Sodicity; Treated wastewater may have elevated levels of salts, which can contribute to soil salinity and sodicity over time. High salinity can degrade soil structure, reduce water infiltration, and negatively impact plant growth by affecting water uptake.	- Regular soil testing to monitor nutrient levels, salinity, and other soil parameters should be conducted. - Implement appropriate soil management practices, such as the addition of organic matter, to maintain soil fertility and structure.
		Effluents	Effluent at site can lead to health risks	Ensure appropriate containment and storage of construction wastewater, including sanitary water. No untreated effluent is discharged.
	Worker health and safety	Occupational Health and Safety Plan	In addition to noise, CO2 and dust emission, workers might be exposed to work-related health and safety risks	Develop an Occupational Health and Safety (H & S) Plan
		Incident reporting		Ensure all H&S related incidents (e.g. observations, accidents) on site are recorded and followed up properly.
		Personal protective equipment		Ensure the provision of Personal Protective Equipment (PPE) for workers (hardhats, masks, safety glasses, safety boots etc. depending on project type).
		UXO/ Damaged structure clearance		Ensure UXO clearance/damaged structure clearance obtained prior to start of works
		First-aid		Provide one trained first aiders per 50 employees and adequate amount of first aid kits on site.

		Access to health care		- Ensure the workforce has access to primary healthcare on site, providing prescriptions and vaccinations where necessary/applicable - In case more than 35 workers are present on site, ensure that a hospital, medical clinic or a health centre can be reached within a period of 45 minutes.
	Community health and safety	Vulnerable Groups	Due to lack of funding, only poor farmers will install modern irrigation. This might raise questions regarding inequity and reduce the trust in the authorities.	Ensure all vulnerable groups are consulted during inception phase and continually throughout project cycle to verify and further identify all specific needs, limitations and constraints. Final decisions on who will benefit will be made with communities and water-user associations

As required by the Adaptation Fund

Table 78 Risks screening of rehabilitation of the irrigation system activities (outputs 2.1.; 2.2.; 2.3.) and modern irrigation system (output 4.1)

Checklist of potential risk areas of non-compliance of the activity / intervention within the adaptation fund's environmental and social and gender principles	**initial environmental or social risks present YES / NO**	**Explanation why yes / no and reference to information**
ADAPTATION FUND PRINCIPLE 1: COMPLIANCE WITH THE LAW: ***Requirement:*** *The proposed activity should be in compliance with all applicable domestic and international law.*		
27. Have all relevant rules, regulations and technical standards been identified?	YES	All relevant rules, regulations and standards have been identified for all proposed project activities. Procedures for compliance of key ones initiated. Therefore, no potential risk of non-compliance exists. This has been fully presented in proposal Part II.E
28. Have the procedures to comply, including authorizing offices been identified?	YES	Authorizing offices and approvals required: ☐ Ministry of Water and Environment - Environmental Protection Authority ☐ Ministry of Agriculture, Irrigation and Fishery-General Administration of Irrigation Local Corporation Water and Sanitation ☐ National Water & Resources Authority – NWRA ☐ Aden and Lahj Local Authorities ☐ Water users' group
29. If an ESIA is required by national law for the proposed activity, has this been prepared and approved?	YES/NO	In Yemen, the following mechanism is in place to obtain environmental approval for projects: ☐ Screening (list all positive and negative impacts); If the negative impacts are not serious, no need to continue. ☐ Scoping (optional): This step should be based on consultations with the local people and national experts after listing the impacts. ☐ Impact assessment ☐ Develop possible mitigation measures (for the negative impacts) ☐ Writing all in an Environmental Impact Assessment (EIA) report ☐ **Send the EIA report to the MWE and EPA to be approved.** The process is at the last step in bold above. These is a small risk the approval of the ESIA-ESMP is not granted before the AF proposal approval
ADAPTATION FUND PRINCIPLE 2: ACCESS AND EQUITY: ***Requirement****: Ensure fair and equitable access to benefits of the activity*		
30. Have all potential beneficiaries and been identified?	YES	All project beneficiaries (i.e. population; groups) have been mapped
31. Have rivals, disputants and concerns related to equal access of project beneficiaries been identified and are measures in place to avoid these?	YES/NO	Community consultations and focus groups discussions have been conducted per beneficiary group to identify possible rivals, disputants and concerns related to equal access of project benefits. Some concerns were raised regarding: ☐ Unequal distribution of irrigated water (to small-holder farmers, women farmers, farmers which have not received support previously and other vulnerable groups) ☐ That interventions may take place during the agriculture season, which may hinder irrigation. ☐ Disruption of gate control mechanism
32. Has the process of allocating and distributing benefits equally (fair and impartial access) been described?	YES	In many cases, interventions will benefit all residents of the area equally. In cases where project benefits are limited, they will be allocated and distributed equally through a participatory process and through joint decision-making through the involvement of water user associations, social/community organizations and women and youth groups.
ADAPTATION FUND PRINCIPLE 3: VULNERABLE AND MARGINALIZED GROUPS: ***Requirement****: Avoid imposing any disproportionate adverse impacts on marginalized and vulnerable groups including children, women and girls, the elderly, indigenous people, tribal groups, displaced people, refugees, people living with disabilities, and people living with HIV/AIDS.*		
33. Have all potential beneficiaries, including marginalized and vulnerable groups been identified?	YES	All project beneficiaries (i.e. population; groups) have been mapped
34. Have the characteristics of the marginalized or vulnerable groups been described?	YES	Desk research, expert consultations and community consultations and focus group discussions have been conducted (see proposal Part II.H) to identify possible risks / adverse impacts of project activities on marginalized and vulnerable beneficiary groups (i.e. specific needs, limitations, constraints and concerns of groups).

35. Have potential adverse impacts that each marginalized and vulnerable group may experience from the activity been identified and have the groups been consulted on specific needs, limitations, constraints and requirements?	YES/NO	As per above, any potential adverse impact has been identified. There will be neither discrimination nor favouritism in accessing project/programme benefits. Project benefits will be allocated and distributed equally through a participatory process and through joint decision-making. There is a small potential risk that needs and concerns of various groups have changed once the project starts.
ADAPTATION FUND PRINCIPLE 4: HUMAN RIGHTS: ***Requirement:*** *The activity shall respect and where applicable promote international human rights*		
36. Has any citing of the host country in any Human Rights Council Special Procedures been identified and has the project described how to deal with potential related issues?	YES	Human right treaties not ratified in Yemen[119]: ❑ CAT-OP - Optional Protocol of the Convention against Torture ❑ CCPR-OP2-DP - Second Optional Protocol to the International Covenant on Civil and Political Rights aiming to the abolition of the death penalty ❑ CED - Convention for the Protection of All Persons from Enforced Disappearance ➢ Citing in relation to the armed conflict ❑ CED, Art.32 - Interstate communication procedure under the International Convention for the Protection of All Persons from Enforced Disappearance ❑ CMW - International Convention on the Protection of the Rights of All Migrant Workers and Members of Their Families ➢ There are issues reported with migrants along the boders Any agreement / contract signed will include reference to compliance with Human rights. Besides that, a Security and Human Rights Management Procedure that is in alignment with UNDSS and the Voluntary Principles of Human Rights will be prepared.
ADAPTATION FUND PRINCIPLE 5: GENDER EQUALITY AND WOMEN'S EMPOWERMENT: ***Requirement:*** *Design and implement the activity in such a way that both women and men 1) have equal opportunities to participate; 2) receive comparable social and economic benefits; and 3) do not suffer disproportionate adverse effects during the development process*		
37. Has the legal and regulatory context with respect to gender equality and women's empowerment been analyzed to identify any obstacles to comply?	YES	A social inclusion plan has been developed. This is a 'gender' plan, but with a less sensitive title considering the context
38. Has the cultural, traditional, religious, or any other grounds that might result in differential allocation of benefits between men and women of the activity been analyzed?	YES	A social inclusion plan has been developed.
39. Does the project actively pursue equal participation and access to activity benefits through specific gender approach?	YES	A social inclusion plan has been developed.
ADAPTATION FUND PRINCIPLE 6: CORE LABOUR RIGHTS: ***Requirement:*** *The activity should meet the core labour standards as identified by the International Labour Organization and respect, promote ILO core labour standards*		
40. Has it been summarized how Executing Entities will comply to core labour standards?	YES	In the ESMP it has been described how executing entities will comply with the core labour standards
41. Has it been identified if the eight ILO core conventions have been ratified in project countries and if not ratified, are measures in place to avoid potential risks of non-compliance?	YES	Core labour rights not ratified in Yemen:[120] ☐ Fundamental Conventions: 8 of 10. Not ratified: **C155** - Occupational Safety and Health Convention, 1981 (No. 155) **C187** - Promotional Framework for Occupational Safety and Health Convention, 2006 (No. 187) **P029** - Protocol of 2014 to the Forced Labour Convention, 1930 ☐ Governance Conventions (Priority): 3 of 4. Not ratified **C129** - Labour Inspection (Agriculture) Convention, 1969 (No. 129)

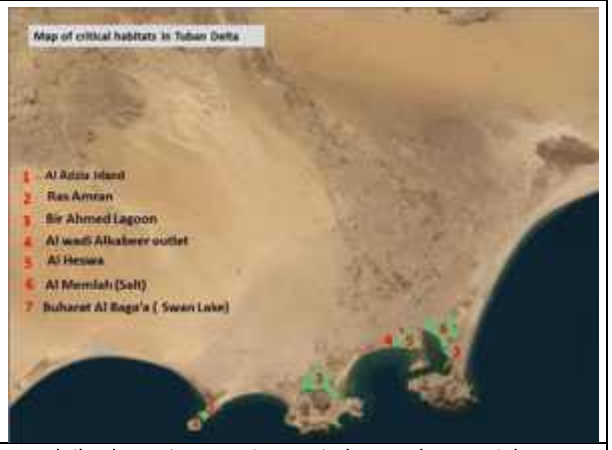
[119] https://tbinternet.ohchr.org/_layouts/15/TreatyBodyExternal/Treaty.aspx?CountryID=170&Lang=EN
[120] ILO ratification (or not) of core labour standards in Yemen

		☐ Technical Conventions: 19 of 177 Any agreement / contract signed will include reference to compliance with ILO labour standards and especially standards related to safety and health and labour inspection.
42. Have potential risks of non-compliance with ILO core labour standards of the activity been identified through consultations (experts and communities) and are measures in place to avoid potential risks of non-compliance?	YES/NO	There is a small risk of core labour standards not being respected by contractors, especially related to standards for safety and health and labour inspection.
ADAPTATION FUND PRINCIPLE 7: INDIGENOUS PEOPLE: ***Requirement**: The activity shall not be inconsistent with the rights and responsibilities set forth in the UN Declaration on the Rights of Indigenous Peoples and other applicable international instruments relating to indigenous peoples.*		
43. Has it been assessed if indigenous people are present in the activity target area? If so:	YES	There have not been any indigenous groups in the area identified utilizing the criteria of the UN-Habitat Environmental and Social Safeguards System[121]: "A distinct social and cultural group possessing the following characteristics in varying degrees: 121.1. Self-identification as members of a distinct indigenous social and cultural group and recognition of this identity by others; and 121.2. Collective attachment to geographically distinct habitats, ancestral territories, or areas of seasonal use or occupation, as well as to the natural resources in these areas; and 121.3. Customary cultural, economic, social, or political institutions that are distinct or separate from those of the mainstream society or culture; and 121.4. A distinct language or dialect, often different from the official language or languages of the country or region in which they reside."
44. Has it been identified if the host country ratified the ILO Convention 169?	YES	ILO convention 169 has not been tarified in Yemen[122]
45. Has it been described how the project (and activity) will be consistent with UNDRIP, and particularly with regard to Free, Prior, Informed Consent (FPIC) during project design, implementation and expected outcomes related to the impacts affecting the communities of indigenous peoples?	N/A	
46. Has it been described how indigenous peoples will be involved in the design and the implementation of the project and provide detailed outcomes of the consultation process of the indigenous peoples?	N/A	
47. Has documented evidence of the mutually accepted process between the project and the affected communities and evidence of agreement between the parties as the outcome of the negotiations been provided?	N/A	
48. Has a summary of any reports, specific cases, or complaints that have been made with respect to the rights of indigenous peoples by the Special Rapporteur and that are relevant to the project/programme been provided?	N/A	
49. Has awareness about the rights of indigenous peoples and how it is a general principle in the implementation of the project been included in the project design?	N/A	

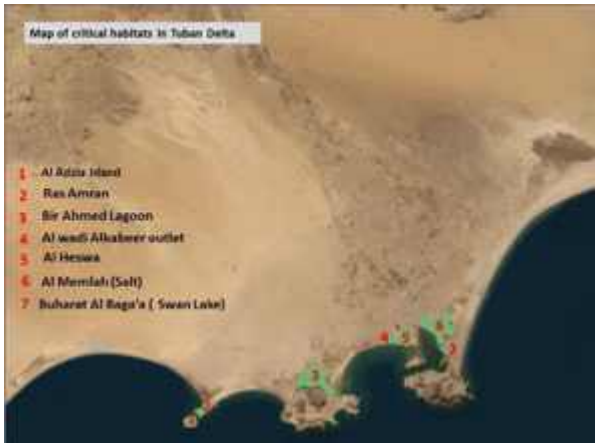
[121] https://unhabitat.org/environmental-and-social-safeguards-system-version-3-esss-31

[122] idem

ADAPTATION FUND PRINCIPLE 8: INVOLUNTARY RESETTLEMENT: ***Requirement**: The activity shall be designed and implemented in a way that avoids or minimizes the need for involuntary resettlement.*		
50. If there is any acquisition of lands, will the procedure be in accordance with the legal system of the country and international standards?	YES	Land acquisition is not required as all proposed interventions will be on publicly owned land ❑ Shift to modern / efficient irrigation o Rehabilitation of main irrigation channel activities is on public land and on locations where irrigation infra already exists. Supporting modern irrigation techniques will be on private land (farmers, but only with the consent of farmers. ❑ Reduce flood risks o Gabions will be placed in the wadi on public land and where no people live or have livelihood activities
51. Will any unnecessary displacement be avoided? Determine if any potential displacement is physical or economic/ livelihood and if it is voluntary or involuntary (through identification of land ownership and use (also informally) and consultations on consent to the activity?	YES	It is not foreseen that land other than public land will be targeted under this project. It has been determined that no physical or economic (even informal) displacement will take place due to project activities. This has been determined by mapping project target sites land ownership (private, public) and land use, also informally, and through consulting communities / users on the possible risk of resettlement and to get agreement on proposed interventions (i.e., no interventions will take place without the consent of inhabitants in the targeted areas). Landowners, private or public, have agreed with using their land for project activities.
52. Is awareness building of involuntary resettlement and the applicable principles and procedures of the activity / project part of the project activities?	YES	This will be part of the grievance and redress mechanism to be implemented
53. If it is involuntary: has justification for the need for involuntary resettlement been provided by demonstrating any realistic alternatives that were explored, and how the proposed involuntary resettlement has been minimized and is the least harmful solution.	N/A	
54. If it is involuntary: have details of the extent of involuntary resettlement been described, including the number of people and households involved, their socio-economic situation and vulnerability, how their livelihoods will be replaced, and the resettlement alternatives and/or the full replacement cost compensation required whether the displacement is temporary or permanent?	N/A	
55. If it is involuntary: have the details of the involuntary resettlement process that the activity will apply been described, and the built-in safeguards to ensure that displaced persons shall be informed of their rights in a timely manner, made aware of the grievance mechanism, consulted on their options, and offered technically, economically, and socially feasible resettlement alternatives or fair and adequate compensation? This also should include an overview of the applicable national laws and regulations.	N/A	
56. If it is involuntary: has it been justified that the involuntary resettlement is feasible?	N/A	
57. If it is involuntary: has the adequacy of the activity / project organisational structure to successfully implement the involuntary resettlement as well as the capacity and experience of the project/programme management with involuntary resettlement been described?	N/A	
ADAPTATION FUND PRINCIPLE 9: PROTECTION OF NATURAL HABITATS: ***Requirement:** The activity shall not result in unjustified conversion or degradation of critical natural habitats*		

58. Has the presence in or near the activity area of natural habitats been identified?	YES	❑ No vulnerable / critical natural habitats in the Tuban delta as per the Convention on Wetlands (Ramsar, Iran, 1971)[123] ❑ No vulnerable / critical natural habitats in the Tuban delta as per the UNESCO Man and the Biosphere Programme.[124] There are two protected biospheres in Yemen (Socotra Archipelago and Bura'a Archipelago), but these are not located in the Tuban delta area ❑ According to government information, Aden wetlands is an ecosystem that provides a breeding and feeding site for more than 100 migratory bird species, including flamingos. As a result, the Aden wetlands are among the most important wetland ecosystems in Yemen and in the entire region. Aden wetlands protected areas comprise of five sites: Al-Heswa, Al-Memlah, Al-Wady Al-Kabeer, Swan Lake, and Khour bir Ahmad. In addition to birds, the sites host several plant and aquatic animal species, such as turtles in AlAzizia island and Ras Amran and coral reefs, seaweeds, halophytes and algae. The ecosystems also provides several services, including protection of coastal areas and support marine habitats and consist lagoons, marshes and beaches. 
59. Has the potential of activity to impact directly, indirectly, or cumulatively upon natural habitats been identified?	YES	The interventions are not planned in or close to natural habitats and indirect or cumulative impacts are not expected as environmental impacts should be positive rather than.
60. Are there any risks management arrangement in place for potential risks identified above?	N/A	N/A
61. If such habitats exist, has the location of the critical habitat in relation to the project and why it cannot be avoided, as well as its characteristics and critical value been described?	N/A	N/A
62. If such habitats exist, for each affected critical natural habitat, has an analysis on the nature and the extent of the impact including direct, indirect, cumulative, or secondary impacts been provided?	N/A	N/A
ADAPTATION FUND PRINCIPLE 10: CONSERVING BIODIVERSITY: ***Requirement:*** *The activity shall be designed and implemented in a way that avoids any significant or unjustified reduction or loss of biological diversity or the introduction of known invasive species.*		

[123] https://www.ramsar.org/wetland/yemen
[124] https://en.unesco.org/biosphere/arab-states#yemen

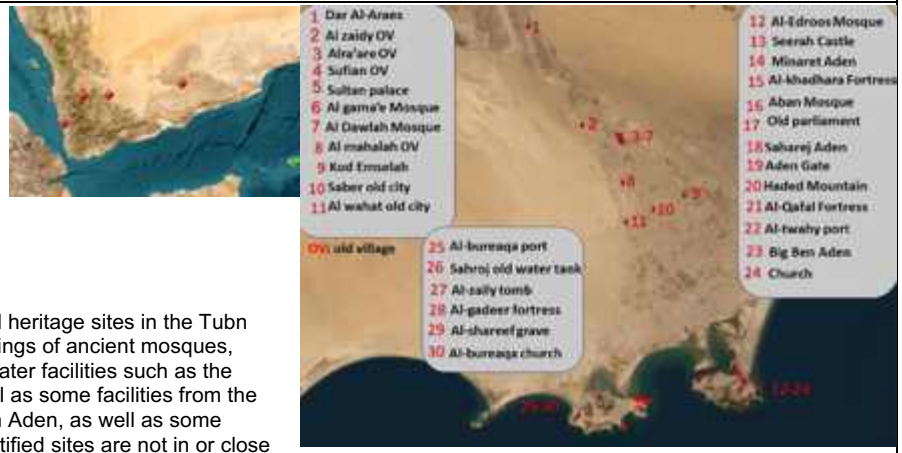
63. Has the presence in or near the project/programme area of important biological diversity been identified?	YES	❑ As per the IUCN Red List of Threated Species[125], there may be some endangered birds in the Tuban delta, including the Egyptian vulture, Saker falcon and Slender-billed curlew. These may be in scrublands, grasslands, wetlands and Marine areas. However, these will not be impacted by the proposed interventions. ❑ According to government information, the Aden Coastal Wetlands are considered to be one of the most important sites for migratory birds and regularly host over 10,000 waterfowl, including three globally threatened and 12 regionally important species populations. The site meets the conditions of the International Ramsar site and Bonn Conventions. Among the most significant species found in the area are Lesser Flamingo (Phoenicopterus minor) with 9200 birds counted on the last census (in 1996), the largest concentration anywhere in the Middle East. Other important species include Great Spotted Eagle (Aquila clanga), Imperial Eagle (Aquila heliaca), and Crab Plover (Dromas ardeola). Aden wetlands host rich marine biodiversity such as sea grasses 6 species, 13 species green and brown algae,19 species of crustaceans and 67 species of mollusks. There are recorded of 24 species of fish from 18 families in Aden wetlands Pas and hard corals were presented as patches in Khor Bir Ahmed. Sea crabs were reported; Soldier crab Charybdis natator and Fiddler crabs Uca sp are common in Khor Bir Ahmed. sea cucumber was recorded includes Halothuria atra, Halothuria edulis, Halothuria scabra and Actinopyga echinites. 
64. Has the potential of a significant or unjustified reduction or loss of biological diversity, and the potential to introduce known invasive species been identified?	YES	The interventions are not planned in or close to critical biodiversity and indirect or cumulative impacts are not expected as environmental impacts should be positive rather than.
65. If important biological diversity exists (Biological diversity), have the elements of known biological diversity importance in the project/programme area been described?	N/A	N/A
66. If important biological diversity exists (Biological diversity), has it been described why the biological diversity impact cannot be avoided?	N/A	N/A
67. Are there any risks management arrangement in place for these identified potential risks?	N/A	N/A
68. If important biological diversity exists (Invasive species), has it been described the invasive species that either may or will be introduced and why such introduction cannot be avoided?	N/A	N/A
69. If important biological diversity exists (Invasive species), has evidence that this introduction is permitted in accordance with the existing regulatory framework and the results of a risk assessment analysing the potential for invasive behaviour been provided?	N/A	N/A

[125] https://www.iucnredlist.org/search?landRegions=YE&searchType=species

<table>
<tr><td>70. If important biological diversity exists (Invasive species), has it been described the measures to be taken to minimize the possibility of spreading the invasive species?</td><td>N/A</td><td>N/A</td></tr>
<tr><td colspan="3">ADAPTATION FUND PRINCIPLE 11: CLIMATE CHANGE:
Requirement: The activity shall not result in any significant or unjustified increase in greenhouse gas emissions or other drivers of climate change.</td></tr>
<tr><td>71. When relevant, has a risk-based assessment of resulting increases in the emissions of greenhouse gasses or in other drivers of climate change been conducted?</td><td>YES</td><td>Some machinery will be used for project activities. However, energy use and related GHG emissions will be limited.</td></tr>
<tr><td colspan="3">ADAPTATION FUND PRINCIPLE 12: POLLUTION AND RESOURCE EFFICIENCY:
Requirement: The activity shall be designed and implemented in a way that meets applicable international standards for maximizing energy efficiency and minimizing material resource use, the production of wastes, and the release of pollutants.</td></tr>
<tr><td>72. Will the activities discharge pollution into water and / or land; use hazardous materials; generate noise and vibration; and/or generate waste including hazardous waste? If so, does the project has measures in place to prevent negative effects, e.g., by preparing a waste and pollution prevention and management plan for the activity or whole project</td><td>YES/NO</td><td>Waste / pollution:
☐ The main wastes are construction materials and deposits from the canals. These wastes will be removed to authorized disposal facilities/sites and processed in coordination with EPA and local authority.

There is a risk that waste will not properly be managed / recycled.

Noise:
Although construction activities will not be close to residential areas, there may be noise or vibration due to the construction activities. The following measures will be put in place to minimize potential negative effects:
☐ Avoid operations and vehicle movements at night.
☐ Set traffic speed limits for construction and operation-related traffic
☐ Position equipment as far as possible from sensitive areas (neighboring communities)</td></tr>
<tr><td>73. Will the project avoid producing / using additional natural resources, including water and energy and / or generate activity- related greenhouse gas emissions? If these are produced / used, does the project has measures in place to prevent or reduce these to manageable levels, e.g., by using water as efficient as possible for the activity or whole project or by compensating for energy use through use of renewable energy?</td><td>YES</td><td>Some machinery will be used for project activities. However, energy use and related GHG emissions will be limited. As for water use, the project intends to maximize efficient use of water sources.</td></tr>
<tr><td colspan="3">ADAPTATION FUND PRINCIPLE 13: PUBLIC HEALTH:
Requirement: The activity shall be designed and implemented in a way that avoids potentially significant negative impacts on public health.</td></tr>
<tr><td>74. Has it been demonstrated that the activity will not cause potentially significant negative impacts on public health and safety of the affected community by screening for possible risks / impacts (related to safe infrastructure, equipment, water, clean air, healthy workspace, safe house, employment and working conditions, etc. and including the results of the screening in the proposal, including general project measures to avoid risks?</td><td>YES</td><td>
<table>
<tr><th>General Potential risk / impact</th><th>Mitigation measures (for more details see ESMP)</th></tr>
<tr><td>☐ Security incidents</td><td>• Ensure health and safety procedure prior to construction that establishes procedures</td></tr>
<tr><td>☐ Occupational Health and Safety</td><td>• Occupational health and safety procedures must be developed, specific to execution entity / project output</td></tr>
<tr><td>☐ Increase in Social Tension due to Contractor-Community Interactions and Security</td><td>• A Worker Code of Conduct must be developed</td></tr>
<tr><td>❑ Increase in Vector Borne and Communicable Diseases</td><td>• A Vector Borne and Communicable Diseases Procedure must be developed</td></tr>
<tr><td>❑ Limited emergency Response Local Capacity and Equipment</td><td>• Audit and gap assessment of local capacity
• Coordinate with local emergency response teams (fire, EMS, police, hospital) and implement mitigations to address gaps</td></tr>
</table>
</td></tr>
</table>

		❑ Workplace health and safety incidents	• An Emergency Preparedness and Response Procedure must be developed
		❑ Interaction with security actors	• Develop Security and Human Rights Management Procedure that is in alignment with UNDSS and the Voluntary Principles of Human Rights • All private security personnel to receive procedural or knowledge training • Engage the public security force through the correct hierarchy and channels early in the process to set up good working relationship and improve opportunities for influence on the adoption of International Standards.
		❑ Stolen Items	• In the case of public spaces, the municipality will assign a guard
		❑ Covid-19 (if relevant)	• A Health and Safety Risk Assessment of each project activity, including supply chains and associated facilities, against International Standards needs to be carried out including specific alignment with IFC PS2 (Labour and Working Conditions) as well as IFC PS4 (Community Health and Safety and Security).
ADAPTATION FUND PRINCIPLE 14: PHYSICAL AND CULTURAL HERITAGE: ***Requirement**: The activity shall be designed and implemented in a way that avoids the alteration, damage, or removal of any physical cultural resources, cultural sites, and sites with unique natural values recognized as such at the community, national or international level.*			
75. Has the presence of heritage in or near the activity been identified?	YES	❑ There are no heritage acknowledged by UNESCO[126] in the Tuban delta. UNESCO acknowledged the following sites in Yemen: **Cultural** (4) - Historic Town of Zabid (1993) - Landmarks of the Ancient Kingdom of Saba, Marib (2023) - Old City of Sana'a (1986) - Old Walled City of Shibam (1982) **Natural** (1) - Socotra Archipelago (2008) ☐ According to government information, local heritage sites in the Tubn Delta include mostly single buildings: buildings of ancient mosques, palaces, castles, and forts, in addition to water facilities such as the Aden natural water tanks (Saharej), as well as some facilities from the British colonial period, such as the Big Ben Aden, as well as some ancient cemeteries and tombs. All the identified sites are not in or close to proposed project interventions.	
76. If heritage exists, has the cultural heritage, the location and the results of a risk assessment analysing the potential for impacting the cultural heritage been described?	N/A	N/A	
77. If heritage exists, have the measures to be taken to ensure that heritage is not impacted, and if it is being accessed by communities, how this access will continue described?	N/A	N/A	
ADAPTATION FUND PRINCIPLE 15: LAND AND SOIL EROSION: ***Requirement:** The activity shall be designed and implemented in a way that promotes soil conservation and avoids degradation or conversion of productive lands or land that provides valuable ecosystem services.*			

[126] https://whc.unesco.org/en/statesparties/ye

78. Soil conservation: Has the presence of fragile soils (e.g. soils on the margin of a desert area, coastal soils, soils located on steep slopes, rocky areas with very thin soil) within the activity area been identified?	YES	☐ Soils on the margin of a desert area: The tuban delta has desert areas, but there will be no project interventions in these areas. ☐ Coastal soils: no vulnerable coastal soils ☐ Soils located on steep slopes, rocky areas with very thin soils; no
79. Soil conservation: Have activities that could result in the loss of otherwise non-fragile soil been identified. If such soils exist and potential soil loss activities will take place:	YES	No loss of soil is expected. On the contrary, project activities aim to reduce any movement of soil
80. Has the following been Identified and described? • Soils that may be impacted by the activity • Activities that may lead to loss of soils. • Reasons why soil loss is unavoidable • Measures that will be taken to minimize soil loss.	YES	See above
81. Has it been described how soil conservation has been promoted to the Executing Entities?	YES	This will be a standard clause in their contract
82. Valuable lands: Have productive lands and/or lands that provide valuable ecosystem services within the activity area been identified.	YES	The Tuban delta is an agriculture area, so the main ecosystem is agroecosystem with agriculture lands (crops, fruits and ornamental shrubs) and windbreaks trees. Other ecosystems include wadies, bare land and sand dunes with plant species such as Acacia sp., Senna sp., these ecosystem is important for shepherds.
83. Has the following been identified and described? • Any valuable lands. • Activities that may lead to land degradation. • Reasons why using these lands is un-avoidable and the alternatives that were assessed, and • Measures that will be taken to minimize productive land degradation or ecosystem service impacts.	YES	See above

Table 79 Potential risks and impact assessment details and measures to avoid / mitigate risks / impacts

AF principle number and description of risks (answer NO)	**Potential risk (+ description)**	**Impact assessment (significance of risk)**	**Mitigation measures**	**Monitoring Indicators (expected result) and means of verification**	**Responsible party / person**	**Cost / Budget**
PRINCIPLE 1: COMPLIANCE WITH THE LAW	There is a potential risk that the ESIA-ESMP is not approved on time by the Yemen government for the project to start	Potential negative environmental and social impacts due to incompliance with relevant standards and regulations and delay due to awaited approval of the ESIA-ESMP	❑ Ensure the ESIA-ESMP approval is granted by the Yemen government no later than the inception phase.	❑ ESIA-ESMP approval document by the Yemen government	UN-Habitat	No cost
ADAPTATION FUND PRINCIPLE 2: ACCESS AND EQUITY	Some concerns were raised regarding: ☐ Unequal distribution of irrigated water (to small-holder farmers, women farmers, farmers which have not received support previously and other vulnerable groups) ☐ That interventions may take place during the agriculture season, which may hinder irrigation. ☐ Disruption of gate control mechanism	Potential disputes if water is irrigated unequally. This may affect farmers in 22 water user associations, including small-holder farmers and women farmers	❑ Final agreement on proposed project interventions during project inception phase between: ▪ Women organizations: 15 ▪ Youth organizations: 7 ▪ Water user associations: 22 ▪ Community organizations (leaders): 13 ▪ Religious leaders ▪ Representative displaced persons ▪ Agriculture office ☐ Implement interventions during November – February and / or ensure irrigation is not disrupted due to project interventions.	❑ Consultation / workshop report and final agreement ❑ Work plan and / or check measures to avoid disruption of irrigation. ❑ Check gate management protocol / method /	UN-Habitat and executing entities	As part of workshop budget and executing entities' budget

			☐ Develop control method or close the gates managed only by the irrigation department.	plan with irrigation department		
PRINCIPLE 3: VULNERABLE AND MARGINALIZED GROUPS	There is a small potential risk that needs and concerns of various groups have changed once the project starts.	This could lead to dissatisfaction about project interventions of project beneficiaries	❑ All project beneficiary groups will be consulted again during the inception phase to verify and further identify all specific needs and concerns of groups (see also above) ❑ Strictly apply the Grievance and Redress Mechanism ❑ The project will ensure equal opportunities in participation and decision-making of women, youth and other vulnerable groups by using quotas and by agreeing on representation in decision-making processes through the use of ToRs, agreements, etc.	❑ Verification report of needs and potential concerns of project beneficiaries ❑ Grievance and Redress mechanism in place ❑ Attendance sheets and workshop / training reports	UN-Habitat and executing entities	As part of comp 1
PRINCIPLE 6: CORE LABOUR RIGHTS:	There is a small risk of core labour standards not being respected by contractors, especially related to standards for safety and health and labour inspection.	Dissatisfaction among workers and employees in the project	The project follows ILO core labor standards. Looking at the conventions and protocols not ratified, the project will be particularly attentive to any health and safety and inspections. ❑ Employment and working conditions following core labour standards to which the project activity will need to comply will be included in all legal agreements with all sub-contractors, including steps and responsibilities to comply. ❑ Regular inspections will be conducted. ❑ Strictly apply the Grievance and Redress Mechanism	❑ Check agreements for relevant clauses ❑ Inspection reports ❑ Grievance and Redress mechanism in place	UN-Habitat	As part of execution fee (consultants)
PRINCIPLE 12: POLLUTION AND RESOURCE EFFICIENCY:	There is a risk that waste (mostly construction materials and deposits from the canals mostly related to output 2.1.) will not properly be managed / recycled.	Waste may be dumped / processed inappropriately with potential negative environmental impacts. Although waste is not expected to be hazardous, it should not be dumped on inappropriate sites or not recycled while this is possible	❑ A waste management plan will be prepared. ❑ Reference to the waste management plan to which the project activity will need to comply will be included in all legal agreements with all sub-contractors, including steps and responsibilities to comply.	❑ Check waste management plan ❑ Check agreements for relevant clauses ❑ Conduct inspections	UN-Habitat	As part of execution fee (consultants)

Table 80 Risks screening of activities related to (re)use of (treated) wastewater (outputs 3.1.; 3.2.; 3.3.; 3.4)

Checklist of potential risk areas of non-compliance of the activity / intervention within the adaptation fund's environmental and social and gender principles	**initial environmental or social risks present YES / NO**	**Explanation why yes / no and reference to information**
ADAPTATION FUND PRINCIPLE 1: COMPLIANCE WITH THE LAW: ***Requirement:*** *The proposed activity should be in compliance with all applicable domestic and international law.*		
84. Have all relevant rules, regulations and technical standards been identified?	YES	❑ All relevant rules, regulations and standards have been identified for all proposed project activities. Procedures for compliance of key ones initiated. Therefore, no potential risk of non-compliance exists. This has been fully presented in proposal Part II.E
85. Have the procedures to comply, including authorizing offices been identified?	YES	Authorizing offices and approvals required: ☐ Ministry of Water and Environment - Environmental Protection Authority

		☐ Ministry of Agriculture, Irrigation and Fishery-General Administration of Irrigation Local Corporation Water and Sanitation ☐ National Water & Resources Authority – NWRA ☐ Aden and Lahj Local Authorities ☐ Water users' group
86. If an ESIA is required by national law for the proposed activity, has this been prepared and approved?	YES/NO	In Yemen, the following mechanism is in place to obtain environmental approval for projects: ☐ Screening (list all positive and negative impacts); If the negative impacts are not serious, no need to continue. ☐ Scoping (optional): This step should be based on consultations with the local people and national experts after listing the impacts. ☐ Impact assessment ☐ Develop possible mitigation measures (for the negative impacts) ☐ Writing all in an Environmental Impact Assessment (EIA) report ☐ **Send the EIA report to the MWE and EPA to be approved.** The process is at the last step in bold above. These is a small risk the approval of the ESIA-ESMP is not granted before the AF proposal approval
ADAPTATION FUND PRINCIPLE 2: ACCESS AND EQUITY: ***Requirement**: Ensure fair and equitable access to benefits of the activity*		
87. Have all potential beneficiaries and been identified?	YES	All project beneficiaries (i.e. population; groups) have been mapped
88. Have rivals, disputants and concerns related to equal access of project beneficiaries been identified and are measures in place to avoid these?	YES/NO	Community consultations and focus groups discussions have been conducted per beneficiary group to identify possible rivals, disputants and concerns related to equal access of project benefits. Some concerns were raised regarding: ☐ Unequal distribution of irrigated water (to small-holder farmers, women farmers, farmers which have not received support previously and other vulnerable groups)
89. Has the process of allocating and distributing benefits equally (fair and impartial access) been described?	YES	Project benefits will be allocated and distributed equally through a participatory process and through joint decision-making through the involvement of water user associations, social/community organizations and women and youth groups.
ADAPTATION FUND PRINCIPLE 3: VULNERABLE AND MARGINALIZED GROUPS: ***Requirement**: Avoid imposing any disproportionate adverse impacts on marginalized and vulnerable groups including children, women and girls, the elderly, indigenous people, tribal groups, displaced people, refugees, people living with disabilities, and people living with HIV/AIDS.*		
90. Have all potential beneficiaries, including marginalized and vulnerable groups been identified?	YES	All project beneficiaries (i.e. population; groups) have been mapped
91. Have the characteristics of the marginalized or vulnerable groups been described?	YES	Desk research, expert consultations and community consultations and focus group discussions have been conducted (see proposal Part II.H) to identify possible risks / adverse impacts of project activities on marginalized and vulnerable beneficiary groups (i.e. specific needs, limitations, constraints and concerns of groups).
92. Have potential adverse impacts that each marginalized and vulnerable group may experience from the activity been identified and have the groups been consulted on specific needs, limitations, constraints and requirements?	YES/NO	As per above, any potential adverse impact has been identified. There will be neither discrimination nor favouritism in accessing project/programme benefits. Project benefits will be allocated and distributed equally through a participatory process and through joint decision-making. There is a small potential risk that needs and concerns of various groups have changed once the project starts.
ADAPTATION FUND PRINCIPLE 4: HUMAN RIGHTS: ***Requirement:** The activity shall respect and where applicable promote international human rights*		

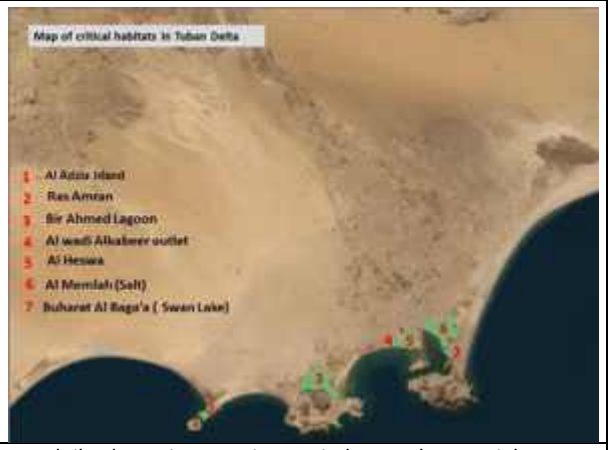
93. Has any citing of the host country in any Human Rights Council Special Procedures been identified and has the project described how to deal with potential related issues?	YES	Human right treaties not ratified in Yemen[127]: ❑ CAT-OP - Optional Protocol of the Convention against Torture ❑ CCPR-OP2-DP - Second Optional Protocol to the International Covenant on Civil and Political Rights aiming to the abolition of the death penalty ❑ CED - Convention for the Protection of All Persons from Enforced Disappearance ➢ Citing in relation to the armed conflict ❑ CED, Art.32 - Interstate communication procedure under the International Convention for the Protection of All Persons from Enforced Disappearance ❑ CMW - International Convention on the Protection of the Rights of All Migrant Workers and Members of Their Families ➢ There are issues reported with migrants along the boders Any agreement / contract signed will include reference to compliance with Human rights. Besides that, a Security and Human Rights Management Procedure that is in alignment with UNDSS and the Voluntary Principles of Human Rights will be prepared.
ADAPTATION FUND PRINCIPLE 5: GENDER EQUALITY AND WOMEN'S EMPOWERMENT: ***Requirement:*** *Design and implement the activity in such a way that both women and men 1) have equal opportunities to participate; 2) receive comparable social and economic benefits; and 3) do not suffer disproportionate adverse effects during the development process*		
94. Has the legal and regulatory context with respect to gender equality and women's empowerment been analyzed to identify any obstacles to comply?	YES	A social inclusion plan has been developed. This is a 'gender' plan, but with a less sensitive title considering the context
95. Has the cultural, traditional, religious, or any other grounds that might result in differential allocation of benefits between men and women of the activity been analyzed?	YES	A social inclusion plan has been developed.
96. Does the project actively pursue equal participation and access to activity benefits through specific gender approach?	YES	A social inclusion plan has been developed.
ADAPTATION FUND PRINCIPLE 6: CORE LABOUR RIGHTS: ***Requirement:*** *The activity should meet the core labour standards as identified by the International Labour Organization and respect, promote ILO core labour standards*		
97. Has it been summarized how Executing Entities will comply to core labour standards?	YES	In the ESMP it has been described how executing entities will comply with the core labour standards
98. Has it been identified if the eight ILO core conventions have been ratified in project countries and if not ratified, are measures in place to avoid potential risks of non-compliance?	YES	Core labour rights not ratified in Yemen:[128] ☐ Fundamental Conventions: 8 of 10. Not ratified: **C155** - Occupational Safety and Health Convention, 1981 (No. 155) **C187** - Promotional Framework for Occupational Safety and Health Convention, 2006 (No. 187) **P029** - Protocol of 2014 to the Forced Labour Convention, 1930 ☐ Governance Conventions (Priority): 3 of 4. Not ratified **C129** - Labour Inspection (Agriculture) Convention, 1969 (No. 129) ☐ Technical Conventions: 19 of 177 Any agreement / contract signed will include reference to compliance with ILO labour standards and especially standards related to safety and health and labour inspection. For more details on measures see the ESMP
99. Have potential risks of non-compliance with ILO core labour standards of the activity been identified through consultations (experts and communities) and are	YES/NO	There is a small risk of core labour standards not being respected by contractors, especially related to standards for safety and health and labour inspection.

[127] https://tbinternet.ohchr.org/_layouts/15/TreatyBodyExternal/Treaty.aspx?CountryID=170&Lang=EN
[128] ILO ratification (or not) of core labour standards in Yemen

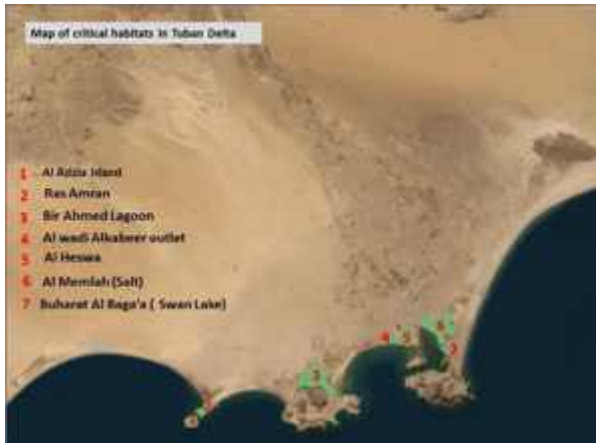
measures in place to avoid potential risks of non-compliance?		
ADAPTATION FUND PRINCIPLE 7: INDIGENOUS PEOPLE: ***Requirement**: The activity shall not be inconsistent with the rights and responsibilities set forth in the UN Declaration on the Rights of Indigenous Peoples and other applicable international instruments relating to indigenous peoples.*		
100. Has it been assessed if indigenous people are present in the activity target area? If so:	YES	There have not been any indigenous groups in the area identified utilizing the criteria of the UN-Habitat Environmental and Social Safeguards System[129]: "A distinct social and cultural group possessing the following characteristics in varying degrees: 121.1. Self-identification as members of a distinct indigenous social and cultural group and recognition of this identity by others; and 121.2. Collective attachment to geographically distinct habitats, ancestral territories, or areas of seasonal use or occupation, as well as to the natural resources in these areas; and 121.3. Customary cultural, economic, social, or political institutions that are distinct or separate from those of the mainstream society or culture; and 121.4. A distinct language or dialect, often different from the official language or languages of the country or region in which they reside."
101. Has it been identified if the host country ratified the ILO Convention 169?	YES	ILO convention 169 has not been tarified in Yemen[130]
102. Has it been described how the project (and activity) will be consistent with UNDRIP, and particularly with regard to Free, Prior, Informed Consent (FPIC) during project design, implementation and expected outcomes related to the impacts affecting the communities of indigenous peoples?	N/A	
103. Has it been described how indigenous peoples will be involved in the design and the implementation of the project and provide detailed outcomes of the consultation process of the indigenous peoples?	N/A	
104. Has documented evidence of the mutually accepted process between the project and the affected communities and evidence of agreement between the parties as the outcome of the negotiations been provided?	N/A	
105. Has a summary of any reports, specific cases, or complaints that have been made with respect to the rights of indigenous peoples by the Special Rapporteur and that are relevant to the project/programme been provided?	N/A	
106. Has awareness about the rights of indigenous peoples and how it is a general principle in the implementation of the project been included in the project design?	N/A	
ADAPTATION FUND PRINCIPLE 8: INVOLUNTARY RESETTLEMENT: ***Requirement**: The activity shall be designed and implemented in a way that avoids or minimizes the need for involuntary resettlement.*		
107. If there is any acquisition of lands, will the procedure be in accordance with the legal system of the country and international standards?	YES	Land acquisition is not required as all proposed interventions will be on publicly owned land ❑ Reuse of treated wastewater o The wastewater treatment activities are on plant locations already existing and existing irrigation channels will be used

[129] https://unhabitat.org/environmental-and-social-safeguards-system-version-3-esss-31
[130] idem

108. Will any unnecessary displacement be avoided? Determine if any potential displacement is physical or economic/ livelihood and if it is voluntary or involuntary (through identification of land ownership and use (also informally) and consultations on consent to the activity?	YES	It is not foreseen that land other than public land will be targeted under this project. It has been determined that no physical or economic (even informal) displacement will take place due to project activities. This has been determined by mapping project target sites land ownership (private, public) and land use, also informally, and through consulting communities / users on the possible risk of resettlement and to get agreement on proposed interventions (i.e., no interventions will take place without the consent of inhabitants in the targeted areas).
109. Is awareness building of involuntary resettlement and the applicable principles and procedures of the activity / project part of the project activities?	YES	This will be part of the grievance and redress mechanism to be implemented
110. If it is involuntary: has justification for the need for involuntary resettlement been provided by demonstrating any realistic alternatives that were explored, and how the proposed involuntary resettlement has been minimized and is the least harmful solution.	N/A	
111. If it is involuntary: have details of the extent of involuntary resettlement been described, including the number of people and households involved, their socio-economic situation and vulnerability, how their livelihoods will be replaced, and the resettlement alternatives and/or the full replacement cost compensation required whether the displacement is temporary or permanent?	N/A	
112. If it is involuntary: have the details of the involuntary resettlement process that the activity will apply been described, and the built-in safeguards to ensure that displaced persons shall be informed of their rights in a timely manner, made aware of the grievance mechanism, consulted on their options, and offered technically, economically, and socially feasible resettlement alternatives or fair and adequate compensation? This also should include an overview of the applicable national laws and regulations.	N/A	
113. If it is involuntary: has it been justified that the involuntary resettlement is feasible?	N/A	
114. If it is involuntary: has the adequacy of the activity / project organisational structure to successfully implement the involuntary resettlement as well as the capacity and experience of the project/programme management with involuntary resettlement been described?	N/A	
ADAPTATION FUND PRINCIPLE 9: PROTECTION OF NATURAL HABITATS: ***Requirement:*** *The activity shall not result in unjustified conversion or degradation of critical natural habitats*		

115. Has the presence in or near the activity area of natural habitats been identified?	YES	❑ No vulnerable / critical natural habitats in the Tuban delta as per the Convention on Wetlands (Ramsar, Iran, 1971)[131] ❑ No vulnerable / critical natural habitats in the Tuban delta as per the UNESCO Man and the Biosphere Programme.[132] There are two protected biospheres in Yemen (Socotra Archipelago and Bura'a Archipelago), but these are not located in the Tuban delta area ❑ According to government information, Aden wetlands is an ecosystem that provides a breeding and feeding site for more than 100 migratory bird species, including flamingos. As a result, the Aden wetlands are among the most important wetland ecosystems in Yemen and in the entire region. Aden wetlands protected areas comprise of five sites: Al-Heswa, Al-Memlah, Al-Wady Al-Kabeer, Swan Lake, and Khour bir Ahmad. In addition to birds, the sites host several plant and aquatic animal species, such as turtles in AlAzizia island and Ras Amran and coral reefs, seaweeds, halophytes and algae. The ecosystems also provides several services, including protection of coastal areas and support marine habitats and consist lagoons, marshes and beaches. 
116. Has the potential of activity to impact directly, indirectly, or cumulatively upon natural habitats been identified?	YES	The interventions are not planned in or close to natural habitats and indirect or cumulative impacts are not expected as environmental impacts should be positive rather than. negative
117. Are there any risks management arrangement in place for potential risks identified above?	N/A	N/A
118. If such habitats exist, has the location of the critical habitat in relation to the project and why it cannot be avoided, as well as its characteristics and critical value been described?	N/A	N/A
119. If such habitats exist, for each affected critical natural habitat, has an analysis on the nature and the extent of the impact including direct, indirect, cumulative, or secondary impacts been provided?	N/A	N/A
ADAPTATION FUND PRINCIPLE 10: CONSERVING BIODIVERSITY: ***Requirement:*** *The activity shall be designed and implemented in a way that avoids any significant or unjustified reduction or loss of biological diversity or the introduction of known invasive species.*		

[131] https://www.ramsar.org/wetland/yemen
[132] https://en.unesco.org/biosphere/arab-states#yemen

120. Has the presence in or near the project/programme area of important biological diversity been identified?	YES	❑ As per the IUCN Red List of Threated Species[133], there may be some endangered birds in the Tuban delta, including the Egyptian vulture, Saker falcon and Slender-billed curlew. These may be in scrublands, grasslands, wetlands and Marine areas. However, these will not be impacted by the proposed interventions. ❑ According to government information, the Aden Coastal Wetlands are considered to be one of the most important sites for migratory birds and regularly host over 10,000 waterfowl, including three globally threatened and 12 regionally important species populations. The site meets the conditions of the International Ramsar site and Bonn Conventions. Among the most significant species found in the area are Lesser Flamingo (Phoenicopterus minor) with 9200 birds counted on the last census (in 1996), the largest concentration anywhere in the Middle East. Other important species include Great Spotted Eagle (Aquila clanga), Imperial Eagle (Aquila heliaca), and Crab Plover (Dromas ardeola). Aden wetlands host rich marine biodiversity such as sea grasses 6 species, 13 species green and brown algae,19 species of crustaceans and 67 species of mollusks. There are recorded of 24 species of fish from 18 families in Aden wetlands Pas and hard corals were presented as patches in Khor Bir Ahmed. Sea crabs were reported; Soldier crab Charybdis natator and Fiddler crabs Uca sp are common in Khor Bir Ahmed. sea cucumber was recorded includes Halothuria atra, Halothuria edulis, Halothuria scabra and Actinopyga echinites. 
121. Has the potential of a significant or unjustified reduction or loss of biological diversity, and the potential to introduce known invasive species been identified?	YES	The interventions are not planned in or close to natural habitats and indirect or cumulative impacts are not expected as environmental impacts should be positive rather than. negative
122. If important biological diversity exists (Biological diversity), have the elements of known biological diversity importance in the project/programme area been described?	N/A	N/A
123. If important biological diversity exists (Biological diversity), has it been described why the biological diversity impact cannot be avoided?	N/A	N/A
124. Are there any risks management arrangement in place for these identified potential risks?	N/A	N/A
125. If important biological diversity exists (Invasive species), has it been described the invasive species that either may or will be introduced and why such introduction cannot be avoided?	N/A	N/A
126. If important biological diversity exists (Invasive species), has evidence that this introduction is permitted in accordance with the existing regulatory framework and the results of a risk assessment analysing the potential for invasive behaviour been provided?	N/A	N/A

[133] https://www.iucnredlist.org/search?landRegions=YE&searchType=species

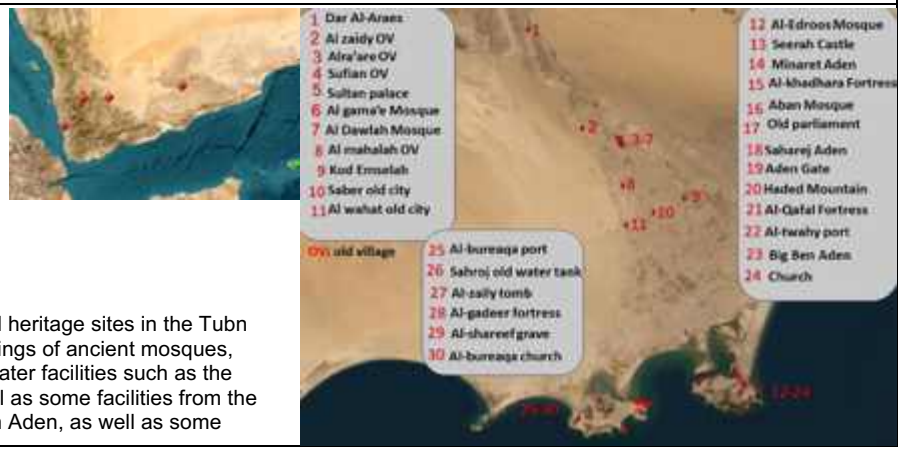
<table>
<tr><td>127. If important biological diversity exists (Invasive species), has it been described the measures to be taken to minimize the possibility of spreading the invasive species?</td><td>N/A</td><td>N/A</td></tr>
<tr><td colspan="3">ADAPTATION FUND PRINCIPLE 11: CLIMATE CHANGE:
Requirement: The activity shall not result in any significant or unjustified increase in greenhouse gas emissions or other drivers of climate change.</td></tr>
<tr><td>128. When relevant, has a risk-based assessment of resulting increases in the emissions of greenhouse gasses or in other drivers of climate change been conducted?</td><td>N/A</td><td>
<table>
<tr><th></th><th>Additional energy use due to project</th><th>Compensation</th></tr>
<tr><td>3.2. Developing efficient and safe water supply alternatives for Al-What, Al-Hawtat cities and surrounding villages.</td><td>33 Kwh / day</td><td>100 solar panel 550 watt each</td></tr>
<tr><td>3.3. Upgrade Tahror WWTP to treat wastewater for use in irrigation.</td><td>NA</td><td></td></tr>
<tr><td>3.4. Upgrade Saber WWTP to treat wastewater for use in irrigation.</td><td>NA</td><td></td></tr>
<tr><td></td><td>NA</td><td></td></tr>
<tr><td>4.1. Support farmers with modern irrigation techniques and system (Urban and Rural Areas)</td><td>268 KwH / day</td><td>67 horizontal solar pumps (4 KwH each)</td></tr>
</table>
</td></tr>
<tr><td colspan="3">ADAPTATION FUND PRINCIPLE 12: POLLUTION AND RESOURCE EFFICIENCY:
Requirement: The activity shall be designed and implemented in a way that meets applicable international standards for maximizing energy efficiency and minimizing material resource use, the production of wastes, and the release of pollutants.</td></tr>
<tr><td>129. Will the activities discharge pollution into water and / or land; use hazardous materials; generate noise and vibration; and/or generate waste including hazardous waste? If so, does the project has measures in place to prevent negative effects, e.g., by preparing a waste and pollution prevention and management plan for the activity or whole project</td><td>YES/NO</td><td>Waste / pollution:
☐ The treated wastewater will still have some pollutants, only suitable for certain crops. Although farmers are aware of the suitability of the use of treated wastewater (for fodders), there is still a risk that treated wastewater will be used inappropriately and that farmers are not using enough health safety equipment.
☐ Related to above some concerns were raised regarding irrigation of inappropriate crops and discharge of bad quality wastewater.
☐ Some sludge may need to be removed from the WWTP sites. There is a risk this will not be processed appropriately.

Noise:
Although construction activities will not be close to residential areas, there may be noise or vibration due to the construction activities. The following measures will be put in place to minimize potential negative effects:
▪ Avoid operations and vehicle movements at night.
▪ Set traffic speed limits for construction and operation-related traffic
▪ Position equipment as far as possible from sensitive areas (neighboring communities)</td></tr>
<tr><td>130. Will the project avoid producing / using additional natural resources, including water and energy and / or generate activity- related greenhouse gas emissions? If these are produced / used, does the project has measures in place to prevent or reduce these to manageable levels, e.g., by using water as efficient as possible for the activity or whole project or by compensating for energy use through use of renewable energy?</td><td>YES</td><td>☐ The two wastewater treatment plants will treat up to 4700 m^3/day. The treated water will be reused for irrigation this will support rationalizing the use of surface and underground water resources and prevent further pollution on the resource. The treated wastewater will irrigate 115 ha, 2 seasons/year.
☐ See principe 11</td></tr>
<tr><td colspan="3">ADAPTATION FUND PRINCIPLE 13: PUBLIC HEALTH:
Requirement: The activity shall be designed and implemented in a way that avoids potentially significant negative impacts on public health.</td></tr>
<tr><td>131. Has it been demonstrated that the activity will not cause potentially significant negative impacts on public health and safety of the affected community by screening for possible risks / impacts (related to safe infrastructure, equipment, water, clean air, healthy workspace, safe house, employment and working conditions, etc. and</td><td>YES/NO</td><td>
<table>
<tr><th>General Potential risk / impact</th><th>Mitigation measures (for more details see ESMP)</th></tr>
<tr><td>☐ Security incidents</td><td>• Ensure health and safety procedure prior to construction that establishes procedures</td></tr>
<tr><td>☐ Occupational Health and Safety</td><td>• Occupational health and safety procedures must be developed, specific to execution entity / project output</td></tr>
</table>
</td></tr>
</table>

including the results of the screening in the proposal, including general project measures to avoid risks?		☐ Increase in Social Tension due to Contractor-Community Interactions and Security — • A Worker Code of Conduct must be developed ❑ Increase in Vector Borne and Communicable Diseases — • A Vector Borne and Communicable Diseases Procedure must be developed ❑ Limited emergency Response Local Capacity and Equipment — • Audit and gap assessment of local capacity • Coordinate with local emergency response teams (fire, EMS, police, hospital) and implement mitigations to address gaps ❑ Workplace health and safety incidents — • An Emergency Preparedness and Response Procedure must be developed ❑ Interaction with security actors — • Develop Security and Human Rights Management Procedure that is in alignment with UNDSS and the Voluntary Principles of Human Rights • All private security personnel to receive procedural or knowledge training • Engage the public security force through the correct hierarchy and channels early in the process to set up good working relationship and improve opportunities for influence on the adoption of International Standards. ❑ Stolen Items — • In the case of public spaces, the municipality will assign a guard ❑ Covid-19 (if relevant) — • A Health and Safety Risk Assessment of each project activity, including supply chains and associated facilities, against International Standards needs to be carried out including specific alignment with IFC PS2 (Labour and Working Conditions) as well as IFC PS4 (Community Health and Safety and Security). There remains a risk that treated wastewater will be used inappropriately and that farmers are not using enough health and safety equipment.

ADAPTATION FUND PRINCIPLE 14: PHYSICAL AND CULTURAL HERITAGE:

***Requirement**: The activity shall be designed and implemented in a way that avoids the alteration, damage, or removal of any physical cultural resources, cultural sites, and sites with unique natural values recognized as such at the community, national or international level.*

132. Has the presence of heritage in or near the activity been identified?	YES	❑ There are no heritage acknowledged by UNESCO[134] in the Tuban delta. UNESCO acknowledged the following sites in Yemen: **Cultural** (4) - Historic Town of Zabid (1993) - Landmarks of the Ancient Kingdom of Saba, Marib (2023) - Old City of Sana'a (1986) - Old Walled City of Shibam (1982) **Natural** (1) - Socotra Archipelago (2008) ☐ According to government information, local heritage sites in the Tubn Delta include mostly single buildings: buildings of ancient mosques, palaces, castles, and forts, in addition to water facilities such as the Aden natural water tanks (Saharej), as well as some facilities from the British colonial period, such as the Big Ben Aden, as well as some 

[134] https://en.unesco.org/biosphere/arab-states#yemen

		ancient cemeteries and tombs. All the identified sites are not in or close to proposed project interventions.
133. If heritage exists, has the cultural heritage, the location and the results of a risk assessment analysing the potential for impacting the cultural heritage been described?	N/A	N/A
134. If heritage exists, have the measures to be taken to ensure that heritage is not impacted, and if it is being accessed by communities, how this access will continue described?	N/A	N/A
ADAPTATION FUND PRINCIPLE 15: LAND AND SOIL EROSION: ***Requirement:*** *The activity shall be designed and implemented in a way that promotes soil conservation and avoids degradation or conversion of productive lands or land that provides valuable ecosystem services.*		
135. Soil conservation: Has the presence of fragile soils (e.g. soils on the margin of a desert area, coastal soils, soils located on steep slopes, rocky areas with very thin soil) within the activity area been identified?	YES	☐ Soils on the margin of a desert area: The tuban delta has desert areas, but there will be no project interventions in these areas. ☐ Coastal soils: no vulnerable coastal soils ☐ Soils located on steep slopes, rocky areas with very thin soils; no
136. Soil conservation: Have activities that could result in the loss of otherwise non-fragile soil been identified. If such soils exist and potential soil loss activities will take place:	YES	No loss of soil is expected. On the contrary, project activities aim to reduce any movement of soil
137. Has the following been Identified and described? • Soils that may be impacted by the activity • Activities that may lead to loss of soils. • Reasons why soil loss is unavoidable • Measures that will be taken to minimize soil loss.	YES	See above
138. Has it been described how soil conservation has been promoted to the Executing Entities?	YES	This will be a standard clause in their contract
139. Valuable lands: Have productive lands and/or lands that provide valuable ecosystem services within the activity area been identified. If such lands exist:	YES	The Tuban delta is an agriculture area, so the main ecosystem is agroecosystem with agriculture lands (crops, fruits and ornamental shrubs) and windbreaks trees. Other ecosystems include wadies, bare land and sand dunes with plant species such as Acacia sp., Senna sp., these ecosystem is important for shepherds.
140. Has the following been identified and described? • Any valuable lands. • Activities that may lead to land degradation. • Reasons why using these lands is un-avoidable and the alternatives that were assessed, and • Measures that will be taken to minimize productive land degradation or ecosystem service impacts.	YES	See above

Table 81 Potential risks and impact assessment details and measures to avoid / mitigate risks / impacts

AF principle number and description of risks (answer NO)	**Potential risk (+ description)**	**Impact assessment (significance of risk)**	**Mitigation measures to avoid / reduce any potential risks**	**Monitoring indicators and verification**	**Responsible party / person**	**Cost / Budget**
PRINCIPLE 1: COMPLIANCE WITH THE LAW	There is a potential risk that the ESIA-ESMP is not approved on time by the Yemen government for the project to start	Potential negative environmental and social impacts due to incompliance with relevant standards and regulations and delay due to awaited approval of the ESIA-ESMP	❑ Ensure the ESIA-ESMP approval is granted by the Yemen government no later than the inception phase.	❑ ESIA-ESMP approval document by the Yemen government	UN-Habitat	No cost
ADAPTATION FUND PRINCIPLE 2: ACCESS AND EQUITY	Some concerns were raised regarding: ☐ Unequal distribution of irrigated water (to small-holder farmers, women farmers, farmers which have not received support previously and other vulnerable groups)	Potential disputes if water is irrigated unequally. This may affect farmers in 22 water user associations, including small-holder farmers and women farmers	❑ Final agreement on proposed project interventions during project inception phase between: ▪ Women organizations: 15 ▪ Youth organizations: 7 ▪ Water user associations: 22 ▪ Community organizations (leaders): 13 ▪ Religious leaders ▪ Representative displaced persons ▪ Agriculture office	❑ Consultation / workshop report and final agreement	UN-Habitat and executing entities	As part of workshop budget and executing entities' budget
PRINCIPLE 3: VULNERABLE AND MARGINALIZED GROUPS	There is a small potential risk that needs and concerns of groups have changed once the project starts.	This could lead to dissatisfaction about project interventions of project beneficiaries	❑ All project beneficiary groups will be consulted again during the inception phase to verify and further identify all specific needs and concerns of groups. ❑ Strictly apply the Grievance and Redress Mechanism ❑ The project will ensure equal opportunities in participation and decision-making of women, youth and other vulnerable groups by using quotas and by agreeing on representation in decision-making processes through the use of ToRs, agreements, etc.	❑ Verification report of needs and potential concerns of project beneficiaries ❑ Grievance and Redress mechanism in place ❑ Attendance sheets and workshop / training reports	UN-Habitat and executing entities	As part of comp 1
PRINCIPLE 6: CORE LABOUR RIGHTS:	There is a small risk of core labour standards not being respected by contractors, especially related to standards for safety and health and labour inspection.	Dissatisfaction among workers and employees in the project	The project follows ILO core labor standards. Looking at the conventions and protocols not ratified, the project will be particularly attentive to any health and safety and inspections. ❑ Employment and working conditions following core labour standards to which the project activity will need to comply will be included in all legal agreements with all sub-contractors, including steps and responsibilities to comply. ❑ Regular inspections will be conducted. ❑ Strictly apply the Grievance and Redress Mechanism	❑ Check agreements for relevant clauses ❑ Inspection reports ❑ Grievance and Redress mechanism in place	UN-Habitat	As part of execution fee (consultants)

PRINCIPLE 12: POLLUTION AND RESOURCE EFFICIENCY:	The treated wastewater will still have some pollutants, only suitable for certain crops. Although farmers are aware of the suitability of the use of treated wastewater (for fodders), there is still a risk that treated wastewater will be used inappropriately and that farmers are not using enough health and safety equipment. Besides that, there is a risk that sludge need to be removed from the WWTP sites, but that this will not be processed appropriately.	Crops (115 ha) may get contaminated, and farmers may get sick. This may also have a secondary negative effect on consumers of the crops Treated water for drinking will be mixed into the water supply network, serving the whole of Aden	❑ Ensure treated wastewater is only used for appropriate crops (through coordination with farmer/water user associations and authorities and related monitoring) ❑ Comply with (international) standards for water quality and monitor water quality. ❑ Ensure farmers are aware of the risks and wear appropriate shoes and gloves (as part of awareness campaign and trainings planned)	❑ Regular water quality checks ❑ Conduct inspections. ❑ Check if is part of the awareness raising campaign and trainings	UN-Habitat	As part of execution fee (consultants), laboratories established and planned awareness campaigns
PRINCIPLE 13: PUBLIC HEALTH	The treated wastewater will still have some pollutants, only suitable for certain crops. Although farmers are aware of the suitability of the use of treated wastewater (for fodders), there is still a risk that treated wastewater will be used inappropriately and that farmers are not using enough health and safety equipment.	Crops (115 ha) may get contaminated, and farmers may get sick. This may also have a secondary negative effect on consumers of the crops	❑ Ensure treated wastewater is only used for appropriate crops (through coordination with farmer/water user associations and authorities and related monitoring) ❑ Comply with (international) standards for water quality and monitor water quality. ❑ Ensure farmers are aware of the risks and wear appropriate shoes and gloves (as part of awareness campaign and trainings planned)	❑ Regular wastewater quality check ❑ Conduct inspections. ❑ Check if is part of the awareness raising campaign and trainings	UN-Habitat	As part of execution fee (consultants), laboratories established and planned awareness campaigns

2. ENVIRONMENTAL ANS SOCIAL RISKS MANAGEMENT PLAN (ESMP) AND SOCIAL INCLUSION PLAN

Environmental and Social risk Management Plan (ESMP)

Summary ESMP

Table 82 Summary environmental and social risks management plan

ESP principle	Initial environmental or social risks present Y/N	Potential risks	Explanation	Impact assessment	Mitigation measures to avoid / reduce any potential risks	Monitoring indicators and verification	Responsible
1.Compliance with the Law	YES	There is a potential risk that the ESIA-ESMP is not approved on time by the Yemen government for the project to start	Relevant national laws and standards and project compliance with these have been identified. A risks screening and impact assessment for proposed project interventions has been conducted. This is awaiting approval	Potential negative environmental and social impacts due to incompliance with relevant standards and regulations and delay due to awaited approval of the ESIA-ESMP	❑ Ensure the ESIA-ESMP approval is granted by the Yemen government no later than the inception phase.	- ESIA-ESMP approval document by the Yemen government	UN-Habitat
2.Access and Equity	YES	Some concerns were raised regarding: ☐ Unequal distribution of irrigated water (to small-holder farmers, women farmers, farmers which have not received support previously and other vulnerable groups) ☐ That interventions may take place during the agriculture season, which may hinder irrigation. ☐ Disruption of gate control mechanism	Project beneficiaries (i.e., population; groups) have been mapped. Community consultations and focus groups discussions have been conducted per beneficiary group to identify possible rivals, disputants and concerns related to equal access of project benefits.	Potential disputes if water is irrigated unequally. This may affect farmers in 22 water user associations, including small-holder farmers and women farmers	❑ Final agreement on proposed project interventions during project inception phase between: ▪ Women organizations: 15 ▪ Youth organizations: 7 ▪ Water user associations: 22 ▪ Community organizations (leaders): 13 ▪ Religious leaders ▪ Representative displaced persons ▪ Agriculture office ☐ Implement interventions during November – February and / or ensure irrigation is not disrupted due to project interventions. ☐ Develop control method or close the gates managed only by the irrigation department. ☐ Quotas and a targeting strategy will be applied for meetings, workshops and trainings	☐ Consultation / workshop report and final agreement ☐ Work plan and / or check measures to avoid disruption of irrigation. ☐ Check gate management protocol / method / plan with irrigation department ☐ Check targeting strategy and attendance sheets and workshop / training reports	UN-Habitat and executing entities
3.Marginalized and Vulnerable Groups	YES	There is a small potential risk that needs and concerns of groups have changed once the project starts.	Project beneficiaries (i.e., population; groups) have been mapped.	This could lead to dissatisfaction about project interventions of project beneficiaries	❑ All project beneficiary groups will be consulted again during the inception phase to verify and further identify all specific needs	❑ Verification report of needs and potential concerns of	UN-Habitat and executing entities

			Community consultations and focus groups discussions have been conducted per beneficiary group to identify needs and possible concerns		and concerns of groups (see also above) ❑ Strictly apply the Grievance and Redress Mechanism ❑ The project will ensure equal opportunities in participation and decision-making of women, youth and other vulnerable groups by using quotas and by agreeing on representation in decision-making processes through the use of ToRs, agreements, etc. ❑ Quotas and a targeting strategy will be applied for meetings, workshops and trainings	project beneficiaries ❑ Grievance and Redress mechanism in place - Check targeting strategy and attendance sheets and workshop / training reports	
4.Human Rights	NO		Any agreement / contract signed will include reference to compliance with Human rights. Besides that, a Security and Human Rights Management Procedure that is in alignment with UNDSS and the Voluntary Principles of Human Rights will be prepared.				
5.Gender Equity and Women's Empowerment	NO		The project has a social inclusion /gender plan and baseline and specific gender targets and quotas. Women (groups) will be involved in the project and there will be women representative(s) in the project steering / technical committees				
6.Core Labour Rights	YES	There is a small risk of core labour standards not being respected by contractors, especially related to standards for safety and health and labour inspection.	In the ESMP it has been described how executing entities will comply with the core labour standards	Dissatisfaction among workers and employees in the project	The project follows ILO core labor standards. Looking at the conventions and protocols not ratified, the project will be particularly attentive to any health and safety and inspections. ❑ Employment and working conditions following core labour standards to which the project activity will need to comply will be included in all legal agreements with all sub-contractors, including steps and responsibilities to comply. ❑ Regular inspections will be conducted. ❑ Strictly apply the Grievance and Redress Mechanism	❑ Check agreements for relevant clauses ❑ Inspection reports - Grievance and Redress mechanism in place	UN-Habitat
7.Indigenous Peoples	NO		No indigenous people have bene identified in the project target area				
8.Involuntary Resettlement	NO		Resettlement as a result of project activities will be avoided at all times. It is not foreseen that land other than public land will be targeted under this project. The project determined that no physical or economic displacement will take place due to the project.				

			This has been determined by mapping project target sites land ownership (private, public) and land use, also informally, and through consulting communities / users on the possible risk of resettlement and to get agreement on proposed interventions (i.e., no interventions will take place without the consent of inhabitants in the targeted areas). Any agreement / contract for project works signed will include a clause mentioning that project activities will not result in any resettlement.				
9.Protection of Natural Habitats	NO		The project ensures that no unjustified conversion or degradation of critical natural habitats will take place because of project activities. The proposed project interventions are not planned in or close to natural habitats and indirect or cumulative impacts are not expected as environmental impacts should be positive rather than. Negative. During project preparation, it has been checked if any critical natural habitats exist in the target location, including their location, characteristics and critical value (i.e., legal protection status, common knowledge or traditional knowledge), as well as possible negative impacts on these due to project activities.				
10.Conservation of Biological Diversity	NO		The project ensures that any significant or unjustified reduction or loss of biological diversity because of project activities will be avoided. The proposed project interventions are not planned in or close to critical biodiversity and indirect or cumulative impacts are not expected as environmental impacts should be positive rather than. Negative. During project preparation, it has been checked if any important biodiversity exists in the target location, including their protection status and other recognised inventories as well as possible negative impacts on these due to project activities.				
11.Climate Change	NO		Any additional energy use due to project activities have been identified and will be compensated by renewable energy sources installed				
12.Pollution Prevention and Resource Efficiency	YES	There is a risk that waste (mostly construction materials, deposits from the canals and sludge will not properly be managed / recycled. Besides, the treated wastewater will still have some pollutants, only suitable for certain	The main wastes are construction materials, the deposits from the canals and sludge. These wastes will be removed and processed in coordination with EPA and local authority. Treated wastewater is already used for irrigation. The treated wastewater will still have some pollutants, only suitable for certain crops. Although farmers are aware of the suitability of the use of treated wastewater (for fodders)	Waste may be dumped / processed inappropriately with potential negative environmental impacts. Although waste is not expected to be hazardous, it should not be dumped on unappropriated sites Crops (115 ha) may get contaminated, and farmers may get sick. This may	❑ A waste management plan will be prepared. ❑ Reference to the waste management plan to which the project activity will need to comply will be included in all legal agreements with all sub-contractors, including steps and responsibilities to comply. ❑ Ensure treated wastewater is only used for appropriate crops (through coordination with	❑ Check waste management plan ❑ Check agreements for relevant clauses ❑ Regular wastewater quality check ❑ Conduct inspections.	UN-Habitat

		crops. Although farmers are aware of the suitability of the use of treated wastewater (for fodders), there is still a risk that treated wastewater will be used inappropriately and that farmers are not using enough health and safety equipment.		also have a secondary negative effect on consumers of the crops Treated water for drinking will be mixed into the water supply network, serving the whole of Aden	farmer/water user associations and authorities and related monitoring) ❑ Comply with (international) standards for water quality. ❑ Ensure farmers are aware of the risks and wear appropriate shoes and gloves (as part of awareness campaign and trainings planned)	❑ Check if is part of the awareness raising campaign and trainings	
13.Public Health	YES	There is a risk that treated wastewater will be used inappropriately and that farmers are not using enough health and safety equipment.	Treated wastewater is already used for irrigation. The treated wastewater will still have some pollutants, only suitable for certain crops. Although farmers are aware of the suitability of the use of treated wastewater (for fodders)	Crops (115 ha) may get contaminated, and farmers may get sick. This may also have a secondary negative effect on consumers of the crops	❑ Ensure treated wastewater is only used for appropriate crops (through coordination with farmer/water user associations and authorities and related monitoring) ❑ Comply with (international) standards for water quality. ❑ Ensure farmers are aware of the risks and wear appropriate shoes and gloves (as part of awareness campaign and trainings planned)	❑ Regular water quality check ❑ Conduct inspections ❑ Check if is part of the awareness raising campaign and trainings	UN-Habitat
14.Physical and Cultural Heritage	NO		There are no heritage sites acknowledged by UNESCO[135] in the Tuban delta. Also, according to government information, no heritage sites will be affected by the project				
15.Lands and Soil Conservation	NO		No loss of soil is expected. On the contrary, project activities aim to reduce any movement of soil				

[135] https://whc.unesco.org/en/statesparties/ye

Based on the screening against the 15 AF principles, the project has been categorised as a “B” category project in terms of the environmental and social risks it poses. See also Part II.L.

For an overview of project activities’ screening results against the 15 AF principles see below table. For details, see the next section.

Table 83 Overview of environmental and social impacts and risks for which further assessments and management are required.

Checklist of environmental and social principles	No further assessment required for compliance (during project implementation)	Potential impacts and risks – further assessment and management required for compliance
16. Compliance with the Law		X
17. Access and Equity		X
18. Marginalized and Vulnerable Groups		X
19. Human Rights	X	
20. Gender Equality and Women’s Empowerment	X	
21. Core Labour Rights		X
22. Indigenous Peoples	X	
23. Involuntary Resettlement	X	
24. Protection of Natural Habitats	X	
25. Conservation of Biological Diversity	X	
26. Climate Change	X	
27. Pollution Prevention and Resource Efficiency		X
28. Public Health		X
29. Physical and Cultural Heritage	X	
30. Lands and Soil Conservation	X	

Table 84 Overview of project activities' screening results against the 15 AF risk areas / principles.

Detailed outputs / activities	Risk screening result	Explanation why triggered or not
Component 1: Integrated and inclusive natural resource management for climate-resilient water systems		
1.1. Capacity development with national and sub-national authorities on climate change resilience, effective water management, including project oversight, development, and implementation of integrated management plans	No risk	❑ No risk principle was triggered as capacity development of national and sub-national authorities will take place based on the needs identified during project preparation, while this will be verified during project inception. Also quotas will be applied for women participation and all relevant stakeholders will be invited
1.2. Establishment of laboratory for wastewater quality testing and water supply quality testing	No risk	❑ No risk principle was triggered as the laboratories will be established in existing buildings and will support water quality testing
1.3. Integrated and inclusive natural resource management planning to support the efficient, sustainable and CC resilient use of water in the Tuban, Aden, Abyan Basin	Potential risks related to AF ESP Principles 2 and 3	☐ Principle 2 was triggered because some concerns were raised during the proposal preparation phase regarding unequal distribution of irrigated water (to small-holder farmers, women farmers, farmers which have not received support previously and other vulnerable groups) ❑ Principle 3 was triggered because the needs and concerns of groups may have changed once the project starts.
1.4. Integrated and inclusive natural resource and climate change risk management process convened bringing together government and community stakeholders	Potential risks related to AF ESP Principles 2 and 3	❑ Principle 2 was triggered because some concerns were raised during the proposal preparation phase regarding unequal distribution of irrigated water (to small-holder farmers, women farmers, farmers which have not received support previously and other vulnerable groups) ❑ Principle 3 was triggered because the needs and concerns of groups may have changed once the project starts.
❑ **Component 2:** Adaptive capacity of the water sector		
2.1. Assessment and verification / technical specification and engineering studies, including surveys required for improved irrigation canals and water intake systems	No risk	No risk principle was triggered as the activity will identify details of concrete interventions below and related potential issues and solutions
2.2. Rehabilitated irrigation canals to improve water access for agricultural purposes in the Tuban	Potential risks related to AF ESP Principles 1, 2, 3, 6 and 12	The existing irrigation channels will be rehabilitated. This may result in some waste ❑ Principle 1 was triggered because there is a chance that the ESIA-ESMP is not approved on time by the Yemen government for the project to start. ☐ Principle 2 was triggered because some concerns were raised during the proposal preparation phase regarding unequal distribution of irrigated water (to small-holder farmers, women farmers, farmers which have not received support previously and other vulnerable groups) and because interventions may take place during the agriculture season, which may hinder irrigation. ❑ Principle 3 was triggered because the needs and concerns of groups may have changed once the project starts. ❑ Principle 6 was triggered because core labour standards may not be respected by contractors, especially related to standards for safety and health and labour inspection. ❑ Principle 12 was triggered because waste from the rehabilitation of canals may not be properly managed / recycled
2.3. Improved water intake structures to increase water supply in the irrigation canals	Potential risks related to AF ESP Principles 1, 2, 3, 6	Water intake structures will be improved as part of existing irrigation channels ❑ Principle 1 was triggered because there is a chance that the ESIA-ESMP is not approved on time by the Yemen government for the project to start. ❑ Principle 2 was triggered because some concerns were raised during the proposal preparation phase because interventions may take place during the agriculture season, which may hinder irrigation and because there may be disruption of the gate control mechanism. ❑ Principle 3 was triggered because the needs and concerns of groups may have changed once the project starts. ❑ Principle 6 was triggered because core labour standards may not be respected by contractors, especially related to standards for safety and health and labour inspection.
2.4. Stone-gabions constructed to reinforce canals and protect agriculture lands and Al-what city from flashing floods.	Potential risks related to AF ESP Principles 1, 3, 6	The stone gabions will be placed on the side of the riverbed, reducing flood risks to settlements. Initial locations for the stone gabions have been identified, based on flood risks. The exact locations will be identified based on further assessments and engineering studies planned as part of the output. ❑ Principle 1 was triggered because there is a chance that the ESIA-ESMP is not approved on time by the Yemen government for the project to start. ❑ Principle 3 was triggered because the needs and concerns of groups may have changed once the project starts. ❑ Principle 6 was triggered because core labour standards may not be respected by contractors, especially related to standards for safety and health and labour inspection.
Component 3: Innovative adaptation practices for water supply systems		

3.1. Assessment and verification / technical specification and engineering studies, including surveys required for improved irrigation canals and water intake systems	No risk	No risk principle was triggered as the activity will identify details of concrete interventions below and related potential issues and solutions
3.2. Developing efficient and safe water supply alternatives for Al-What, Al-Hawtah cities and surrounding villages	Potential risks related to AF ESP Principles 1, 3, 6, 12 and 13	This intervention will supply 6,931 m^3/day water to Al-Waht, Al-Hawtah cities and surrounding villages, serving 89,000 people. The intervention will be on public land ❑ Principle 1 was triggered because there is a chance that the ESIA-ESMP is not approved on time by the Yemen government for the project to start ❑ Principle 3 was triggered because the needs and concerns of groups may have changed once the project starts. ❑ Principle 6 was triggered because core labour standards may not be respected by contractors, especially related to standards for safety and health and labour inspection. ❑ Principle 13 was triggered because the quality of the water supplied may not be ensured without standards and procedures in place to ensure the quality
3.3. Upgrade Tahror WWTP to treat wastewater for use in irrigation	Potential risks related to AF ESP Principles 1, 2, 3, 6, 12 and 13	This intervention will supply 3,800 m3/day treated water to irrigate 95 ha, serving 525 farms. The intervention will be on public land ❑ Principle 1 was triggered because there is a chance that the ESIA-ESMP is not approved on time by the Yemen government for the project to start ❑ Principle 2 was triggered because some concerns were raised during the proposal preparation phase regarding unequal distribution of irrigated water (to small-holder farmers, women farmers, farmers which have not received support previously and other vulnerable groups) ❑ Principle 3 was triggered because the needs and concerns of groups may have changed once the project starts. ❑ Principle 6 was triggered because core labour standards may not be respected by contractors, especially related to standards for safety and health and labour inspection. ❑ Principle 12 was triggered because treated wastewater could be used inappropriately, and farmers may not be using enough health and safety equipment. ❑ Principle 13 was triggered because treated wastewater could be used inappropriately, and farmers may not be using enough health and safety equipment.
3.4. Upgrade Saber WWTP to treat wastewater for use in irrigation	Potential risks related to AF ESP Principles 1, 2, 3, 6, 12 and 13	This intervention will supply 900 m3/day treated water to irrigate 20 ha, serving 280 farms. The intervention will be on public land ❑ Principle 1 was triggered because there is a chance that the ESIA-ESMP is not approved on time by the Yemen government for the project to start ❑ Principle 2 was triggered because some concerns were raised during the proposal preparation phase regarding unequal distribution of irrigated water (to small-holder farmers, women farmers, farmers which have not received support previously and other vulnerable groups) ❑ Principle 3 was triggered because the needs and concerns of groups may have changed once the project starts. ❑ Principle 6 was triggered because core labour standards may not be respected by contractors, especially related to standards for safety and health and labour inspection. ❑ Principle 12 was triggered because treated wastewater could be used inappropriately, and farmers may not be using enough health and safety equipment. ❑ Principle 13 was triggered because treated wastewater could be used inappropriately, and farmers may not be using enough health and safety equipment.
Component 4:		
4.2. Support farmers with modern irrigation techniques and systems (Urban and Rural Areas)	Potential risks related to AF ESP Principles 1, 2, 3, 6, 12 and 13	This intervention will cover 200 ha serving 350 farmers. The intervention will be on private land (farmers) but only with their consent. There will be no excavations. ❑ Principle 1 was triggered because there is a chance that the ESIA-ESMP is not approved on time by the Yemen government for the project to start ❑ Principle 2 was triggered because some concerns were raised during the proposal preparation phase regarding unequal distribution of irrigated water (to small-holder farmers, women farmers, farmers which have not received support previously and other vulnerable groups) ❑ Principle 3 was triggered because the needs and concerns of groups may have changed once the project starts. ❑ Principle 6 was triggered because core labour standards may not be respected by contractors, especially related to standards for safety and health and labour inspection. ❑ Principle 12 was triggered because treated wastewater could be used inappropriately, and farmers may not be using enough health and safety equipment.

			❑ Principle 13 was triggered because treated wastewater could be used inappropriately, and farmers may not be using enough health and safety equipment.
4.3.	Develop maintenance plans for canals, irrigation system and wastewater treatment plants and KM of all components	No risk	❑ No risk principle was triggered as this is mitigation measure to ensure maintenance and sustainability of proposed interventions
4.4.	Strengthen water user associations for improved monitoring, maintenance, and dissemination of information on irrigation techniques and skills development	Potential risks related to AF ESP Principles 2 and 3	❑ Principle 2 was triggered because some concerns were raised during the proposal preparation phase regarding unequal distribution of irrigated water (to small-holder farmers, women farmers, farmers which have not received support previously and other vulnerable groups) ❑ Principle 3 was triggered because the needs and concerns of groups may have changed once the project starts.
4.5.	Skills development with women and youth on water management and climate change adaptation	No risk	❑ No risk principle was triggered as the selection of women and youth groups will be agreed upon by all groups, by also identifying and addressing and concerns and specific needs these groups have
4.6.	Capacity development for communities with a focus on women and youth civil society organizations on integrated and inclusive natural resource management plan	No risk	❑ No risk principle was triggered as the selection will be agreed upon by large stakeholder group, by also identifying and addressing and concerns and specific needs
4.7.	Awareness raising with local communities on water conservation and climate change in Aden and the Tuban Delta	No risk	❑ No risk principle was triggered as the awareness raising target communities will be agreed upon by large stakeholder group.

Allocated roles and responsibilities for implementing the ESMP

UN-Habitat will be responsible for environmental and social risks management of the project, including implementation of the Project ESMP. A safeguard expert (i.e., project execution supervisor) will be part of the project execution team. This expert, together with the national project coordinator, will also supervise the executing entities on the implementation of the Project ESMP. Guidelines showing how to comply to the AF ESP and GP will be tailored to and shared with the executing entities, and these will be guided on the process, including monitoring. Monitoring project staff will also require having expertise on environmental and social risk management and be familiar with the AF safeguarding system.

Table 85 project safeguarding roles and Responsibilities.

Team	Role	Responsibility
UN-Habitat	Project execution supervisor, project coordinator and M & E (from execution fee)	• Guide the executing entities on implementing the ESMP • Prepare guidelines / plans for executing entities to implement the ESMP • Documentation of site, interviews with beneficiaries • ESMP monitoring
	Overall project supervision (from project cycle management fee_	• Review ESMP at inception phase • ESMP monitoring • Reporting (PPR)
Contractor	Project Manager	• Reporting to UN-Habitat on implementation of ESMP • Appoint project grievance mechanism focal point to implement the Grievance Redress Mechanism
Project steering committee	Approve changes when required	• When changes in project activities or additional activities are required, these will need to go through a new risks screening and impact assessment process in compliance with AF, UN-Habitat and national policies and standards. When this is required, this will be led by UN-Habitat and the steering committee would need to approve the changes.

All project-related ToR's and contracts will include clauses stating contractors require to comply to the AF ESP, especially principle 1 (law), 4 (human rights), 5 (gender), 6 (core labour standards) 8 (involuntary resettlement), 11 (GHG emissions), 12 (waste and pollution), 13 (health and safety) and 14 (heritage sites) and to the AF GP. This includes:

- ☐ Principle 1: References to laws and standards to which project activities need to comply will be included in all legal agreements with all sub-contractors, including steps and responsibilities to comply.
- ☐ Principle 4: References to relevant Humans rights declarations to which the project activity will need to comply will be included in all legal agreements with all sub-contractors, including steps and responsibilities to comply.
- ☐ Principle 5: Reference to the social inclusion plan to which the project activity will need to comply will be included in all legal agreements with all sub-contractors, including steps and responsibilities to comply.
- ☐ Principe 6: Employment and working conditions following core labour standards to which the project activity will need to comply will be included in all legal agreements with all sub-contractors, including steps and responsibilities to comply.
- ☐ Principle 8: Commitment that no involuntary resettlement will take place due to project activities.
- ☐ Principle 11: Commitment to avoiding GHG emission due to project activities
- ☐ Principle 12: Reference to the waste management plan to which the project activity will need to comply will be included in all legal agreements with all sub-contractors, including steps and responsibilities to comply.
- ☐ Principle 13: References to relevant ICSC international health and safety standards to which the project activity will need to comply will be included in all legal agreements with all sub-contractors, including steps and responsibilities to comply.
- ☐ Principle 14: Reference to a heritage chance find procedure to which the project activity will need to comply will be included in all legal agreements with all sub-contractors, including steps and responsibilities to comply.

Minimum requirements and standard clauses will include:

Table 86 Principle 1: Compliance with the laws

Potential risk / impact	Mitigation measure
Non-compliance with laws / standards	☐ Standard clause / references to laws and standards to which project activities need to comply will be included in all legal agreements with all sub-contractors, including steps and responsibilities to comply.

Table 87 Principle 2: access and equity

Potential risk / impact	Mitigation measure
Unequal access to project benefits	❑ Final agreement on proposed project interventions during project inception phase between: ▪ Women organizations: 15 ▪ Youth organizations: 7 ▪ Water user associations: 22 ▪ Community organizations (leaders): 13

	▪ Religious leaders ▪ Representative displaced persons ▪ Agriculture office ☐ Quotas and a targeting strategy will be applied for meetings, workshops and trainings

Table 88 Principle 3: Marginalized and vulnerable groups

Potential risk / impact	Mitigation measure
Changing needs and concerns	❑ All project beneficiary groups will be consulted again during the inception phase to verify and further identify all specific needs and concerns of groups (see also above) ❑ Strictly apply the Grievance and Redress Mechanism ❑ The project will ensure equal opportunities in participation and decision-making of women, youth and other vulnerable groups by using quotas and by agreeing on representation in decision-making processes through the use of ToRs, agreements, etc. ❑ Quotas and a targeting strategy will be applied for meetings, workshops and trainings

Table 89 Principle 4: Human Rights

Potential risk / impact	Mitigation measure
Limited awareness on human rights	• Standard clause / references to relevant Humans rights declarations to which the project activity will need to comply will be included in all legal agreements with all sub-contractors, including steps and responsibilities to comply. • Share information on human rights with project beneficiary groups at the inception phase of the project. Share information on the grievance and Redress mechanism and human rights at every meeting

Table 90 Principle 5: Gender Equality and Women's Empowerment.

Potential risk / impact	Mitigation measure
Limited awareness of social inclusion / gender plan	• Reference to the social inclusion plan to which the project activity will need to comply will be included in all legal agreements with all sub-contractors, including steps and responsibilities to comply.

Table 91 Principle 6 Core labour standards

Potential risk / impact	Mitigation measure
- Non-involvement of local employment	• Work with local community on verification of local workers where feasible, including migrant workers
- Non-compliance with worker rights, including migrants and non-compliance with safety and health standards	• Screen potential contractors and contracts o Expected workers to be involved (direct, contract, supply chain) and how? o Expected working conditions (Human resource policies and procedures; working conditions and terms of employment; workers' organizations; non-discrimination and equal opportunities (women, youth, other); grievance redress mechanism. o Measures to protecting the work force (incl. child labor; forced labor) • Include standard clause in all contracts: o HR policy aligned with ILO Core Conventions o Worker Grievance Mechanism to be established. o Enforce minimum age expectations (according to ILO) o Measures to ensure Contractor adopts project HR Policy standards (either contractually or through monitoring) o Ensure all employees are provided with a written employment contract before start of works. o Provide details of the transport arrangements for all workers to and from their accommodation (dedicated or in the local community) o Refer to occupational health and safety procedures
- Limited Facilities	• Contractor to provide or facilitate access to necessary worker facilities which include but are not limited to: toilets, rest areas, smoking areas, canteen and potable drinking water to WHO standards • All worker facilities and accommodation will be cleaned, maintained, and centrally managed

Table 92 Principle 11 climate change

Potential risk / impact	Mitigation measure
Increased GHG Emissions due to Project Emissions	• Exact project-related energy use to be verified through engineering studies and to be compensated through installation of solar PV

Table 93 Principle 12 Pollution Prevention and Resource Efficiency

Potential risk/ impact	Mitigation measure
Lack of appropriate waste management procedure	A Waste Management procedure/ plan will be developed and at a minimum include the following mitigations: • Identification of appropriate waste management to handle, treat and / or recycle waste, including land fill if required. • Regular inspections schedule

Table 94 Principle 13 Health (and safety)

Potential risk / impact	Mitigation measure
Security incidents	• Ensure health and safety procedure prior to construction that establishes procedures
Occupational Health and Safety	Occupational health and safety procedures must be developed, specific to each Project output, for the following: • Working at height • Heavy lifting • Working in confined spaces • Excavation works

Potential risk / impact	Mitigation measure
	• Hot work • Working and scaffolding • Electrical safety • Working with machinery • Site clearance (debris management, unexploded ordinances) • Collapsing structures • Handling of hazardous materials • Weather conditions • Lone working • Material transport (unloading and storage) • Earthmoving and concreting • Permit to work system • Lock Out Tag Out (LOTO) System • Minimum Mandatory PPE (incl. shoes, helmets, gloves, high-visibility vest, safety glasses) • Proper Safety signage • Medical clinic and first aid • Housekeeping
Increase in Social Tension due to Contractor-Community Interactions and Security	A Worker Code of Conduct must be developed and at a minimum must: • Outline general requirements and expectations on security interaction with community and external stakeholders, respectful, polite, and honest behavior is expected from all employees. • Outline requirements on conflict avoidance and sensitivity to local cultures, traditions, and lifestyles. • Ensure that no workers are to engage with the local community except via an appointed representative. • Ensure zero tolerance of illegal activities by all personnel including: prostitution; illegal sale or purchase of alcohol; the sale, purchase, or consumption of drugs; gambling and fighting. • Be included as part of induction and signed by all employees.
Increase in Vector Borne and Communicable Diseases	A Vector Borne and Communicable Diseases Procedure must be developed and at a minimum must: • Limit the spread of vector borne disease and communicable diseases
Limited emergency Response Local Capacity and Equipment	• Audit and gap assessment of local capacity • Coordinate with local emergency response teams (fire, EMS, police, hospital) and implement mitigations to address gaps
Workplace health and safety incidents	An Emergency Preparedness and Response Procedure must be developed and at a minimum must: • Define individual emergency response actions for all potential scenarios. • Define a schedule of emergency drills and scenarios. • Establish an Emergency Response Team with dedicated resources and equipment. • Ensure emergency communications system is in place and reliable. • Implement a drill schedule and provide reports. • Define COVID-19 procedure (see below)

Interaction with security actors	• Develop Security and Human Rights Management Procedure that is in alignment with UNDSS and the Voluntary Principles of Human Rights
	• All private security personnel to receive procedural or knowledge training in:
	  • Guard-post orders and procedures
	  • Proper conduct and ethics/human rights
	  • Rules of engagement and use of force
	  • Community interaction and community grievance mechanism
	• Engage the public security force through the correct hierarchy and channels early in the process to set up good working relationship and improve opportunities for influence on the adoption of International Standards.

Stolen Items	• In the case of public spaces, the municipality will assign a guard
Covid-19 (if relevant)	• A Health and Safety Risk Assessment of each project activity, including supply chains and associated facilities, against International Standards needs to be carried out including specific alignment with IFC PS2 (Labour and Working Conditions) as well as IFC PS4 (Community Health and Safety and Security). The assessment involves a four-step process: 1. Conduct a Health and Safety Risk Assessment to identify the potential risk and impact of COVID-19 on project activities, including supply chains and associated facilities. 2. Develop and implement mitigation measures to manage health risks for each project activity (to be provided in the ESMPs during the project inception phase). 3. If despite the implementation of mitigation measures a positive COVID-19 case is identified, then alternative “lower risk” activities will be proposed. 4. If “lower risk” activities are not an option, then activities will be delayed/postponed. Contractors should start to implement COVID-19 mitigation measures now, even if the virus has not arrived in the communities they are operating within. The following is a list of mitigation measures to prevent the spread of COVID-19 in the workplace that must be implemented at each work site: Ensure workplaces are clean and hygienic. Surfaces (e.g. desks and tables) and objects (e.g. telephones, keyboards) need to be wiped with disinfectant regularly. Promote regular and thorough hand washing. Put sanitizing hand rub dispensers in prominent places around the workplace and ensure these dispensers are regularly refilled. Display posters promoting hand washing and ensure that workers have access to places where they can wash their hands with soap and water. Brief workers that if COVID 19 starts spreading in your community anyone with even a mild cough or low-grade fever needs to stay at home. Where N95 masks are not available, ordinary surgical face masks will be provided.

Potential risk / impact	Mitigation measure
	The World Health Organization (WHO) has additional information and best practice approaches to occupational health and safety during the COVID-19 outbreak. The International Finance Corporation (IFC), also provides specific guidance regarding preventing and managing health risks of COVID-19 in the workplace and support for workers.

Table 95 Principle 14 Physical and Cultural Heritage

Potential risk / impact	Mitigation measure
Chance Finds	A Chance Finds Procedure must be developed and requires: • Stop work in the event of a find and cordon off until next steps are agreed. • Identify relevant national authority for communication in the event of a chance find. • In the event of a find, prepare Next-step Action Plan (if required). • Liaise with Competent Authority to arrange oversight of the excavation works and storage and transportation of any finds

Opportunities for adaptive management

When changes in project activities or additional activities are required, these will need to go through a new risks screening and impact assessment process in compliance with AF, UN-Habitat and national policies and standards. When this is required, this will be led by UN-Habitat and the steering committee would need to approve the changes.

Arrangements to supervise executing entities for implementing the ESMP.

Table 96 Capacity of potential executing entities to implement ESMP

Potential executing entity	Skills and expertise to implement ESMP	Specific requirements execution entities for compliance	Capacity building needs
TBD	Limited (although some experience with UN agencies)	- Appoint an ESP compliance focal point - Enough capacity to implement the ESMP - Enough capacity to monitor the implementation of the ESMP	- Awareness on requirements - Share tailored ESMP - Share guidelines to comply - Guide on implementation - Coordinate with technical committee if needed - Provide training if needed
NGO	Experience with UN agencies and should have capacity		
MWE	Limited (although some experience with UN agencies)		
CAC Bank	Limited		

Budget provision for implementing the ESMP.

Dedicated risks / safeguard management time is allocated under project execution fees (Project execution supervisor: USD 214.000 in total, and M & E person: USD 99.120 in total). This person will be supported by UN-Habitat regional office and headquarters on compliance with relevant policies.

General measures to avoid, minimize, or mitigate potential risks and impacts.

The table below sets out the general Environmental and Social (E&S) commitments/policies to avoid, minimise or mitigate potential risks, that are to be fulfilled by the contractor, supported by UN-Habitat, during project activities.

Table 97 Detailed project-level mitigation policies

Item	Mitigation, Management and Enhancement Measures	Means of Verification	Responsibility	Monitoring Procedure
A. General Requirements				
A1. Responsibilities and Liabilities	Ensure that all workers, suppliers, and possible subcontractors are familiar and comply with the requirements and specifications of the ESMP. Review Contracts to ensure that safeguard requirements are included	Contracts	UN-Habitat and contractor	Review of Contracts to ensure that ESS requirements are included
	Review and adjust ESMP if needed. Identify if further Management Plans need to be prepared.	Final Project-specific ESMP	UN-Habitat and contractor	Review at project inception phase
A2. Resources allocated to safeguard Management	People responsible risk management including requirements and responsibilities to be defined. A safeguard expert (i.e., project execution supervisor will be part of the project execution team. Besides that, focal points within the executing entities will be defined.	Final Project-specific ESMP	UN-Habitat and contractor	Review at project inception phase

Item	Mitigation, Management and Enhancement Measures	Means of Verification	Responsibility	Monitoring Procedure
A. General Requirements				
A3. Reporting	Reporting of progress ESMP, including potential incidents, accidents, observations, etc.	Final Project -specific ESMP Reporting protocol for Major Incidents	UN-Habitat	Review at project inception phase
A4. Safeguard Training	Provided if required during implementation for UN-Habitat and executing entities	Training performed and recorded	UN-Habitat	Review of training records

Item	Mitigation, Management and Enhancement Measures	Means of Verification	Responsibility	Monitoring Procedure
B. Protection of the Environment				
B1. Emissions and dust	Use to the extent possible, vehicles in appropriate technical conditions.	Technical Specification Sheet	Contractor/ EE	Prior to commencement of works and each time new equipment/ vehicle is used at the site. Visual inspection on regular basis
	Ensure that vehicle engines and equipment on site are not left running unnecessarily.	Engines switched off	Contractor/ EE	Site inspection
	Best practice to ensure minimization of dust emissions during dry and windy conditions (e.g. proper stockpiling, watering etc.).	Watering conducted, no dust emissions are observed, no workers' grievances	Contractor/ EE /	Regular site inspection Review of grievance records
	Exact project-related energy use to be determined during project inception phase. 'Extra' energy use to be compensated through installation of solar PV	Recording of energy use	Contractor/ EE	Regular monitoring and review of energy use
B2. Noise and vibration	Avoid operations and vehicle movements at night.	No work conducted between 10 pm and 7 am No grievances received	Contractor/ EE	Random site inspection Review of grievance records Review of accident/incident records
	Set traffic speed limits for construction and operation-related traffic	Speed signs installed. Accident/incident reports	Contractor/ EE	Random site inspection Review of grievance records Review of accident/incident records
	Position equipment as far as possible from sensitive areas (neighboring communities)	Distances between equipment and receptors are kept	Contractor/ EE	Once prior to commencement of works Review of grievance records
B3. Wastewater management	Ensure access to toilet facilities or portable toilet facilities that will be serviced on a weekly basis	Visual inspection of condition of facilities	Contractor/ EE	Random site inspection
	Control surface water and where appropriate incorporate storm water management into project designs	Visual inspection, design review	Contractor/ EE	Regular site inspection Final project design
B4. Pollution prevention	Ensure all works carried out minimize pollution risk (e.g. liquid effluents, air quality and emissions, noise and vibration management, vehicle and equipment maintenance and selection, fuel, oil and chemical storage and handling) including the whole duration of the Project. The local authorities and the wastewater companies will monitor the quality of the outflow to be used for irrigation A comprehensive water quality monitoring program to assess the content of nutrients, heavy metals, pathogens, and other contaminants in the treated wastewater. Regular soil testing to monitor nutrient levels, salinity, and other soil parameters should be conducted. Implement appropriate soil management practices, such as the addition of organic matter, to maintain soil fertility and structure.	Ensure that potential pollutants are not stored and handled within 50 m of sensitive receptors (particularly watercourses).	Contractor/ EE	Regular site inspection Review of grievance records
B5. Effluents	Ensure appropriate containment and storage of construction wastewater, including sanitary water. No untreated effluent is discharged.	No untreated wastewater discharge	Contractor/ EE	Regular site inspection Review of grievance records
B6. Waste Management	Identify waste management facilities and ensure disposal through treatment/removal/recycling of each of the waste types.	Waste management procedure Waste transfer notes	Contractor/ EE	Inspect waste management facilities Review of waste transfer records

Item	Mitigation, Management and Enhancement Measures	Means of Verification	Responsibility	Monitoring Procedure
B. Protection of the Environment				
	Ensure that all wastes produced are properly collected, segregated, stored, transported and treated	Waste collection areas existent, waste inventories Waste transfer notes	Contractor/ EE	Random site inspection, Review of waste inventories Review of waste transfer records
	Minimize the waste production to the extent possible.	Records of waste production are kept Waste Management Plan Training performed and recorded	Contractor/ EE	Monitor (e.g. monthly) the amount of waste produced Review of training records
	Document all waste related operations (type of wastes, quantities produced etc.).	Storage, transport and treatment of waste is documented. Waste transfer notes Waste inventories	Contractor/ EE	Review of waste transfer records Review of waste inventories
	Appropriate and safe storage of fuels, construction materials, wastes and any materials that can cause spills (e.g. batteries from energy generators).	Safe storage of materials Spill prevention and response procedure Spill response and remediation equipment in place.	Contractor/ EE	Random site inspection
B7. Land uses	The contractor will fix any degradation after rehabilitating the canals for example, no trees should be cut, and no soil should be removed. Trees will be replanted.	Visual inspection of areas	Contractor/ EE	Review of pictures and reports
B8. Biodiversity	In cooperation with local authorities, the activities will be planned to avoid sensitive periods for breeding or migration of wildlife and any affected native vegetation will be replanted in new locations. Moreover, low-impact construction techniques and equipment will be used to minimize soil erosion, habitat destruction, and noise disturbance.	Execution plans; Visual inspection of areas	Contractor/ EE	Review of pictures and reports

Item	Mitigation, Management and Enhancement Measures	Means of Verification	Responsibility	Monitoring Procedure
C. Worker Health and Safety				
C1. Occupational Health and Safety Plan	Develop an Occupational Health and Safety (H & S) Plan	Occupational H&S Plan in place	Contractor/ Safeguard Consultant Team (for review)	Review of Occupational H&S Plan
C2. Incident reporting	Ensure all H&S related incidents (e.g. observations, accidents) on site are recorded and followed up properly.	Reporting protocol for Major Incidents	Contractor/ EE	Check incident/accident records
C3. Personal protective equipment	Ensure the provision of Personal Protective Equipment (PPE) for workers (hardhats, masks, safety glasses, safety boots etc. depending on project type).	PPE used by everyone on-site.	Contractor/Site Manager	Random site inspection
C4. UXO/ Damaged structure clearance	Ensure UXO clearance/damaged structure clearance obtained prior to start of works.	Documentation of clearance (Commencement of Works Letter)	Contractor/ EE	Review documentation
C5. First-aid	Provide one trained first aiders per 50 employees and adequate amount of first aid kits on site.	Suitable first aid kits on site Ensure the presence of first aid helpers in all shifts. First aid certificates	Contractor/ EE	Regular monitoring of first aid kits Review of first aider certificates Review of number of first aiders required by local legislation
C6. Access to health care	Ensure the workforce has access to primary healthcare on site, providing prescriptions and vaccinations where necessary/applicable	Healthcare available on site	Contractor/ EE	Random site inspection Review of grievance records Review of medical records (in case not confidential)
	In case more than 35 workers are present on site, ensure that a hospital, medical clinic or a health centre can be reached within a period of 45 minutes.	Medical centres in the proximity of the site.	Contractor/ EE	Medical centres in the proximity of the site identified once prior the commencement of works

Item	Mitigation, Management and Enhancement Measures	Means of Verification	Responsibility	Monitoring Procedure
D. Community Health and Safety				
D1. Contractor-Community Interactions and Security	Engage/ communicate/ inform communities. Ensure consultations with the local authorities and communities regarding the construction.	Minutes of Meetings Grievance Mechanism	Contractor/ EE	Review of grievance register Minutes of consultation meetings
	Initiate an efficient Grievance Mechanism to allow potentially affected individuals to raise their concerns.	Grievance Mechanism in place, grievances recorded	Contractor/ EE	Review of grievance register
	Establish a Code of Conduct taking into consideration legislation, safety rules, driving safety rules, substance abuse, environmental sensitivity, communicable diseases, gender issues (sexual harassment), respect for local beliefs and customs, community interactions etc.	Code of Conduct in place and rules shared with personnel	Contractor/ EE	Review of Code of Conduct induction records Review of reported punishable or misconduct behavior Review of grievance records
D2. Traffic and transportation management	Use local traffic signage and collaborate with the responsible local authorities and communities. Use flagmen where appropriate and install clear and visible signage.	Warning signs	Contractor/ EE	Inspection of traffic routes, Review of grievance register
	Implement speed limits for all project vehicles. In the case of road closures, crossing for pedestrians will be provided.	Local access plan	Contractor/ EE	Review of local access plan Random site inspection Review of grievance records
	All vehicles used to transport workers to site must meet national requirements, demonstrate that their condition has been checked and approved prior to use. All drivers shall conduct daily inspections before operating a vehicle.	Technical Specification Sheet	Contractor/ EE	Prior to commencement of works and each time new equipment/ vehicle is used at the site. Visual inspection on regular basis
D3. Vector Borne and Communicable Diseases	Ensure the provision of adequate space, supply of water, adequate sewage and garbage disposal system, appropriate protection against heat, cold, damp, fire and disease-carrying animals and insects, adequate sanitary and washing facilities, adequate lighting, and basic medical services, in accordance with all applicable health and safety regulations and norms.	Vector Borne and Communicable Diseases Procedure Appropriate conditions for workers on site Irrigation plans and procedures	Contractor/ EE	Regular inspection Review of grievance records
D4. Emergency scenarios prevention	Ensure immediate cleaning of any spills and remediation of contaminated areas after construction.	Emergency Preparedness and Response Procedure Workers trained. Emergency Response Team (ERT) is in place	Contractor/ EE	Random site inspection after spill events One-time inspection after construction Review of training records Review of ERT
D5. Security and Human Rights	Ensure security and human rights in alignment with UNDSS SOP, IFC PS4 and the Voluntary Principles of Human Rights	Security and Human Rights Management Procedure	Contractor/ EE/UNH	Regular inspection Review of grievance records
D6. Damage to people and property	Ensure that site areas are provided with appropriate security, fencing, signage and lighting. Use hazard notices/signs/barriers to protect children and other vulnerable people from harm and prevent access to non-workers.	H&S planning of construction site done, items installed	Contractor/ EE	Inspection prior to the activities. Random site inspection Review of grievance register
D7. Involuntary resettlement	Ensure no physical displacement. Include standard clause in MoU / all contracts: Stating no physical displacement will take place due to project activities (unless project beneficiaries request this)	Contracts Resettlement Action Plan (if necessary)	Contractor/ EE	Review of Contracts
	Ensure no economic displacement. Include standard clause in MoU / all contracts: Stating no economic displacement (even informal) will be take place due to project activities (unless project beneficiaries request this)	Contracts Livelihood Restoration Plan (if necessary)	Contractor/ EE	Review of Contracts
D8. Vulnerable Groups	Ensure all vulnerable groups are consulted during inception phase and continually throughout project cycle to verify and further identify all specific needs, limitations and constraints. Final decisions on who will benefit will be made with communities and water-user associations	Meeting Minutes Grievance Mechanism in place, grievances recorded	Contractor/ EE	Review of grievance register Minutes of consultation meetings and consultation reports

Item	Mitigation, Management and Enhancement Measures	Means of Verification	Responsibility	Monitoring Procedure
E. Labour				
E1. Worker Rights	Ensure minimum legal labour standards as per ILO regulations (child/forced labour, sexual assault, no discrimination, equal opportunities, working hours, minimum wages) are met.	Grievance Mechanism Records	Contractor	Review of Inspection reports (also from labour authorities), Review of grievance records
	Ensure that all direct and indirect workers have access to and are aware about the Workers Grievance Mechanism were they can raise workplace relevant complaints anonymously.	Workers Grievance Mechanism in place and grievances recorded	Contractor	Review of workers grievance register
	Ensure all workers have the same rights and are treated equally.	Non-discrimination policy in place	Contractor	Random site inspection Review of grievance register
E2. Local employment and procurement	Ensure local communities are preferred for the supply of goods and services to the Project and Project personnel, where appropriate.	Local Employment and Procurement Records	Contractor	Review procurement and employment records Review of grievance register
E3. Facilities	Ensure provision of OR facilitate access to necessary worker facilities which include but are not limited to: toilets, rest areas, smoking areas, potable drinking water to WHO standards	Appropriate H&S and sanitary facilities provided at site	Contractor	Regular inspection Review of grievance records
E4. Fossils/ Archaeological Chance Finds	Establish specific procedures to manage the protection of archaeological and historical sites, chance finds and fossils. Ensure all finds of cultural heritage (e.g. graves, old ceramic, old building fragments) are reported immediately to the relevant authority and avoid excavation in the ultimate neighborhood of a chance find, fence the chance find and await instructions from the competent authority.	Notification records to relevant authority Training records, Records about chance finds	Contractor/ EE	Site inspection

Item	Mitigation, Management and Enhancement Measures	Means of Verification	Responsibility	Monitoring Procedure
F. Supply Chain – Suppliers and Disposal				
F1. Supply Chain Verification	Verify that operations of these facilities meet Lybian national standards and are permitted.	Visual inspection of facility operations and review of permits	EE/ UN-Habitat	Verification at Project commencement
	Verify if facilities require expansion for Project works.	Visual inspection on a quarterly basis	EE/ UN-Habitat	Regular quarterly monitoring
F2. Supply Chain Monitoring	Monitor the operations of these facilities for risks related to: 1. Controversial linkages with sanctioned entities. 2. Exclusion list (including child labour and trafficking of arms along supply routes); and 3. Security (number of checkpoints along supply routes)	1. Verification of receipts of material sources 2. Visual inspection of facility operations and supply routes 3. Visual inspection of supply routes	EE/ UN-Habitat	Regular quarterly monitoring

Risks monitoring system / indicators.

The environmental, social and climate risks management approach includes monitoring of potential risks and implementation of risks mitigation measures. This monitoring program commensurate with project activities and will report on the monitoring results to the Fund annual, and terminal performance reports. Monitoring will be done to ensure that actions are taken in a timely manner and to determine if actions are appropriately mitigating the risk / impact or if they need to be modified to achieve the intended outcome. Annual reporting will include information about the status of implementation of this ESMP, including those measures required to avoid, minimize, or mitigate environmental and social risks. The reports shall also include, if necessary, a description of any corrective actions that are deemed necessary.

UN-Habitat will be responsibility for environmental and social risks management, including monitoring of the implementation of the ESMP. Gender specific indicators and targets have been developed as shown in the results framework. M&E staff under the execution fee section will require having expertise in environmental and social risk management and be familiar with the AF safeguarding system.

Table 98 monitoring arrangements for general risks management

Action	Indicator and method	Responsibility and frequency
Monitoring of capacity execution entities to comply	❑ Guidelines and action plans shared ❑ Monitoring reports comply to requirements	UN-Habitat within half a year from inception when reports are required
Implementation of grievance mechanism	❑ Grievance mechanism information is at target locations (buildings, etc.) ❑ Grievance mechanism information is shown on UN-Habitat project website	UN-Habitat in coordination with execution entities Within half a year from inception
Monitoring of measures to avoid or mitigate risks / impacts per output	❑ See table above	UN-Habitat in coordination with execution entities When reports are required

Grievance and Redress Mechanism

For all Project activities, a Grievance Redress Mechanism will be employed to receive and address Project Affected Persons (PAP) concerns, complaints, and grievances about any project's environmental and social performance. The Grievance Redress Mechanism addresses affected people's concerns and complaints promptly, using an understandable and transparent process that is gender responsive, culturally appropriate, confidential (if desired) and readily accessible to all segments of the affected people at no costs and without retribution.

UN Habitat in coordination with the execution entities were appropriately informed Project Affected Persons about the Grievance Redress Mechanism at the commencement event of project and throughout the lifecycle of the project through project grievance focal points (Dr. Mohammed Zain – project coordinator).

Communication Channels for Submitting Grievances: Potential communication channels for submitting grievances could include those identified in the table below. When confirmed, this information will be readily available throughout project implementation and communicated during engagement activities

Table 99 Communication Channels for Submitting Grievances

Communication Channel	Description
Engagement Activities	• Grievances can be communicated during engagement activities verbally and/or written and submitted into a comment box
Verbal	• Grievances can be communicated directly to project focal points
Phone	• Phone Number to be provided in relevant ESMP • Phone Number to be provided on billboard at project site location • Calls will be received from: 9AM - 5PM
WhatsApp	• Phone Number to be provided in relevant ESMP • Phone Number to be provided on billboard at project site location • Grievances can be communicated through WhatsApp instant messaging system with audio and video support if required
Email	• Email to be provided in relevant ESMP • Written grievances can be communicated through email
Comment Box	• A comment box will be available at all engagement activities and at Management Team office for written grievances

Receiving Grievances**:** Grievances will be recorded in a Grievance Form and Grievance Register by the project's focal points within two days of receipt. A template for a Grievance Form will be developed. The project grievance focal point will assist the applicant at all stages of their grievance and ensure that their grievance is properly handled and addressed by the appropriate party. The following is the procedure for receiving grievances.

Receive a grievance: Stakeholders shall be able to use the following methods to submit a grievance:

Phone / WhatsApp

- Email
- Verbally to project focal point

The grievance is recorded in the Grievance Form and classified in a Grievance Register by the project's grievance focal point. If the Complaint is readily resolvable and can be dealt with immediately, the project grievance focal point takes action to address the issue directly and records the details in the Grievance Register.

1. **Grievance is formally acknowledged** through a personal meeting, phone call, or letter as appropriate, within 5 working days of submission. If the grievance is not well understood or if additional information is required, clarification should be sought from the complainant during this step.

2. **The project grievance focal point delegates the grievance** in writing to the relevant department(s)/personnel / contractor for development of an appropriate response. The project grievance focal point will estimate the subject matter of this grievance and identify the risk category. If required, the grievance may be sent for consideration of the senior management.

3. **A response is developed** by the delegated team and the project grievance focal point, with input from senior management and others, as necessary.

4. **Required actions are implemented** to deal with the issue, and completion of these is recorded on the Grievance Register.

5. **The response is signed-off** by the project grievance focal point. The sign-off may be a signature on the grievance form or in correspondence, which should be filed with the grievance to indicate agreement.

6. **The response is communicated to the affected party;** the response should be carefully coordinated. The project grievance focal point ensures that a suitable approach to communicating the response to the affected party is agreed and implemented. The response to a grievance will be provided 20 working days after receipt of the grievance.

7. **The response of the complainant is recorded** to help assess whether the grievance is closed or whether further action is needed. The project grievance focal point will use appropriate communication channels, most likely telephone or face-to-face meeting, to confirm whether the complainant has understood and is satisfied with the response. The complainants' response should be recorded in the Grievance Register.

8. **The grievance is closed** with sign-off from the project grievance focal point, who determines whether the grievance can be closed or whether further attention and action is required. If further attention is required the project grievance focal point should return to Step 2 to re-assess the grievance and then take appropriate action. Once the project grievance focal point has assessed whether the grievance can be closed, they will sign off to approve closure of the grievance on the grievance log or by written communication.

9. In case the affected person is not satisfied with the decision resulting from the consideration of grievance, a stakeholder may turn to court in accordance with the existing legislation of Yemen.

Table 100 grievance form

Grievance Form	
Reference No:	
Please enter your contact information and grievance. This information will be dealt with confidential. Please note: If you wish to remain anonymous please enter your comment/grievance in the box below without indicating any contact information – your comments will still be considered.	
Full Name	_____
Anonymous submission	☐ **I want to remain anonymous**
Please mark how you wish to be contacted (mail, telephone, e-mail).	☐ **By Mail (Please provide mailing address):** _____ _____ ☐ **By Telephone (Please provide Telephone number):** _____ **By E-mail (please provide E-Mail address):** _____
Preferred Language for communication	☐ **Arabic** ☐ **English**

	☐ **Other, please specify: _____**
Description of Incident or Grievance:	What happened? Where did it happen? Who did it happen to? What is the result of the problem?
Date of Incident/Grievance: _____	☐ **One time incident/grievance (date _____)** ☐ **Happened more than once (how many times? _____)** ☐ **On-going (currently experiencing problem)**
What would you like to see happen to resolve the problem?	

Social inclusion plan

Purpose

The purpose of this section is to demonstrate how this project complies with the AF Gender Policy (GP) and what challenges need to be addressed for equal[136] opportunities for women and men and for women empowerment in the proposed project. Thus, this section should show the project interventions' suitability to meet the adaptation needs of targeted women and men and youth.

Methodology

During the project preparation phase, potential gender equality and women's and youth empowerment challenges and opportunities have been identified through initial data analysis / desk research, surveys and focus group discussions with women, youth and other groups. Through these methods, specific women and youth needs were identified, as well as potential gender-related risks and impacts, including possible concerns regarding proposed project activities. The outcomes are summarized below. A gender-specific data baseline has been established, which is necessary at the project start against which implementation progress and results can be measured.

Determinants for social inclusion-responsive stakeholder consultations

Table 101 Stakeholders consulted to develop gender approach.

Type of stakeholder	Specific stakeholder	Inputs incorporated in the proposal
UN agencies and NGO's	▪ UN Women	❑ Target share of women in project steering committee: 10 per cent ❑ Target share of women in technical committee: 30 per cent ❑ Awareness raising, capacity strengthening and planning activities will include farmers, women and youth groups, as well as community leaders, religious leaders and IDPS. ❑ Using the term gender will be avoided during engagement at national and local level; that is why this plan is called social inclusion plan
Government	▪ Women focal point	❑ TBC
Community level	▪ Focus group discussions with women and youth (6) ▪ Consultations with women and youth groups / associations (2)	Concerns regarding involvement and project benefits. Awareness raising, capacity strengthening and planning activities will include farmers, women and youth groups, as well as community leaders, religious leaders and IDPS. Quotas and a targeting strategy will be applied for meetings, workshops and trainings

Initial assessment

Positive aspects

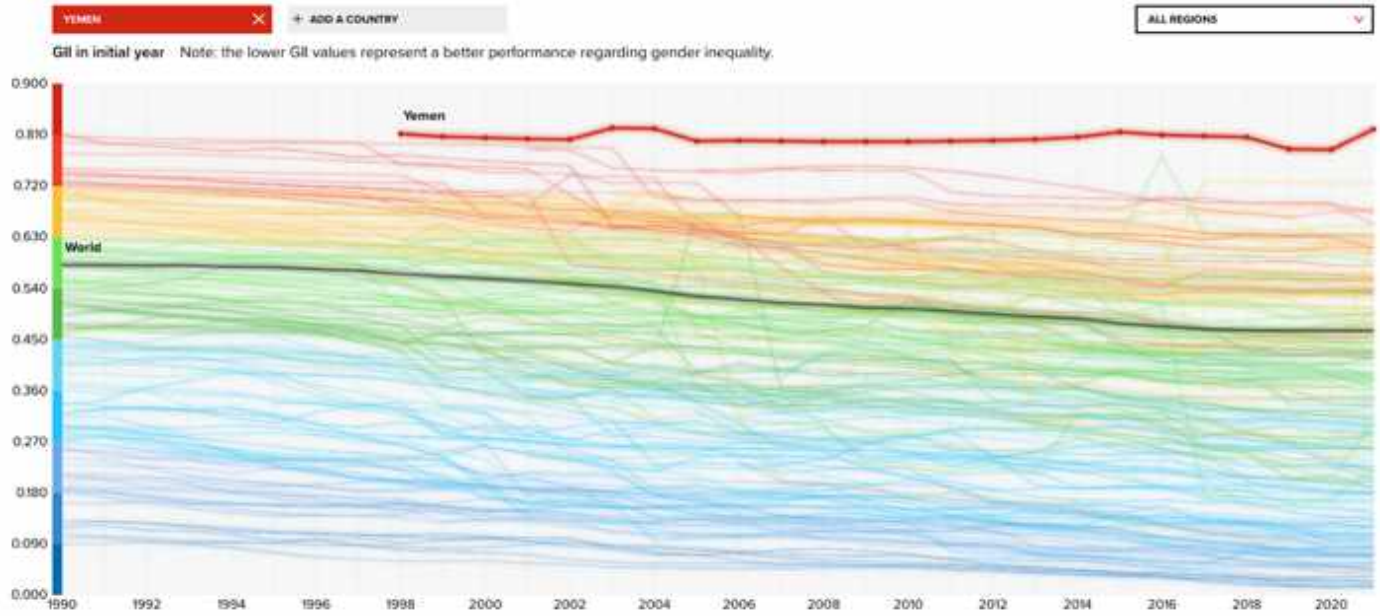
[136] Equal rights, responsibilities and opportunities and access of women and men; equal consideration of their respective interests, needs and priorities

- ❑ Cedaw was ratified in 1984
- ❑ Legislative reforms, in particular the adoption of Law No. 25 in 2010 on Amending Law No. 6 of 1990 Concerning Yemeni Nationality. [137]
- ❑ Efforts to improve its institutional and policy framework aimed at accelerating the elimination of discrimination against women and promoting gender equality. [138]

Principal areas of concern

- ☐ Yemen ranked second last in the Gender Gap Index in 2021, just before Afghanistan[139]
- ☐ Yemen ranks last in the Gender Inequality Index[140]
- ☐ The CEDAW committee reviewing the 2007 Yemen CEDAW report (their 6th periodic report) noted among other concerns a very low rate of representation of women in decision-making positions in Parliament (0.3 per cent), in the Government (1.82 per cent of commissioned ministers) and in the judiciary (1.65 per cent), low rates of girls' education, women's paid employment, and the legalization of girl marriage below age 15.[141] This has been exacerbated by the war since the last review.
- ☐ Deterioration of the rule of law and massive internal displacement have exacerbated women's and girls' vulnerability to violence, including sexual violence, child and forced marriages, and arbitrary detentions and enforced disappearance perpetrated by all parties to the conflict. [142]
- ☐ More than 77 per cent of internally displaced persons in Yemen are women and children, and at least 26 per cent of displaced households are now female-headed, a significant increase from pre-war level.[143]
- ☐ Lack of representation of women in the political / leadership sphere[144]
- ☐ Prevailing traditional gender norms in Yemen, including that Yemen has one of the world's lowest female labour force participation rates (estimated at 7 percent).[145]

Figure 64 -Yemen ranks last in the Gender Inequality Index



Data baseline

Table 102 Project beneficiaries' baseline – women and youth

Detailed outputs / activities	Direct		Indirect	
	Women	Youth	Women	Youth
1.1. Capacity development with national and sub-national authorities on climate change resilience, effective water management, including project oversight, development and implementation of integrated management plans	80	0		
1.2. Establishment of laboratory for wastewater quality testing and water supply quality testing	N/A			

[137] CEDAW/C/YEM/CO/7-8 - Concluding observations on the combined seventh and eighth periodic reports of Yemen*
[138] Idem
[139] Resourcewatch gender gap index
[140] UNDP GII
[141] Draft UN Women country gender equality brief Yemen (March 2023)
[142] Idem
[143] USAID. September 2022. Yemen: Complex Emergency Fact Sheet #11.
[144] OHCHR
[145] YEMEN Women's economic empowerment in the Yemeni context

1.3.	Integrated and inclusive natural resource and climate change risk management process convened bringing together government and community stakeholders	30%	20%	50%	
2.1.	Assessment and verification / technical specification and engineering studies, including surveys required for improved irrigation canals and water intake systems	N/A			
2.2.	Rehabilitated irrigation canals to improve water access for agricultural purposes in the Tuban	33,000		44,588	
2.3.	Improved water intake structures to increase water supply in the irrigation canals				
2.4.	Stone-gabions constructed to reinforce canals and protect agriculture lands and Al-what city from flashing floods.	23,064			
3.1	Assessment and verification / technical specification and engineering studies, including surveys required for improved irrigation canals and water intake systems				
3.2	Developing efficient and safe water supply alternatives for Al-What, Al-Hawtah, Saber cities and surrounding villages	40,940			
3.3	Upgrade Tahror WWTP to treat wastewater for use in irrigation	241		345	
3.4	Upgrade Saber WWTP to treat wastewater for use in irrigation	128		184	
4.1.	Support farmers with modern irrigation techniques and systems (Urban and Rural Areas)	630			
4.2.	Develop maintenance plans for canals, irrigation system	N/A			
4.3.	Strengthen water users associations for improved monitoring, maintenance and dissemination of information on irrigation techniques and skills development	6			
4.4.	Skills development with women and youth on water management and climate change adaptation	100			
4.5.	Capacity development for communities with a focus on women and youth civil society organizations on integrated and inclusive natural resource management plan	50			
4.6.	Awareness raising with local communities on water conservation and climate change in Aden and the Tuban Delta				

* 'Age' and 'disability' also to be considered as part of the targeting strategy

Differentiated climate change impacts.

Table 103 Differentiated climate change impacts on men and women

Sector / Livelihood relevant to the project	Climate change impact	Gender and youth equality and empowerment issues, incl. specific Vulnerabilities / barriers to adapt	Capacity to adapt and opportunities for promoting a 'women' and 'youth' as agents of change
Food security and Agriculture	Water scarcity and food insecurity	❑ Women-headed households and girls are at higher risk of food insecurity, many to most having no steady source of income, exposing these families to risks of exploitation, harassment and abuse[146] ❑ Less than 1 per cent of agricultural landholders in Yemen are female. However, women have a major role in agriculture, providing 60 per cent of labour in crop farming, 90 per cent in livestock farming and 10 per cent of wage labour. (IFAD) ❑ Lack of official papers are an obstacle for women, boys and girls to be registered and be entitled to food distribution. Restrictions in mobility (due to security and cultural reasons) are an obstacle for women and girls to go to the food distribution points.[147]	❑ Ensure women's equal representation in decision making bodies (committees) ❑ Promoting equality in work ❑ Ensure women's equal access to information, technology, markets and work ❑ Promote women access to project benefits and equal benefits of project activities to women, ❑ Ensure safety of women when beneficiaries of the project ❑ Ensure equal treatment of internally displaced persons, including women ❑ Address potential risks to migrant workers, incldluing women
Water, Sanitation and Hygiene	Water scarcity and food insecurity	❑ Women, girls and boys are the primary carriers of water in rural areas. Men's role is passive, especially if the water point is not in the village or within proximity. This places women and girls under threat of harassment and potential GBV while going to wells and water points. Women and children are also at risk of being injured by mines and UXOs while trying to access WASH infrastructure and services. ❑ Women and children might spend between one to two hours fetching water for domestic use. This causes delays in other vital roles that women and children should play in their daily lives (for example attending school for children and carrying out economic activities or paid work for women). ❑ Women and girls are specially affected when they must travel long distances to use shared toilets, or practice open defecation. Many choose to wait until nightfall (sometimes more than 12 hours), making them vulnerable to harassment or violence. Many also limit their consumption of food and drink to delay the need to relieve themselves. Both strategies increase the chance of urinary tract infections. The shame and indignity of defecating in the open and the lack of water for washing clothes and personal hygiene affects women's self-esteem. ❑ Men, women, boys and girls lack basic hygiene education. They are equally in need of hygiene promotion.[148]	

[146] UN Yemen. 2022. United Nations Yemen Sustainable Development Cooperation Framework, 2022 –2024.
[147] **gender considerations in the humanitarian response in yemen**
[148] IDEM

Capacity gaps for social inclusion plan compliance.

Table 104 Capacity of potential executing entities to carry-out social inclusion plan gender responsive activities.

Potential executing entity	Skills and expertise to implement ESMP	Specific requirements execution entities for compliance	Capacity building needs
TBD	Limited (although some experience with UN agencies)	- Appoint an social inclusion plan compliance focal point - Enough capacity to implement the social inclusion plan - Enough capacity to monitor the implementation of social inclusion plan - Awareness of social inclusion issues and potential risks	- Awareness on issues, risks and requirements - Share social inclusion plan - Share guidelines to comply - Guide on implementation - Coordinate with technical committee if needed - Provide training if needed
NGO (TBC)	Experience with UN agencies and should have capacity		
MWE	Limited (although some experience with UN agencies)		
CAC Bank	To be determined		

Opportunities for promoting change.

The project aims to target women (and youth) in community level skill building and trainings and to especially target women-headed households. Opportunities include:

- ❑ Ensure women's equal representation in decision making bodies (project committees). Project technical committee to have > 30 % women. Project steering committee to have > 10 % women. Women focal point from government in project steering committee.
- ❑ Promoting equality in work. Ensure women have same opportunities to be employed by the project as men. The same accounts for youth, elderly and disabled.
- ❑ Ensure women's equal access to information, technology, markets and work. Have targeting strategy and communication strategy. The same accounts for youth, elderly and disabled
- ❑ Promote women access to project benefits and equal benefits of project activities to women. Have at least 30 % women participate in workshops and trainings. Target/maximize women-headed households as beneficiaries of irrigation interventions. Have outputs specifically designed to benefit women and youth and have workshops/trainings and other activities tailored for the needs and concerns of women. Age and disablity also to be considered fort he targeting strategy
- ❑ Ensure safety of women when beneficiaries of the project. Labour rights and health and safety standards to be applied considering specific needs and concerns of women. The same accounts for youth, elderly and disabled
- ❑ Ensure equal treatment of internally displaced persons, including women. Ensure participation of women IDPs in the project.
- ❑ Address potential risks to migrant workers, including women. Ensure participation of women IDPs in the project.

Project planning and design.

Table 105 Gender baseline, goals and activities. A more detailed action plan will be developed at inception phase

Project outputs	Disaggregated beneficiaries, gender specific issues and needs / baseline	Key gender goals (to improve equality)	Entry points (to integrate gender considerations / empower women / youth)	Additional activities needed to ensure gender perspective, incl. potential risk mitigation measures	Specific 'gender' output Indicator / targerts
1.1	Lack of representation of women in the political / leadership sphere	Ensure women's equal representation in decision making bodies (committees)	Trainings to include issues of gender considerations & empowerment of women	Ensure buy-in from the highest political levels	40 women trained at national level; 40 women trained at sub-national level
1.2	N/A				
1.3	Lack of representation of women in the political / leadership sphere	Ensure women's equal representation in decision making bodies (committees)			At least 30% attendance by women in meetings
2.1	N/A				
2.2	N/A				
2.3	N/A				
2.4					23,000 of people protected by reinforced canals are women/girls
3.1	N/A				
3.2	Women, girls and boys are the primary carriers of water in rural areas.				At least 40,000 women and girls benefit from

					increased access to treated drinking water
3.3					
3.4					
4.1	Less than 1 per cent of agricultural landholders in Yemen are female.	Ensure women's equal access to information, technology, markets and work			30% of farmers applying modern irrigation techniques that are women
4.2	N/A				
4.3	Lack of representation of women in the political / leadership sphere	Ensure women's equal representation in decision making bodies (committees)			At least 6 strengthened WUA are women-led
4.4	Prevailing traditional gender norms in Yemen, including that Yemen has one of the world's lowest female labour force participation rates	Ensure women's equal access to information, technology, markets and work			100 women are trained in skills development on water management and CCA
4.5	Lack of representation of women in the political / leadership sphere	Ensure women's equal representation in decision making bodies (committees)			50 women receive capacity development on integrated natural resource plans
4.6		Ensure women's equal access to information, technology, markets and work			30% of women in the area are aware of predicted adverse impacts of climate change

Project implementation

UN-habitat aims to have a gender responsive and adaptable management approach in place which, when needed, allows adjustment based on learning from earlier decisions and interventions and received feedback. This is done through having gender expertise and focal points in place, who should identify challenges, barriers or restrictions that arise during project implementation, which might hinder the equal participation of men and women in activities. Execution entities will be supported to ensure gender is mainstreamed and to identify any challenges that may arise during project implementation, which might hinder the equal participation of men and women in activities. This requires appointing a gender focal point and having quota targets for women and youth participation in project activities. Gender focal points from the government will be part of the steering committees. The project Grievance mechanism established will be capable to accept grievances and complaints specifically related to gender equality and women's empowerment.

Performance Monitoring and Evaluation

The gender responsive management approach includes gender responsive monitoring and evaluation, which is participatory and where 'gender disaggregated data' will be collected and analyzed. Where possible, women and youth will be encouraged to participate in monitoring activities.

Knowledge Management, Information Sharing and Reporting

UN-Habitat aims to have a gender responsive knowledge management approach in place, where specific gender considerations are highlighted through reporting on the project commitment to gender equality and women's empowerment in all outreaches, communication and information sharing efforts.