Water-related Conflict Assessment Report

Resilience Programme in the Irrigation and Agricultural Sector

Yemeni villagers collecting water from water tank. Photo Credit: UNDP Yemen

By:

Lisa Guppy

International Consultant

Email: lisaguppy@gmail.con

Sadeq Alnabhani

National Consultant

Email: sadekalnabhani@gmail.com

January 2023

Acknowledgements

The Water-related Conflict Assessment Report was prepared in a process led by the Peace Operations Support (POS) Unit at UNDP's Yemen Country Office, with Lisa Guppy and Sadek Al-Nabhani as lead authors under the day-to-day guidance of Dr. Tawfeek Saeed, Deputy Team Leader of the Peace Operations Support Unit (POSU). The authors are grateful to Tsunetaka Tsuchiya, POSU Team Lead, for strategic directions. This document benefitted from technical feedback provided by Dr. Tanja Walter, Dr. Zsuzsanna Kacso, Prof. Abdullah Noman, Anis Al-Sharjabi, Simon van Meijeren, and Rehab Al-Sanabani.

Cover photo: UNDP

Date of publication: January 2023

Disclaimer

This product is one of the outputs of the 'Resilience Programme in the Irrigation and Agricultural Sector' project. With financial support from the BMZ through KfW, the project is implemented in Yemen jointly by the Food and Agricultural Organization of the United Nations (FAO) and the United Nations Development Programme (UNDP), aiming to enhance livelihood resilience and sustainable peace in Yemen through sustainable water management. Specifically, the project has three main outcomes, including 1) Agricultural production and resilience to water scarcity and food security are strengthened; 2) Enhanced livelihoods of targeted communities; and 3) Reduced water related conflicts in target locations. Outcomes 1 and 2 are implemented by FAO while Outcome 3 by UNDP. This report is produced under Outcome 3 of the project.

Table of Contents

Acknowledgements 2

Abbreviations 6

Executive summary 7

1. Project: Resilience Programme in the Irrigation and Agricultural Sector 10

1.1 Assignment Scope and Objectives 10

1.2 Project Description 10

1.3 Analysis approach and methodology 10

1.3.1 Context Assessment 11

Figure 1.1. Proportion of women and men contributors 11

1.3.2 Stakeholder analysis 11

1.3.3 Trend and factor analysis 12

2. Introduction 12

2.1 Water and conflict in Yemen 12

2.1.1 First order - Physical water scarcity 13

Figure 1: Estimation of groundwater drop in critical basins 14

2.1.2 First order scarcity and conflict 15

2.1.3 First order solutions 15

2.1.4 Second order – economic water scarcity 16

2.1.5 Second order water scarcity and conflict 17

2.1.6 Second order solutions 18

Photo 2.1 CfW for rehabilitation of irrigation infrastructures, Abyan | Photo Credit: UNDP, March 2022 20

Photo 2.2 CfW on large, damaged irrigation structures, Abyan | Photo Credit: UNDP, March 2022 20

2.1.7 Third order - structural water scarcity 21

2.1.8 Third order solutions 23

2.1.9 Women, water and conflict 26

3. District and Local Analyses 27

3.1 Abyan Governorate: Khanfar and Zinjibar District Overview 28

3.2 Khanfar Context 29

Photo 3.1 Damaged control gate and gates frames Wadi Bana, Abyan | Photo Credit: UNDP, March 2022 30

Photos 3.2a and 3.2b. Sediments and damages in irrigation canals and sub-canals, Khanfar district, Abyan | Photo Credit: UNDP, March 2022 30

3.3 Khanfar Stakeholder Analysis 32

3.3.1 Local influencers 32

3.3.2 Government 33

3.3.3 Legal actors 33

3.3.4 INGOs, donors and external actors 33
3.3.5 Sheikhs and traditional local leaders 33
3.3.6 Mediators 33
3.3.7 Water Groups 34
3.3.8 Women 34
Photo 3.3 Women Participation in CfW cleaning irrigation sub-canals, Kanfar district, ... 34
Abyan | Photo Credit: UNDP, March 2022 34
3.4 Zinjibar Context 34
3.5 Zinjibar Stakeholder Analysis 35
3.5.1 Local influencers 35
3.5.2 Government 35
3.5.3 Water Groups 36
3.5.4 Women 36
3.6 Khanfar and Zinjibar Trend/Factor Analysis 36
Table 3.1: Summary of risks, Abyan 37
Figure 3.1. Key drivers of water-related conflict according to Key Informants- number of KIs, Abyan 38
3.6.1 First order/ physical 38
3.6.2 Second order 40
3.6.3 Third order 41
3.7 Hadhramout Governorate: Al-Qatn and Shibam district overview 43
3.8 Al-Qatn and Shibam Context 44
3.9 Al-Qatn and Shibam Stakeholder Analysis 45
3.9.1 Local influencers 45
3.9.2 Government 45
3.9.3 Sheikhs and traditional local leaders 46
3.9.4 Water Groups 46
3.9.5 Women 46
3.10 Al-Qatn and Shibam Trend/Factor Analysis 47
Table 3.2 Summary of drivers of risk in Hadhramout 47
Figure 3.2. Key drivers of water-related conflict according to Key Informants- number of KIs, Hadhramout 48
3.10.1 First order 48
3.10.2 Second order 49
3.10. 3 Third order 49
3.11 Dhamar Governorate- Jabal Al-Sharq District Overview 50
3.12 Jabal Al-Sharq Context 51
3.13 Jabal Al-Sharq Stakeholder Analysis 52
3.14 Jabal Al-Sharq Trend/Factor Analysis 52
4. Recommendations 54

5. Summary and Recommendations: Women and water-related conflict 57
Table 6.1: Summary of issues raised on women and water-related conflict at local levels 58
6. Summary and conclusions 60
Appendix 1: Methodology in detail 61
Foundation Task: Preliminary stakeholder mapping 61
Foundation Task: Systematic discussion with experts and partners 61
Secondary data collection and analysis 61
Primary data collection 61
Table A1.1: Sample sizes for questionnaires, Focus Group Discussions and Key Informant Interviews .. 63
Appendix 2: Documents and databases referenced in desk review 65
Appendix 3: Stakeholders in the Yemen water sector 67
Table A3.1 Stakeholders 67
Appendix 4: Details from Abyan 73
Table A4.1 Governance Structures in Abyan – summary 73
Table A4.2 Water User Associations – Abyan 74
Table A4.3 Water-related Structures in Khanfar and Zinjibar 75
Table A4.4 Key drivers of water-related conflict according to Key Informants – Abyan 78
Appendix 5: Details from Hadhramout 81
Figure A5.1. Al-Qatn and Shibam districts 81
Table A5.1 Governance Structures in Hadhramout – summary 81
Table A5.2 Water User Associations - Hadhramout 83
Table A5.3 Water related Conflicts in Hadhramout 84
WUGs for wells' water in Shibam and Al-Qatn Districts of Hadhramout 84
Table A5.4 Key drivers of water-related conflict according to Key Informants – Hadhramout 86
Table A5.5 Key drivers of water-related conflict in Hadhramout Governorate 89
Appendix 6: Details from Dhamar 91
Figure A6.1. Wadi Siham and Wadi Rima upstream catchment and land use 91
Table A6.1 Key Wadi Rima/Siham upper catchment recommendations 92
Table A6.2 Water User Associations - Jabal Al-Sharq District of Dhamar 93
References 94

Abbreviations

AREA: Agricultural Research Extension Authority

BMZ: the German Federal Ministry for Economic Cooperation and Development

CfW: Cash for Work

CSOs: Civil Society Organisations

DFA: De-facto authority

EPA: Environmental Protection Authority

FAO: Food and Agriculture Organization of the United Nations

GARWSP: General Authority for Rural Water Supply Projects

IRG: Internationally Recognised Government of Yemen

MAI: Ministry of Agriculture and Irrigation

MoF: Ministry of Finance

MoLA: Ministry of Local Administration

MoPIC: Ministry of Planning and International Cooperation

MoWE: Ministry of Water and Environment

NGOs: Nongovernment Organizations

NWRA: National Water Resource Authority

NWSA: National Water and Sanitation Authority

UNDP: United Nations Development Programme

WUAs: Water User Associations

WUCs: Water User Committees

WUGs: Water User Groups

Executive summary

This analysis report is a part of the *Resilience Programme in the Irrigation and Agricultural Sector* project, which is funded by the German Development Bank (KfW) and implemented in Yemen by the Food and Agricultural Organization of the United Nations (FAO) and the United Nations Development Programme (UNDP).

This report is an analysis of water related conflicts of Abyan (Khanfar and Zinjibar districts), Dhamar (Jabal Al-Sharq district), and Hadhramout (Al-Qatn and Shibam districts) governorates, with two main objectives: to build evidence, knowledge and understanding of water-conflicts, and to provide conflict-sensitive programming recommendations, ensuring that unintended negative impacts generated by project implementation are minimised and positive impact generation is maximized.

One useful conceptual framework is the classification of water scarcity in terms of first, second and third orders. First order scarcity is defined as insufficient availability – in quantity or quality – of water resources compared to demand[i]. Second order scarcity relates to a lack of economic or technical resources required to successfully adapt to the first order water scarcity, and third order scarcity is the lack of social capacity to respond to and change social use and management of water.[ii,iii] These scarcity orders can be simplified to physical, economic and structural scarcity. Water-related conflicts in Yemen and in each of the five districts under study are investigated in terms of first, second and third orders of scarcity.

Drawing on this analysis, based on published lessons learned, project workshops, key informant interviews, focus group discussions and questionnaires directed at a range of stakeholders, several recommendations are synthesised and summarised here. In order to consider the full detail of the recommendations, please go to Section 5.

1. **Which areas of the current project interventions might need to undergo revision given potential risks of fuelling conflict around water?**
    i. Consider necessary revisions to traditional water rules before implementation in each location.
    ii. It is important to fully describe flooding and other water hazards to beneficiary and downstream communities, and supplement 'hard' solutions with information sharing, hazard mapping, response planning and other 'soft' solutions.
2. **Which areas of project interventions are recommended to be strengthened, given their potential to exploit opportunities for stability/peace?**
    i. Technically and socially, water interventions should consider the whole hydrological system. It is important to analyse, design for, and then clearly articulate to all stakeholders, including downstream stakeholders, what the hydrological impacts of activities will be.
    ii. Water user groups, associations and conflict resolution committees involved in this project must become economically self-sufficient to stay active after this project closes. Clear detail on how groups will be sustained are a priority to plan and share.
    iii. The provision of irrigation advisory and extension services for Water User Associations (WUAs) and farmers could explicitly share data and knowledge on water resources and build knowledge and capacity on water-related conflict, and mitigation.
    iv. To turn awareness raising and extension into behaviour change, there may be opportunities to establish social mobilisation teams, and train them as "champions" or "insiders" for water peacebuilding. These teams should include youth, women and girls.
    v. Improving irrigation efficiency is important. Some approaches may be useful, including to implement the lowest technology solutions that will fulfil the aim; start by mapping and developing the support available - including spare parts supply chains and mechanical skills training; provide ongoing support services including dedicated, regular expert visits, farmer field schools and peer to peer learning and continuous knowledge exchange; support technology with activities aimed at behaviour change.

3. **Are there areas of intervention that should be included but are not yet considered in the current Project document to ensure greater effectiveness and/or impact of the project?**

   i. Integrated water resource management (IWRM) and basin-wide planning, monitoring and research are approaches that should be harnessed as far as possible. Some aspects important to emphasise in the project are research and hydrometeorological monitoring including water quality monitoring.

   ii. In Yemen, there is often a weak overlap between public and private water management. Conflict analysis and mediation will be different for private, primarily groundwater, and public, primarily spate irrigation, sources and infrastructure. This can lead to different types of water-related conflict issues, and different mechanisms for conflict resolution and mitigation depending on the source of water, and it is important to consider this in planning and implementation.

   iii. Existing water resources in Yemen cannot meet rising demand equitably and, likely, peaceably. Therefore, the search for alternative or 'new' water sources is important. Developing alternative water should be part of IWRM (3.i).

4. **How to better enhance women's contribution to WUAs and water-related conflict resolution.**

   i. Forming water user groups with a larger proportion of female membership and leadership is an important task in this project, and consideration of how to best raise awareness of the positive outcomes of this adjustment should be emphasised sensitively by project staff and partners who are also well briefed on the topic.

   ii. Women could be valuable project "insiders", peer facilitators or social mobilisation leaders (see recommendation 2.iii).

   iii. Water monitoring could be a task that female and young members of WUAs could be trained to undertake (see recommendation 3.i).

   iv. Awareness raising at local level is needed to increase recognition of the fact that women can play a role in water-related conflict reduction and mitigation. Training, capacitating and resourcing local NWRA staff to take on this role may be beneficial, particularly if both male and female staff could be involved.

   v. It is clear that women will be involved in Cash for Work (CfW), and providing female trainers and facilitators may be useful to ensure female CfW beneficiaries are comfortably supported.

5. **How could the proposed activities take an innovative approach in empowering women to play role in resolving conflicts to achieve community-born peace and stability?**

   i. Female respondents identified several challenges in contributing to WUA, which should be considered:
      a. Lack of awareness at community level of how women may play a role.
      b. Weak awareness of women's contributions and activities by central, regional and district institutions.
      c. Absence of the state and lack of larger projects and activities in the women's sector at local levels.
      d. Poverty and poor family financial situations.
      e. Lack of time. Respondents reported that 60 per cent to 70 per cent of agriculture work is carried out by women in addition to their responsibilities as housekeepers, breeding livestock, taking care of their children and other household obligations.

   ii. When providing training and capacity building for reactivated or new groups, it would be useful to ask female members if they wish for specific training that may be additional to or different in some aspects from that provided to the men.

   iii. Outside formal groups, there may be opportunities to establish social mobilisation teams, and training them as "champions" or "insiders" for water peacebuilding. Women and girls could be trained as social mobilisers in order to contribute to water-related conflict mitigation in a formal or

informal roles.

A discussion of physical, economic and structural water scarcity in Yemen has demonstrated that the project *Resilience Programme in the Irrigation and Agricultural Sector* has a strong component aimed at reducing water-related conflict and improving water management through awareness-raising and disaster preparedness at the local level.

In the conflict-affected, poverty-ridden and complex context of rural Yemen, it is not possible to guarantee that no water-related conflicts will be exacerbated by international projects. However, in implementing the *Resilience Programme in the Irrigation and Agricultural Sector*, an outcome of more peaceful water sharing is far more likely in all project districts.

1. Project: Resilience Programme in the Irrigation and Agricultural Sector

1.1 Assignment Scope and Objectives

This analysis report is a part of the *Resilience Programme in the Irrigation and Agricultural Sector* project, which is funded by the German Federal Ministry for Economic Cooperation and Development (BMZ) through German Development Bank (KfW) and implemented in Yemen by the Food and Agricultural Organization of the United Nations (FAO) and the United Nations Development Programme (UNDP).

This report is an analysis of water related conflicts of Abyan (Khanfar and Zinjibar districts), Dhamar (Jabal Al-Sharq district), and Hadhramout (Al-Qatn and Shibam districts) governorates, with two main objectives: to build evidence, knowledge and understanding of the above mentioned water-conflicts, and to provide conflict-sensitive programming recommendations, ensuring that unintended negative impacts generated by project implementation are minimised and positive impact generation is maximized.

The analysis will focus on community-level water-related conflict, with the understanding that district, governorate, national and international dynamics and conflicts will influence the analysed community dynamics.

Key questions around which analyses and recommendations are developed are:

- Which areas of the current project interventions might need to undergo revision, given potential risks of fuelling conflict around water?
- Which areas of project interventions are recommended to be strengthened given their potential to exploit opportunities for stability/peace?
- Are there areas of intervention that should be included but are not yet considered in the current Project document to ensure greater effectiveness and/or impact of the project?
- How to better enhance women's contribution to WUAs and water-related conflict resolution?
- How could the proposed activities take an innovative approach in empowering women to play role in resolving conflicts to achieve community-born peace and stability?

1.2 Project Description

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.

The project's main theory of change is: If the impacts of water scarcity are reduced through successful initiatives such as implementing sustainable water management and water-climate smart agriculture, achieving the repair of damaged and neglected infrastructure and construction of new infrastructure, and capacity strengthening of gender-inclusive local water entities (including Water User Associations and Groups), then food security and livelihood resilience will be enhanced, equal access to water will be ensured to community members including vulnerable groups, and water-related disputes will be peacefully resolved, enhancing social cohesion, and promoting stabilisation.

1.3 Analysis approach and methodology

Conflict analysis is not a 'neutral' activity. It can be regarded by participants, stakeholders and partners as an intervention in itself. Therefore, the approach taken was conflict-sensitive. A large part of this approach was being guided by the principles outlined in the UN Development Group's Conflict and Development Analysis Guidance[iv], of which the most relevant are: to 'd*o no harm'*; to be *inclusive*; to be

responsive to *local context*; to ensure a *participatory process;* and, to ensure a focus on *gender and vulnerable groups*.

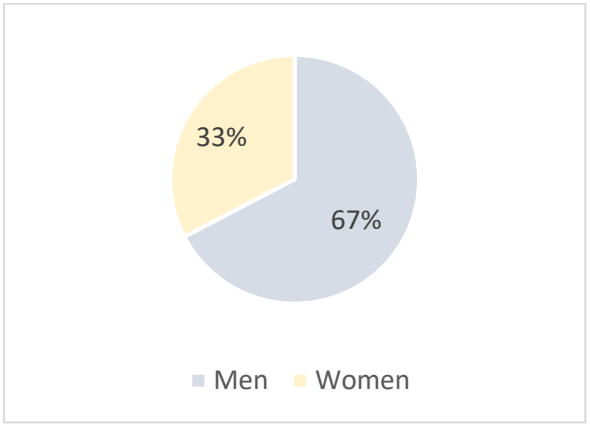
This analysis comprises three key components: context analysis, stakeholder analysis and trends or factor analysis. A summary of how each component was developed is below, and details are in Appendix 1.

1.3.1 Context Assessment

The data necessary for the development of the report have the following sources:

- *Secondary data (desk) review* of available data, analyses and resource materials. The results of the desk review have been presented as the introduction to this analysis report – Section 2.1. There were 28 core publications and databases were consulted in the process from international organisations, NGOs and academia. These are referenced in Appendix 2. All references are listed in the bibliography.
- *Conflict-sensitivity workshops,* which were undertaken in two parts near the beginning and near the end of the analysis. The workshop allowed collaboration between a small group of project partners and key United Nations (UNs) and International Non-governmental Organization (INGO) stakeholders to assess and understand how positive impacts could be maximised and negative impacts minimised through a conflict-sensitive implementation of the project.
- *Primary data collection* including national, project and field-level surveys, key informant interviews and focus group discussions, primarily related to: a) drivers and causes of water-related conflict; b) local water conflicts; and c) water conflict resolution mechanisms. In all, 210 people were consulted through key informant interviews, questionnaires and focus group discussions. The details of the participants (roles or titles only, names not indicated) and data collection design and implementation details are listed in Appendix 1. The proportion of women and men interviewees and discussants is shown in Figure 1.1.

Figure 1.1. Proportion of women and men contributors



1.3.2 Stakeholder analysis

The recent report from the Hague Institute for Global Justice analysed stakeholders in Yemen water management at a national level. This analysis is supplemented by information from this analysis, and is shared in Appendix 3.

A draft stakeholder map for each study location in Abyan, Dhamar, and Hadhramout was created and shared with all project partners. The map was revised and completed through a 'snowball' process of

contacting stakeholders who, in turn, provided more information on new stakeholders for each study location.

To complete a stakeholder analysis based on the stakeholders identified in the map, a *secondary (desk) review*, *primary data collection* and *interviews with relevant project staff* were undertaken.

1.3.3 Trend and factor analysis

These analyses are synthesised into recommendations that will focus on how to implement sensitively such that potential negative impacts are minimised and positive impacts are maximised in each implementation area. The analysis was designed to assist in identifying programming strategies and entry-points as well as potential risks and how to mitigate them based on the circumstances.

2. Introduction

2.1 Water and conflict in Yemen

As stated in the National Agriculture Sector Strategy[v] (NASS), the availability of water is the most often mentioned constraint to the development of the agriculture sector across Yemen. Water scarcity in Yemen has been described as a crisis since at least the 1990s. It has been an ever-accelerating issue with a multitude of social and economic effects, which include local to national level tension, disputes, and violence.

The wider conflict in Yemen is a mosaic of multifaceted local, regional, and international power struggles with numerous root causes. It is indivisible from social tension and fragmentation that are experienced by many communities. Although competition for scarce water resources does not always, or even typically, lead to violence, the conflict context of Yemen means that water-related disagreements all too often spiral into violence and conflict at a community level. In the current war context, it is also true that local disputes between clans, families, leaders or communities may hinder or completely obstruct water initiatives and projects at community level.

According to researchers from Sana'a University, 70 - 80 per cent of disputes in rural Yemen are related to water[vi]. It has been estimated that one-third of the cases taken to criminal courts in Yemen focus on water-related conflict deaths, with an estimated 2,500 people killed annually over water disputes[vii].

Community-based dispute resolution can decrease the risk of water-related violence. There is considerable momentum for peaceful implementation of international water projects, as overall, rural communities in Yemen see international projects as the primary vehicle for improvements in their irrigation water, and are positive about project implementation. Despite this, many attempts to build equitable, local water management structures and mechanisms to support community conflict resolution and mitigation have been less than optimal due to challenges in empowering, sustaining and maintaining these structures and mechanisms, which are significant in Yemen.

For this analysis, it is important to assess drivers of water-related conflicts and their solutions in a clear framework, so that causal linkages between the different root causes of water-related and final, peaceful resolutions are clearly understood. It is critical to ensure that solutions and interventions are designed to effectively address the correct root causes. A framework must also demonstrate that solutions to equitable water availability, access and sharing, which all contribute to peaceful water use, need to be designed to prevent and/or mitigate different kinds of water scarcity.

One useful conceptual framework is the classification of water scarcity in terms of first, second and third orders. First order scarcity is defined as insufficient availability – in quantity or quality – of water resources compared to demand.[viii] Second order scarcity relates to a lack of economic or technical resources required to successfully adapt to the first order water scarcity, and third order scarcity is the lack of social capacity to respond to and change social use and management of water.[ix,x] These scarcity orders can be simplified to physical, economic and structural scarcity.

Physical, economic and structural water scarcity have proven to be key drivers of conflict in different parts of the country, and previous studies have documented these cases in the governorates this project covers. Examples in the study areas of this project will be detailed in this report in later sections.

In Yemen, water-related disaster risk is also of concern, with recurrent drought and floods impacting [particularly the rural poor. The overlaying conflicts exacerbate vulnerability, and reduces the resilience of communities/ neighbourhoods to withstand and recover from water-related disasters, shocks and stresses. Reduced resilience can be one of the major contributors to water-related conflict across the country.

2.1.1 First order - Physical water scarcity

Yemen has one of the lowest water availability rates in the world, at an estimated 74 m^3 per inhabitant per year in 2018.[xi] Data on water use are scarce but one 2008 study estimated that the average daily use of domestic water in villages across the Dhamar district was 12.75 litres per person per day (l/pp/pd).[xii] This contrasts with commonly accepted international opinion of adequate domestic water levels for long term health and wellbeing of 50 l/pp/pd.[xiii]

Water scarcity extends to agricultural water, which is the focus of the project. Renewable water resources used in agriculture in the study locations include rainfall, ephemeral surface water (often termed flood, torrent or spate water in Yemen), groundwater and subsurface water[1]. In Yemen, with only 917 km^2 of surface water[2] across the country and with no perennial rivers, the physical availability of water is largely dependent on infrastructure: Yemenis need traditional or modern infrastructure and technology to access and utilise water sources.

The use of spate waters[3] occurs seasonally in all of the study locations of this project. Spate irrigation is an ancient form of water management that involves the diversion of rivers in spate using deflectors or bunds constructed from sand, stones and brushwood on the beds of normally dry wadis. Diversion structures can be more permanent and if they are modern, can be built of more substantial materials including concrete.

Due to worsening conditions in Yemen including increasing poverty, the conflict context and weak governance, building new and maintaining existing spate irrigation infrastructure is a serious problem affecting agricultural resilience and primary water scarcity in all of the project districts.

Groundwater is accessed through wells, which can be dug, or bores, which are drilled. The term 'well' is often used for both in Yemen. Bores require significant resources and technology to construct and assets including pumps to utilise. National Water Resources Authority (NWRA) have estimated that there are 800 drilling rigs in Yemen, and more than 100,000 wells, including an estimated 2,099 in Abyan and 3,000 in Hadhramout.[xiv] Drilling commonly accesses fossil aquifers, which are not significantly recharged from current rain or surface flows.

Overexploitation of groundwater is a widespread problem across Yemen and declining groundwater levels are reported in all major agricultural areas.[xv] Overexploitation means that rapid falls in water tables of between 1 and 8 meters a year are reported or assumed in deep aquifers in agricultural Yemen, which is a trend that is set to continue.[xvi] Figure 1 shows the best estimates of groundwater table declines in key areas; this figure is reproduced from the NWRA.[xvii]

---

[1] Subsurface flow refers to any flow below the surface of the ground that is in-between surface water and the groundwater. It includes low flow (base flow) and quick flow (subsurface stormflow). In Yemen, there are no formal water rights or allocation rules formulated for subsurface flow and data on subsurface quantity and quality are scarce. Subsurface flow is not comprehensively considered in this report due to the lack of hydrological and other data available in the project districts,

[2] Lakes, rivers, estuaries and artificial water bodies as measured by UNEP for SDG 6: https://www.sdg6data.org/indicator/6.6.1

[3] A spate river is a largely rain-fed, fast-flowing river, which is usually fast-rising and fast falling. The source of spate rivers begins high up, usually in mountains or hills which leads to a fast flow. These spates usually flow strongly for only a few hours and have recession flows lasting from only one to a few days.

Figure 1: Estimation of groundwater drop in critical basins

Source: NWRA, 2021.

This means that in many agricultural areas, constructing new bores is becoming more costly because the drilling has to go deeper as the water table falls. Existing bores may also need to be re-drilled and/or pumps need to be lowered if tables fall, leading to higher running costs. There are documented cases in Yemen of irrigation fields or whole farms being abandoned as groundwater becomes more inaccessible.

Poor water quality is also a part of water scarcity. There are indications that in the study areas, over-exploitation of groundwater is leading to worsening water quality in some locations, with increasing salinity and contaminants being linked to deeper water extraction. If spate water is saline, brackish or otherwise contaminated, soil condition and fertility will also be affected over time. Studies have found pollutants including heavy metals in groundwaters in different parts of Yemen, but due to a lack of monitoring and research capacity, it is not known how many water sources are contaminated above safe standards.[xviii] With a lack of sanitation and water treatment services across Yemen and weak enforcement of environmental safeguards for industry, including the oil industry, it is also difficult to ascertain how many people are exposed to surface and ground water bacteriological and other pollutants and leachates beyond safe levels. Without a functioning water monitoring system, these data are not easily available at district and local level.

Another significant, though as yet not fully quantified, threat to physical water security and agricultural productivity is climate change and variability. The maximum temperature of Yemen is predicted to rise between 2.3°C and 3°C.[xix] NWRA[xx] has indicated that climate change effects are likely to include:

- Heavy precipitation events, which can increase flooding, have adverse effects on the quality of surface and groundwater, and can then damage crops and livestock health through erosion and waterlogging.
- Higher variability of precipitation and increased drought, which can change run-off, decrease water availability and increase water pollution due to lower dissolution of sediments, nutrients, dissolved organic carbon, pathogens, pesticides and salts, which can then lower crop yields and lower livestock health due to exacerbated land degradation.
- Increased temperatures, which will increase water temperatures, evapotranspiration and evaporation which may lower soil moisture, and decreased nutrient and oxygen concentration in water bodies.
- Sea levels rise, which is already exacerbating salinisation of land and water in deltaic locations, including the Abyan Delta.

Climate impacts on the water cycle in Yemen will in turn impact agricultural production, as agriculture utilises 80 - 90 per cent of Yemen's water resources. As climate changes are predicted to impact different agroecological zones in Yemen very differently, impacts on different crops and grazing land in the study areas will also vary [vii]. However, with a largely non-functional hydrometeorological monitoring network in Yemen, there are few data that can support clear predictions of climate changes at wadi level as yet.

Water is only definable as scarce when compared to demand. Although water-related data for Yemen are poor, FAO estimates that since 2005, water withdrawals in Yemen remain at around 169 per cent of total water resources available (SDG 6.4.2- freshwater withdrawal as a proportion of available freshwater resources)[xxi] – meaning that Yemen has, for many years, been using more water than is renewed. The NWRA estimates that the water deficit in Yemen will be more than 3 billion m^3 by 2025[xxii], in the context of 2.1 – 2.5 billion m^3 total renewable resources available. Demand is further discussed in Section 2.1.4.

2.1.2 First order scarcity and conflict

With a heavy reliance on water infrastructure for access, water-related disputes in Yemen commonly focus on water management networks and infrastructure. For example, key community conflict lines highlighted in a recent study of water conflict in Hadhramout include maintaining and efficiently operating torrent (spate) pathways in Wadi Edid, and the quality of water infrastructure.[xxiii]

However, disputes have been triggered by the building of new, or the rehabilitation of existing infrastructure, and related upstream and downstream competition and disagreement is widespread in Yemen. Reported conflict lines in Hadhramout also included the impact of new water developments on existing traditional water sharing.[xxiv] Reported triggering events from different parts of Yemen have ranged from a single family illegally or legally constructing a new well on their land, to construction initiated by government or international agencies that have been perceived as unfair by some groups or some communities.

Surface water use at one point inevitably affects the availability of water downstream. The further upstream an intervention is, the more downstream users may be affected. It is therefore important for projects to assess what the hydrological impacts of activities will be, focusing on downstream water availability and accessibility. Further, water resource monitoring should be put in place not only in the locations of interventions, but downstream from them, in order to track any detrimental changes that may occur so they can be mitigated over the term of the project and beyond. These priorities reflect an Integrated Water Resource Management (IWRM) or basin-wide approach that is enshrined in government policy.

Water has been a conflict target, with an unknown but significant proportion of water infrastructure intentionally damaged or destroyed by the parties to conflicts or by community members faced with water disputes. The accessibility of water sources has also been reduced in some areas due to insecurity and conflict. Access can be limited by the ownership or occupation of the resource by warring parties; by active conflict taking place near water sources; or by the danger of physically going to a water resource due to unexploded remnants of war (ERW). However, it is not expected that armed conflict will be the key feature of water scarcity in the project districts.

2.1.3 First order solutions

First order solutions are typified by supply-side projects that include storage and network infrastructure such as dams, rainwater tanks, pipelines, canals and bores, and the development of alternative water sources such as desalinated water.

The current project is seeking to implement identified, high priority, first order solutions in the project districts, including:

- Rehabilitation of canals (clearing and fortification to avoid sedimentation).
- Maintenance of the existing water infrastructures: weirs, check dams, diversion canals, and control structures and gates.
- Protection of critical wadi banks.
- Construction of underground cisterns and open wadi pits.
- Rehabilitation of shallow water wells.
- Rehabilitation of terraces.
- Construction of water harvesting storage tanks and rehabilitation of old water harvesting/distribution tanks.

Government and international agencies have a long history of providing or repairing physical water structures in Yemen. These solutions are fundamental to enable peaceful access for all Yemenis.

Although infrastructure rehabilitation and repair are critical, it is clear that existing water resources in Yemen cannot meet rising demand under climate change. Therefore, the search for alternative or 'new' water sources is important.

Reused and recycled wastewater are common alternative water sources, and the NASS flags the promotion of the usage of treated wastewater as a key action to combat water scarcity in the agricultural sector. However, Yemen is estimated to safely treat only around 34 per cent of household wastewater[xxv] - which is probably an overestimation as wastewater treatment plants are commonly understood to be operating without adequate resources and in exceedance of their design capacity. Emphasising this problem, it is estimated that only 19 per cent of the population has access to safely managed sanitation[xxvi], implying that more than 80 per cent of sewage is currently not treated adequately.

Significant resourcing, infrastructure construction and capacity development would be needed to develop a safe and reusable water resource. This will be challenging as Official Development Assistance for basic sanitation is the lowest sector across water-related overseas development assistance (ODA) at US$ 2 million in 2019.[4] Decentralised wastewater recycling and reuse are potential options in the near future. The treatment of domestic wastewater and irrigation wastewater in decentralised, low-technology and nature-based processes that allow less contaminated[5] water to be reused for agriculture is conceptually feasible.

Desalinised water is also a key "new" water globally, however, desalination has been adopted in only two locations in Yemen. It is expensive in terms of infrastructure development as well as running costs. In the project districts, and particularly the more remote and rural communities, it is unlikely that desalination is a potential solution.

Fog water harvesting is also being investigated in Yemen for areas with suitable climatological conditions. Its applicability to the project districts is unknown at this point, and fog conditions would have to be researched in order for any analysis to be made.

Even the more feasible alternatives require new infrastructure, skills and knowledge to implement and maintain, which is difficult to sustain in the current Yemeni context. Current opportunities to create 'new' water cannot supplement existing resources enough to peacefully meet all rising demands without additional economic and structural solutions.

The added challenge of climate change is also difficult to address economically in Yemen. The NASS recognises this gap and prioritises efforts to meet the effects of climate change on the agriculture sector, including undertaking the research required to develop plans for adaptation and resilience at country level.

2.1.4 Second order – economic water scarcity

Economic water scarcity is critical in Yemen in part because of the current dependence on groundwater for agricultural irrigation. As outlined previously, in areas where groundwater tables are falling, groundwater use is likely to become uneconomic or unaffordable at some point. Poverty in 2021 affected an estimated three-quarters - 71 to 78 per cent - of Yemenis, while fuel, used for groundwater pumping, is rising in price. Fuel prices at Yemen Petroleum Company (YPC) stations in DFA (de-facto authority)-controlled areas increased by 76 per cent between July 2018 and April 2021, from YER 6,807 to YER 12,000 (approximately US$ 15.17 to US$ 20.03) per 20 litres.[xxvii] In IRG (Internationally Recognised Government of Yemen)-controlled areas, prices rose by 108 per cent between July 2018 and April 2021, from YER 5,372 to YER 11,175 (approximately US$ 11.86 to US$ 11.98) per 20 litres, because of alignment with currency depreciation.[xxviii] Fuel costs may rise as the result of war in the Ukraine. Impacts include abandonment of

[4] Measured as constant 2019 US$ for SDG 6.a.1: https://www.sdg6data.org/country-or-area/Yemen#anchor_6.a.1

[5] Domestic wastewater can be classified into two categories: blackwater and greywater. They have different levels of contamination and must be treated differently. Blackwater is primarily the wastewater from toilets. Greywater is the wastewater that comes largely from other household and hygiene uses and often agriculture; it requires a lower level of treatment to make safe.

groundwater irrigation, a situation that has already been documented in several parts of the country as farmers leave the land, or turn to other water sources for irrigation or to rainfed agriculture. This prediction has been termed a "race to the bottom of the aquifer" as overexploitation continues as a common trend in Yemen.[xxix]

How to ease economic scarcity in Yemen is also a complex challenge. The use of solar-powered pumping to access water has grown considerably in rural areas of Yemen. Solar power used to pump groundwater for irrigated agriculture has been partly funded by international projects but primarily by well owners and operators, and is thus more available to the wealthier segments of society. However, there are some who link the increasing use of solar powered pumps on the overextraction of groundwater in Yemen. A 'solar revolution', replacing diesel and electric powered pumps without clear rules and restrictions, particularly on qat farms, could lead to the expansion of the cultivation area and to an uncontrolled increase in groundwater overexploitation.[xxx] Fully decoupling the established relationship between diesel costs and pumping has benefits for farmers, but may also price water much too cheaply compared to its real value to Yemen.

Valuing water rationally, at least conceptually, is key for food security. Yemen is largely dependent on food assistance and commercial imports, with local cereal production supplying less than 20 per cent of food need.[xxxi] This has created a reliance on virtual water trade[6] - Yemen essentially imports not only food, but the water that was required to produce that food. Virtual water is also a largely unacknowledged component of the supply of food to vulnerable communities within Yemen, depending on local drought, conflict and other conditions. The lack of internal food security is exacerbated by farmers turning to the cultivation of market-based, non-food crops, particularly qat, for cash. Given the country's declining oil revenues, the depletion of hard currency reserves, the decline in remittances and donor attention, climbing inflation, declining humanitarian funding, and overall economic fragility, food security will remain a critical concern[xxxii] and virtual water will need more strategic attention and analysis if it is to remain a key component of managing water scarcity into the future.

The nexus of water and food demonstrates second order challenges in Yemen. In 2021, the UN reported that more than half of the population is facing acute levels of food insecurity and that levels of malnutrition in children under five are rising, with close to 400,000 children suffering from severe acute malnutrition (SAM) and 2.25 million children at risk of acute malnutrition to June 2021.[xxxiii]

While the Development Plan for Poverty Reduction (DPPR) aims to expand the agricultural sector to increase food security and nutritional status, expansion will be critically limited by water scarcity. For example, modelling in 2007 indicated that in Hadhramout, water equilibrium will be reached only if there is an 87 per cent reduction in irrigated agricultural area, based on current irrigation technology.[xxxiv]

2.1.5 Second order water scarcity and conflict

Conflict has contributed to declining levels of service and a lack of infrastructure maintenance, as resources are redirected to security concerns, and insecurity limits the abilities of government and private water suppliers to operate.

Operations are also worsened by a widespread decline in public and private payments and funding for water services as conflict exacerbates poverty in many areas. Where irrigation services, for example, spate irrigation structures, are in operation and managed publicly, there is usually still a requirement for local farmers to contribute payments in order to maintain and operate the systems. Local and national authorities largely lack the funds and capacity to fully operate and maintain structures without a user-pays system.

Inability to pay for water is also impacting self-built water sources, such as farmer-dug or drilled wells. If fuel costs rise beyond a certain point, depending on the crop or livestock being managed, agriculture

[6] Virtual water trade (VWT) is the amount of water, either green (soil moisture) or blue (renewable and non-renewable), that is consumed in the production of agricultural goods that are then traded on the international market. Allan, J., 1998. Virtual water: a strategic resource. Ground Water 36, 545–547.

becomes unprofitable or unaffordable. Fuel costs are affected by the conflict economy of Yemen, but also have the potential to drive water-related conflicts in local areas as some water sources become less affordable and therefore, scarcer. This increases pressure on and competition for more affordable sources, which will vary depending on locality but may include spate water.

There are also water users who are benefiting from the status quo, and would seek to prevent improved water management. For example, when a farmer has established a private bore and sells water to their neighbours, their profits can rise as water becomes more expensive. A more equitable service would, in that case, be of detrimental economic value to them, and they may seek to block new developments, causing water disagreement with other local stakeholders and project managers.

2.1.6 Second order solutions

Central second-order solutions are to meet existing water demands with fewer resources, and to reduce demand, in an approach often referred to as demand management.

Meeting more demand with fewer resources is challenging in Yemen. Agriculture uses around 90 per cent of water resources in Yemen, and is currently having to use more water resources to produce less if irrigation efficiency is considered: Sustainable Development Goal (SDG) 6 reporting indicates that water use efficiency (SDG 6.4.1), already very low in 2007, decreased almost 53 per cent between then and 2018;[xxxv] between 2015 and 2018, it is estimated that water use efficiency in the agriculture sector dropped by 18 per cent.[xxxvi]

Improving irrigation efficiency is a focus of the Government and many agencies, and is included as a priority in this project. Although it is an important component of peaceable water saving and sharing, technological solutions such as drip irrigation can be difficult for local farmers to maintain in Yemen. In order to shift to new technology, the capacity level of the beneficiaries needs to be increased. Beyond installing and training farmers in its use, project managers also need to ask: is there support available long term for farmers to maintain and run the technology effectively? Where are spare parts coming from? Who has the skills to repair faults or damage? How will maintenance be budgeted and paid for? In a project workshop, one expert stated that lowest technology solutions and traditional experience and methods should be considered first in any low resource setting; only when that proves ineffective should awareness raising, then capacitating and training, and then installation of more sophisticated systems be introduced. International examples and examples from Yemen support this approach, with abandoned, repurposed or discarded equipment being a common sight in many poorer and more isolated rural areas.

When introducing new technology is agreed to be important, it should begin by mapping and developing the support available - including spare parts supply chains and mechanical skills training. Long term success will be reliant on good support services being in place at community level before any technology is rolled out.

Successful projects have incorporated services including a dedicated person or group who work together with the farmers to implement new technologies and can answer questions or visit the field every week or every two weeks over a longer term. ‘Farmer field schools’ have also been successful in other locations. In some successful schools, farmers are taken to visit trial plots or technology demonstrations every two weeks for 30 minutes to understand what is happening and think through how they would manage it on their own farms. Peer review and a continuous transfer of knowledge and learning has also proven beneficial if it is well facilitated with experts who are regularly present in the field.

While improving efficiency is a key second order solution, it is recognised that it must be supported by third order solutions as well (discussed in the next section). Without this, negative unintended consequences could occur. For example, experience shows that as improved irrigation techniques result in reduced water and energy use, farmers can afford to expand their irrigation coverage which in turn increases the demand for water. Without structural approaches designed to support sustainable choices[xxxvii], irrigation efficiency may not improve or could even worsen local water scarcity.

Another stream of solutions centres on demand-side management and seeking to resolve competition between domestic, agricultural and industrial water uses. Yemen has one of the highest rates of population growth in the world. With a population of nearly 30 million people in 2020 and an annual population growth of 2.3 per cent in 2020,[xxxviii] total renewable water resources per capita have fallen over 45 per cent between 1992 and 2018.[xxxix] The predicted population for 2050 is 48,080,000 people.[xl] In a rough estimate, if each person accesses even half of a healthy amount of water – perhaps 25 l/pp/pd - this will mean that Yemen must safely provide an extra 592,000 litres per day, every day for the next 28 years until 2050 to meet only additional domestic water demand. This will add to 216,000 m^3 of water supply every year for 28 years. This is in addition to the 15.4 million people estimated to be in urgent need of safe water in Yemen today, which translates to an immediate need for 385,000 m^3. The questions to be asked include not only how infrastructure will be developed to supply this water, but essentially, where will this water come from?

Drinking water for cities is socially, politically and economically important and is usually prioritised when allocating water. There are documented cases where drilling and diversions for urban areas have had significant detrimental impacts on rural and agricultural users, which has led to conflict and violence in Yemen[xli] and may be already impacting, or may impact in the future, the districts linked to this project.

Despite these concerning statistics, with one of the lowest water availability rates in the world and a fragile economy, it is likely that few demand management solutions will be effective or equitable solutions for consideration in this project. One 2008 groundwater study concluded that while the range of possible demand management interventions is theoretically wide (water pricing, metering, removal of fuel subsidies, increased regulation, water markets, targeted taxes and so on), the range of potentially effective interventions in the Yemeni context is very narrow.[xlii]

In the positive, the NASS lists the promotion of the production of rain-fed and drought-tolerant crops, and research support to develop new varieties of drought-resistant crops or alternative crops, as key water strategies for the sector; these may be seen as an important demand-side improvements. This project will also support work led by UNDP that aims to reduce the amount of qat grown, empowering farmers to change to crops that support food security such as coffee. This will in part be a demand-side solution, as qat requires high water inputs.

The urgency of reducing demand does vary locally. For example, in Wadi Hadhramout, the over-extraction of groundwater is severe – with extraction around seven times the rate of recharge. However, the aquifer is extremely large[xliii] and in Wadi Hadhramout, it is more important to estimate the economic lifespan of the water remaining in the aquifer than to share information on demand and use.

Payment for public services is another second order topic that is included in this project, which aims to strengthen Water Users Associations including Women Water User Groups, Basins Committees, national and governorates water resources authorities as well as the traditional mechanisms, which all need resources to operate sustainably, as noted in the project documents completed for this project. Local management groups are a critical part of third order – structural – solutions and will also be discussed in the next section.

When considering the ability of users to pay for water in the agricultural sector, livelihood support must also then become a second order solution. For example, the CfW component of this project provides livelihoods support to already vulnerable populations, contributing to decent work prospects at the community level.

However, CfW can be problematic if not managed sensitively. In Section 3, examples of cases where the selection of CfW beneficiaries has led to local conflict are noted. Beneficiary selection is of course a very charged issue in Yemen, with poverty in rural areas so high and widespread. CfW is also, at times, controversial. For example, one key expert noted that a risk to this project's peaceful outcomes is that unskilled local people who are typically beneficiaries of CfW are not qualified to construct or repair water infrastructure, and problems around **poorly completed work or even unsafe structures have been experienced in the past** when workers were not supervised, trained or guided sufficiently, or given inappropriately skilled tasks.

A high level of technical expertise is needed to design, prepare and complete construction, and CfW beneficiaries can only support skilled project managers in this sense. Appropriate personal protective gear is standard in Yemen (for example, see hardhats in Photo 2.1) but this may have to be reviewed if COVID-19 is an issue in the selected work areas and depending on the size and level of repair needed on the infrastructure (for example, see Photo 2.2 for an example of large, heavy infrastructure). There may also be a requirement for female CfW beneficiaries to be provided with a female trainer and manager, in order that their work is well supported and they are comfortable to contribute.

Photo 2.1 CfW for rehabilitation of irrigation infrastructures, Abyan | Photo Credit: UNDP, March 2022

Project documentation recognises this point by stating that "*FAO's technical expertise in water and land management, disaster risk reduction, and climate change adaptation is key to ensure the quality and sustainability of the productive assets built or rehabilitated through CfW*." This strong leadership at field and infrastructure level should ensure no disputes are causes during project implementation or after structures are completed.

Photo 2.2 CfW on large, damaged irrigation structures, Abyan | Photo Credit: UNDP, March 2022

In summary, this project prioritises several second order solutions:

- Installations of modern irrigation systems.
- Installation of conveyance systems.

- Selection and cost estimation of water infrastructure for repair, improvement, and/or rehabilitation.
- Delivery of water infrastructure equipment/construction materials.
- Community mobilisation to select beneficiaries, based on pre-defined criteria.
- Cash for Work approaches to water infrastructure rehabilitation.

2.1.7 Third order - structural water scarcity

Yemen is one of the oldest irrigation civilisations in the world. Dam irrigation and rainwater harvesting techniques were developed "when Rome was still an undrained marsh".[xliv] Water scarcity has led to a rich history of locally developed norms and traditions to manage and share water.

Each location has its own traditional water-relating rules and regulations. These are often unwritten in rural areas and can differ significantly between different localities, although there exist some standing norms and customs relating to the organisation, arrangement and sharing of water, as well as mechanisms for conflict resolution.

One recent report argued that rural people in Yemen have clear (although sometimes incompatible) concepts of how local society should be organised and administered, and these provide a foundation for peaceful water allocations - where politics permit.[xlv] This can be seen as a social asset to be recognised in project planning and implementation, and a part of the good practice of planning interventions alongside local leaders, traditions and rules.

However, some researchers have noted that traditional water management often treats water as if it is an infinite resource. When allocating and sharing water, current and indeed future scarcities need to be taken into account to make long-lasting, peaceful solutions.

In addition, many local traditions have been weakened while others have declined or vanished due to the war context, modernising water infrastructure, socio-political changes, or environmental impacts such as drought and climatic change. Similarly, the role of local leaders including sheiks in the water sector have often weakened. In 2007 it was reported that "Governance systems have not adapted to the changing resource situation, or where they have, it has been largely to consolidate the pattern of resource capture by the better off. These days, sheikhs are no longer mediators but interested parties, and may no longer be primus inter pares but part of the governing patronage system".[xlvi] A political economy analysis noted a concerning historical decline: under the rule of Saleh, local division and competition was sought by, for example, appointing local individuals as sheikhs who were without status or experience in customary law or tribal traditions.[xlvii] This undermined the authority of authentic sheikhs. This same analysis concluded that the current weak rule of law creates opportunities for sheikhs and other powerful individuals to claim water resources without local resistance; and that most respondents felt that they are increasingly oppressed by a system of corruption.

Public or formal water management has been created at national level in increasingly cohesive water policies, strategies and laws. The roles of government institutions including the Ministry of Agriculture and Irrigation (MAI) and the NWRA are included in Appendix 3. Key strategics and policies developed at central level are referred to and used in this analysis.

However, due to the war context, lack of public funding, and other drivers that are discussed further in Section 3, central governance, the enforcement of water laws, bylaws and related regulations, and the application of policy and strategy are largely absent from districts covered in this project. Overall, policies are outdated, being less relevant to real conditions under the current conflict. This makes it difficult to assess policy impacts on water-related conflict and peace at district level.

In addition to traditional leadership and central policy making, both current literature and the stakeholder analysis undertaken for this report show that there are many and diverse public and private agricultural and rural water management stakeholders in Yemen, leading to a complex and often fragmented situation with regards to who are drivers of water-related conflict and who are peacemakers.

In addition to weakened traditional and central governance, the fragmentation of water management is at least in part due to the fact that despite strong moves towards water conservation for a public good in Yemen since the 1990s, there is still limited overlap between the public sector and private water use. Although the extent of this weak overlap varies between different locations in Yemen, it is a key characteristic that must be recognised and managed particularly in programmes focused on rural agricultural water and those recommending any scaling up of public involvement[xlviii]. This weak overlap means that there are different types of water-related conflict issues between spate irrigation and groundwater irrigation, and potentially different types of or mechanisms for conflict resolution and mitigation for private and public water source conflicts.

Related to this, both central and traditional water law is often weaker for groundwater and there may be conflicts or misalignment between central laws and local rules particularly around wells and groundwater use. For example, under water law farmers are not allowed to drill wells without central permission, but they may be given permission under local water agreements. This leads to the need for every project to consider how they will recognise and potentially deal with "illegal" water structures, and how project managers work with potentially conflicting frameworks. Declaring this transparently from the beginning with all stakeholders can avoid creating conflict and building peace with all stakeholders.

Another critical issue is data. A lack of data leads to the inability to make evidence-based decisions, laws and regulations in Yemen. The NWRA in 2021[xlix] estimated that of 432 hydrometeorological monitoring stations across Yemen, 348 (81 per cent) are not functional; and that only 36 per cent of manual well measuring locations are monitored. The NWRA stated that "Water studies data contribute to making appropriate decisions by decision makers. Hence, studies gain great importance in the management and development of water resources, and represent the basic base in formulating water policies, strategies and plans". The NWRA highlight the weak role of scientific research and technology transfer in the water sector; the fact that technical studies of some basins have not been completed; and that the technical data of basins have not been updated for 16 years. Key studies have been identified for areas including Dhamar, where a hydrometeorological monitoring network update, water quality monitoring and a well inventory have been flagged as urgent.

Corruption, nepotism and systemised self-interest are also of long-standing, serious concern in Yemen. At all levels, conflicting interests and powers for water governance further limit effective water sharing and sustainable management. With a fragile governance system, it is common for political, social and economic elites to preferentially gain access to water, despite water laws and regulations that are intended to curb this. Other water-related inequities based on age, ethnic identity, and other identities can be observed in many parts of the country.

In summary, four major challenges have been noted by FAO and UNDP that lead to structural water scarcity and affect the risk of water-related disputes:

- The lack of coordinated and integrated planning and allocations - between water-consuming sectors and vertically across the various governance levels.
- Non-implementation of relevant laws, policies and strategies.
- Absence of the private sector involvement.
- The lack of clear institutional responses, especially to extreme water events which are accelerating due to climate change, as noted in key project documents.

The NWRA [xxxviii] recently prioritised third order issues including:

- Weakness of water legislation.
- Lack of national strategy for management and development of water resources.
- Unavailability of reliable and up to date data.
- Lack of specific training and qualifications of water professionals.
- Weak institutional structures.
- Weak participation of local councils and communities in water conservation.

Additional structural challenges are location-specific. For example, the weaponisation of water has been experienced as humanitarian water deliveries and services are denied or blocked by different warring parties. A deterioration in environmental management has also been experienced in part from the conflict context, which is likely to worsen water quality and potentially quantity in the longer term. Additionally, drought and other extreme events, likely increasingly driven by climate change impacts, have combined with precarious rural livelihoods to contribute to people, particularly youth, joining armed groups which can increase conflict risks.

These challenges mean that leaders, from national to local contexts, are unable or unwilling to fairly and sustainably allocate and deliver water, which is central to Yemen's water crisis and to water-related disputes. They result in cascading and complex water problems, including high non-revenue losses, the continuation of uncontrolled drilling and unpermitted groundwater abstraction, poorly understood land and water rights, and so on.[i]

Local water-related risks and conflicts need to be considered in a context of both vulnerability and resilience. Many districts host internally displaced persons, who under international law require access to water and other services that can nevertheless be difficult or contentious for host communities to supply. COVID-19 is also exacerbating vulnerability. With less than 10 per cent of the population vaccinated and poor access to handwashing and preventative hygiene, the health, social and economic impacts of the pandemic are well documented in least developed countries. Recurring cholera epidemics, which are water-borne, are also impacting health and mortality in Yemen. Cholera outbreaks have been exacerbated by the destruction of sewerage and wastewater treatment infrastructure and a lack of affordable fuel limiting the operation of these plants.

The project has identified key third order challenges:

- Lack of coordination and planning between sectors and across scales.
- Ineffective participatory planning and increased dialogue on cooperative water management at various levels.
- Lack of enforcement, monitoring, and compliance of the rules and regulations.
- Limited private sector involvement in water management.
- Lack of adequate adaptation mechanisms to address extreme weather events.
- The inadequate institutional response to floods due to climate change.
- Major existing and imminent disputes concerning water resources in Yemen are not fully understood.
- Lack of community-based conflict prevention and resolution at the local level.
- Lack of integrating the humanitarian-development nexus along with holistic catchment sustainable provisions.
- A significant gender gap limiting women's access to irrigation and participation in water user associations and/or governance mechanisms.

2.1.8 Third order solutions

Attempting to determine the highest priority for structural solutions at a local level in Yemen is almost overwhelming. Key points involving water user groups, traditional water laws, coordination between stakeholders and behaviour change will be introduced here, and other key points are discussed at district level in Section 3.

The first two challenges identified in this project are a lack of coordination and planning between sectors and across scales, and ineffective participatory planning and increased dialogue on cooperative water management at various levels. One study of Yemen concluded that there is "much potential to gain from improving understanding, facilitating deliberation and consensus-building, and supporting local initiatives to manage groundwater and other water resources more carefully and more wisely".[ii] The study notes that national institutions who provide support to inform and enable local problem-solving could be most effective. Stronger agreement, coordination and collaboration between mandated leaders in the water

sector, primarily MAI and NWRA, and local groups may be key to making water improvements more peaceful and effective.

As a key solution, the NASS prioritises building the institutions and capacities within the agriculture sector to promote water conservation. In line with this, the promotion of capacity building and expansion of gender-based organisations and water user associations are prioritised in this project. The following discussion focuses on WUAs but is also relevant to women's groups and Conflict Resolution Committees that will be formed or supported by this project.

Project documentation shows a key secondary effect of the project will be that: *through the implementation of project activities, the capacities of water user associations at the governorate and district level will be enhanced through the use of participatory and collaborative approaches that will seek to invest in people and systems and provide working solutions that last beyond the life span of the project.* With the key role of WUAs in this project, it is important to consider their precise current or proposed roles at district level, which is explored in Section 3, in relation to lessons learned from past projects in Yemen. For example, a report from 2007 cautioned against 'imaginary WUAs', which have in the past been set up under international projects in order to "chase benefits" or to superficially satisfy project requirements.[lii]

In a project workshop, experts noted several key points related to Water User Groups, Associations and Committees:

- If WUGs are truly representative of the community, they can be drivers of peace. If they are not representative of the whole community, including potentially disgruntled persons or groups, they can contribute to conflict or play a less positive role in projects.
- In some districts, WUGs are overseen or instructed by local authorities. In this case, they are often not a "strong" power on their own but are a less powerful part of a water management structure. In some localities, this means that if the local authority is obstructive or does not have a positive relationship with the project, the WUA can be also.
- The content and tone of the relationship between WUGs and local authorities also makes a difference to local agendas or hidden agendas.
- If WUGs are part of beneficiary selection and it is not seen to be fair by all, there can be negative impacts throughout the life of the project.
- It is important to involve the WUAs in the project preparation, planning and design as well as implementation from the beginning. Alongside this, it is important to provide training and capacity building to ensure that they have the ability and skills to act as competent and knowledgeable contractors and partners.
- If WUAs are to be drivers of peace, capacity development and training specifically on conflict resolution and mitigation is important. If local people can be guided by the WUAs to understand a common ground and accept dialogue as a means of resolution, WUAs can be key in reducing water-related conflict.
- It is important for the sustainability of WUAs to be able to collect fees from members or beneficiaries of the infrastructure they manage, or to have another source of income that continues after the end of the project. It is believed that the charging of affordable fees is not opposed by communities if services are delivered well, though the impacts of poverty in most parts of Yemen are increasing.

The building of positive support from and empowerment of WUAs will be a key priority in this project, beginning with WUAs' input into beneficiary selection and ending with an appropriate project closure that does not lead to the collapse of the WUAs.

WUAs can have key roles in supporting both central water law and traditional water rules, norms and laws. In a project workshop, one expert noted that in a previous project in Abyan, spate water irrigation has been rehabilitated. After the rehabilitation, water use had changed, but the traditional rules hadn't been changed to suit the new situation. This meant that traditional rules were no longer suitable, and this led to some disputes. Many respondents to questionnaires and focus group discussants of this analysis raised

similar points: that when water use changed, whether it was after new people moved in and used water in new ways, supply was updated by an international project, or any other situation, disputes would likely arise if rules and traditional agreements were not adapted to the new situation.

In international projects, experience shows that revising traditional rules and plans often only happens after the first disagreement happens. As best practice, this should be discussed during planning phases and right at the beginning of community consultation and implementation. Consultation should involve sitting with key stakeholder, including downstream, upstream and beneficiary male and female farmers to discuss changes.

As part of this and many other aspects of international projects, awareness raising for behaviour change is an important activity. The NWRA's National Communication and Awareness Strategic Programme for Integrated Water Resources Management (NCASP) indicates that awareness-raising is a key mission in Yemen and mandate for the NWRA. It is necessary among all layers of the Yemeni social and political landscape, in order to achieve the national water strategy and implement the Water Law and associated regulations. The NCASP states that "legal force alone can never succeed in bringing the necessary changes in mentalities and behaviours which may one day concretely improve the water management situation in the country".[liii] Key impacts of the NCASP are that water issues have become priorities on the national political agenda and that Yemeni people's mentalities and behaviours towards water are changing/have changed; both of these are integral also to the outcomes sought in this project.

While frequent references are made to the need to strengthen extension services to raise awareness amongst farmers and water groups, little information is available about what messages should be conveyed.[liv] If local stakeholders are to be mobilised to solve local water disagreements, the foundation for their actions should be an awareness of how much water they have, where is it going, and what current trends in water availability are – for example, what the projected life of the locally utilised aquifer is. Supporting agricultural extension to issues that might change behaviour from "business as usual' to more climate smart and resilient action, albeit within the relatively limited options available in rural Yemen, will be critical at local level.

Extension and training may re-emphasise available data on predicted climate change impacts and the impacts of lowering groundwater tables in connection with the activities undertaken in this project sooner rather than later may be useful to settle any disgruntlement or disputes made early in the timeline. This extension could also emphasise the need for careful use of solar power in the context of the long-term risks versus the short-term gains of groundwater overexploitation.

Finally, in a project workshop experts followed NWRA statements to note that awareness-raising alone doesn't bring more water efficient practices. Incentivising change and promoting it from the "inside" may also be key in Yemen.

In a project workshop, experts noted that selecting and properly capacitating community champions or "insiders", can be a key solution to peaceful water use. In past projects, "insiders" have been chosen using certain criteria - education level, and so on - from each of the different groups in the area, which can include hosts and IDPs or different ethnic groups. Experience has proved that even if insiders are from different groups who do not interact, the process of empowerment and capacity development can draw them together to begin talking. This capacity development should specifically focus on conflict sensitivity and mediation training, and can include the importance of changing water use behaviour for communal outcomes. For example, insiders can learn how to approach other societies as a non-biased person, rather than taking up a position or taking part in the conflict. Once trained, the insiders are not utilised in their own communities but work in a different location as 'peer' teachers and mitigation specialists.

FAO has previously utilised peer engagement mechanisms for inter-village learning, bringing beneficiaries or participants from one project area to their neighbours to share knowledge about projects. This may be very useful in the project, especially to create dialogue between upstream and downstream communities, when downstream communities may perceive – correctly or incorrectly – that project works upstream will reduce their opportunities to capture water.

The threat of climate change is also difficult to address structurally in Yemen. The NASS emphasises the importance of developing policies, strategies and investment programmes for climate change, drought resistance and combating desertification within the National Adaptation Program of Action (NAPA) for submission to the United Nations Framework Convention on Climate Change (UNFCCC). However, progress on international commitments are slow.

Overall, this project has identified third order/ structural priorities including:

- Community consultation to define water infrastructural interventions.
- Stakeholder workshops on water conflicts in each project location.
- Meetings on the impact of conflict over water bodies in each project location.
- Informant meetings on the importance of women's participation in conflict resolution: to be held with the influential actors in project locations.
- Round table discussions on possible conflict solutions, with individuals and group meetings through the implementation of mediation, reconciliation, and collaborative water governance strategies (co-developed in the stakeholder workshops and round table discussions) for selected water-related conflicts.
- Identify and formulate the most suitable mitigation measures.
- Establishment of Conflict Resolution Committees or integration into existing conflict resolution mechanisms already existing on the ground.
- Formulate the negotiated agreement with the communities.

2.1.9 Women, water and conflict

Aims of this project include how to better enhance women's contribution to WUAs and water-related conflict resolution, and how the proposed activities could take an innovative approach in empowering women to play role in resolving conflicts to achieve community-born peace and stability.

Several studies have pointed to a lack of engagement with water-related conflict mitigation by women in Yemen.[lv] Despite their responsibilities and concerns regarding water and sanitation, and despite the honour and respect they are accorded by Yemeni culture, women have little or no voice in the management of water-related conflict at community level as yet. International initiatives have made various efforts to build a stronger role for women in the water sector, but these have often, so far, proved unsustainable in the cultural and social context of Yemen.

The context of women and their role in water conflict was explored in depth by FAO.[lvi] The FAO writes that there has been a slow and subtle change in the roles of women in livelihood generation women and youth represent 60 per cent of the agriculture workforce, and under the current conflict, the role of women and youth has increased in supporting the household needs and livelihoods for the typical Yemeni family. More women are becoming their family's primary earners, as men are working less due to the conflict, leading to increased income-earning opportunities for women. In addition, the engagement of men in conflicts has increased the number of female-headed households.[lvii]

FAO also writes that women and youth have been and are directly impacted by water-related conflicts in their communities; therefore, they are directly interested in their resolution. In addition, the possible role of women and youth in local and community-based conflict meditation and resolution fora could boost the sustainability of water conflict resolution results.

The tribal areas provide examples of avenues through which they can contribute to the de-escalation of tensions. As reported by UN Women, some of these roles are:

- Direct actions: education of children to handle conflicts peacefully, advising family towards mediation instead of revenge, relief work, taking away weapons, invoking *tadreek* (suspension of hostilities) to ask for arbitration, asking the opponents for *tahkeem* (arbitration).
- Symbolic actions: cutting their hair off, taking off the veil and placing it with the opponent.

Increasing women's participation and leadership of WUA's is a key project pathway to enhancing women's roles under the project, and the overarching community participation approach will be applied via the

WUA's that are formed or re-activated in this project. Although this is a positive step towards creating a role for women in water-related conflict resolution and peacebuilding, key questions on how women will contribute – for example, if the WUA will allow mixed meetings or whether women members will have to meet separately; what child care arrangements are in place for mothers who wish to attend a meeting; and so on, will have to be considered proactively and participatively in this and similar projects. This is particularly important as women, on the whole, do not own key water infrastructure including bores and wells that may be under dispute. Further exploration of women's roles and related issues in each district is undertaken in Section 3.

3. District and Local Analyses

There are two sets of reports that detail water resources in the study areas, which will not be repeated here. The reader is referred to:

- *Water Availability in Yemen:*[7] provides a detailed analysis of water resources in the study areas, although data and analysis for Hadhramout are only available at Wadi level, not district level.
- *Assessment of water infrastructure and use:*[8] reports in three parts for districts in Abyan, Dhamar and Hadhramout.

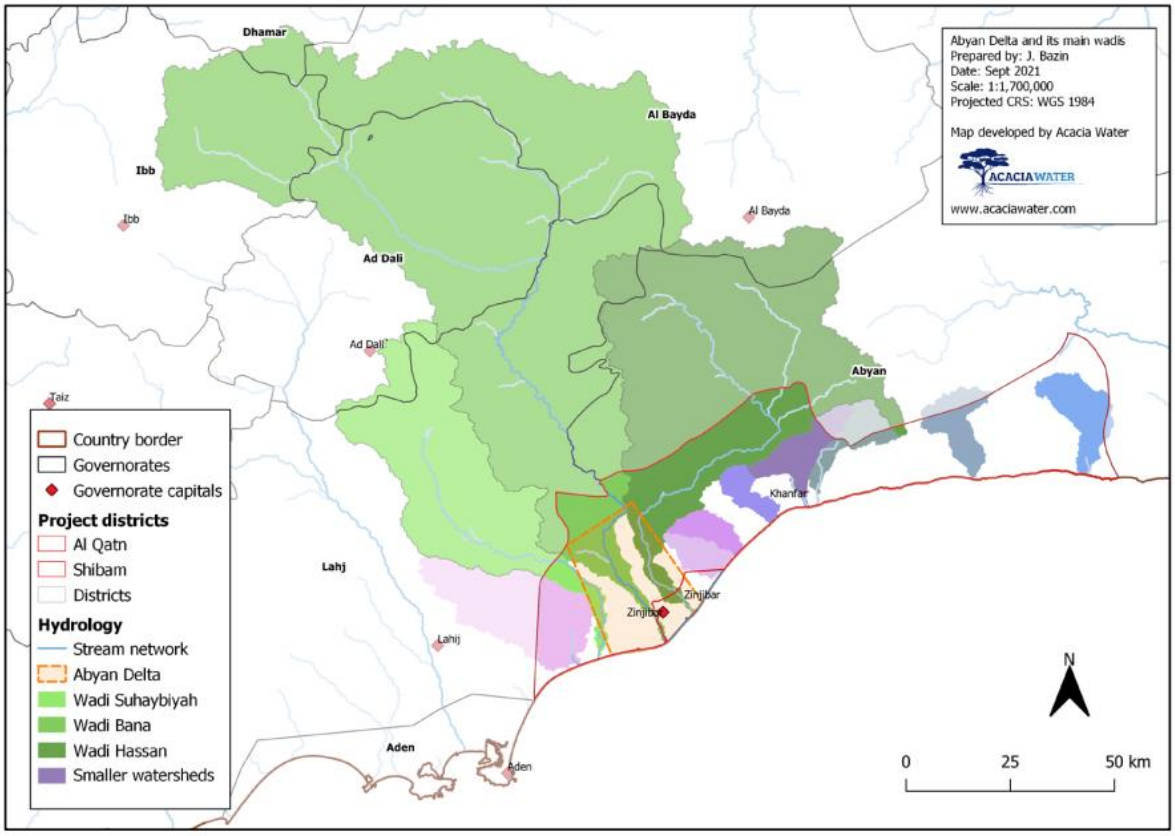
This section offers:

- A one-page overview of water resources in each study district, primarily extracted from the *Water Availability in Yemen* publication.
- In-depth context analysis of water and conflict-related topics synthesised from a wide range of literature and primary data collection in each district.
- District-level stakeholder analyses.
- District level trends/ factors analyses.

[7] https://en.acaciawater.com/nw-29143-7-3937413/nieuws/review_of_yemens_water_resources.html?page=0

[8] *Assessment of water infrastructure and use [for the project] Resilience Program in the Irrigation and Agricultural Sector [in three parts]* FAO Yemen, February 2022.

3.1 Abyan Governorate: Khanfar and Zinjibar District Overview



Wadi description: These districts are part of the southwestern drainage basin that covers wadis that originate within the higher rainfall areas of the southern highlands and midlands and drain toward the Gulf of Aden coastal plain. Two large Wadis feed into Khanfar – Bana and Hassan, with wadis including Suhaybiah and Maharia also approaching the Delta from the west and joining through Wadi Bana. The total area of Wadi Bana is 7200 km^2, of which 66 per cent lies in the Yemen Arab Republic. The area of Wadi Hassan is about 3,300 km^2 and it lies completely within the PDR Yemen borders. Wadis Bana and Hassan contain irrigation canals developed in the 1970s to supply spate irrigation, and by the Bana Irrigation Project, which was established in the 1940s and is operated by MAI. However, much of this infrastructure has suffered damage or has deteriorated without maintenance, and remains unrepaired.

Groundwater description: Groundwater is an important resource in these wadis. However, there is calculated to be a water balance deficit, with extractions exceeding annual groundwater recharge by more than seven times.

Abyan Delta: The Abyan Delta is marked on the map above and is part of both Khanfar and Zinjibar. It is a flat plain located in an arid to sub-tropical area that lies in the Gulf of Aden, 55 km northeast of Aden. Wadi Bana is the main water contributor to the Abyan Delta, draining from highlands that receive 150 mm - 200 mm per year rainfall. The rainfall is erratic and flow in Wadi Bana is characterised by flood fluctuations – from no or little flow to flash floods, with flows in both summer and autumn (March to October) in up to 19 floods a year. Wadi Bana has a mean annual inflow of 162 million m^3. Baseflow also occurs in certain conditions to enter the Abyan Delta.

The delta is considered vital for irrigation and water supply purposes and it has been called the most promising area for agriculture development in Yemen. Agricultural lands in the Abyan Delta are mainly under cooperatives and state farms. There are five cooperatives in the Delta, having an average yearly cultivated area of about 10,000 ha, operating mainly on spate irrigation, and ten state farms cultivating an area of 1,400 ha, mainly on tube well irrigation. The average annual groundwater abstraction in the Abyan delta has been estimated to be 86.4 MCM, which leads to an average annual storage depletion of 15 MCM. Declining groundwater levels up to 1 m/y are reported, and it is concluded that groundwater over-abstraction is still increasing.

Agricultural water in Khanfar: Previously published information indicates that spate irrigation supplies approximately 11,433 ha in the district. Other water resources include wells (3,649 ha), rain (524 ha) and springs (104 ha) and other methods (25 ha) that irrigate approximately 15,744 ha in total.

Agricultural water in Zinjibar: Wadi Hassan provides most surface water and flood waters (1,760 ha). Wells (1,015 ha) with some rain-fed (57 ha) and other methods (2.2 ha) water a total of approximately 2,834 ha.

3.2 Khanfar Context

In the past, the irrigation system in Wadi Bana was under the responsibility of agricultural cooperatives and state farms, who were responsible for the distribution of irrigation water to farmers, as well as maintenance, operation and improvement of irrigation schemes.

After unification in 1990, the Irrigation Department of the MAI was actively in charge of managing irrigation water from the agriculture office in Ja'ar. The Irrigation Department prepare, each year, an irrigation schedule with the help of representatives from local committees. The role of local committees is in the distribution of water to farmers, as well as in solving problems that arise with farmers. Water shares and irrigation quotas are determined from: the quantities that were distributed in the previous season, the degree of reliance on floodwater, and the degree of salinity of agricultural lands.

Despite efforts, this system is not effective. It was reported that some landowners do not respect this distribution system in the context of, first, the lack of enforcement of laws and legislation. Although excellent on-paper policies and laws exist for surface water sharing, and while water law is an appropriate mechanism for resolving water-related conflicts, legal pathways are impeded by the lack of enforcement of water and relevant laws and bylaws in Khanfar. It is clear from respondents that there is also a lack of confidence in the judicial authorities, as well as a recognition of a very slow resolution of cases through the courts.

Government bodies, specifically the Irrigation Department of MAI together with basin committee and WUAs, were evaluated by key informants among the institutions that have, in the past, managed water most effectively and kept water infrastructure in repair, often with a system of contributions from community members. On the whole, interviewees indicated that in the past, the Irrigation Department also ensured relatively equitable water sharing, although it was noted by one key informant that there were powerful people who did violate the traditional and central rules of the irrigation system.

The MAI Irrigation Department is still responsible for the operation and management of spate and canal irrigation structures in Khanfar. However, in reality, no entity is in charge in the current war conditions due to a lack of funds, resources, skilled personnel, the absence of effective governance, and similar issues already highlighted in Section 1. For example, the Irrigation Department in Abyan lacks an office building from which to implement their daily work, their equipment has been looted or fallen into disrepair and not replaced, and they do not have the funds to operate the irrigation system in the Abyan Delta. Remaining staff experience long periods without being paid and lack training to address key issues in the district. They are in dire need of capacity building including logistics, training and renewal of staff, and infrastructure support.

Linked to these issues, water resources monitoring networks are essential for good planning and management of water resources, which can support peaceful water sharing. However, monitoring and modelling are also lacking in Abyan.

A key result of these contexts in Khanfar is the decline of most of the spate irrigation system.

> A key barrier to agricultural water management is that an estimated 85 per cent of existing irrigation structures, both within the district and upstream from it, are inoperative, damaged or in urgent need of maintenance and rehabilitation.

During one male Focus Group Discussion in Khanfar, a participant noted: "*The whole irrigation system in the wadi is damaged and almost 80 per cent of wadi flow runs into the sea. Accordingly, and under the current war conditions, equality is not a subject. The issue is how to benefit from wadi flow through systematic rehabilitation of irrigation structures to irrigate our lands and then, fairness and equality on local decisions and judgements on water-related conflicts will be discussed*."

Details of existing spate water structures in Khanfar and, where possible, their level of functionality, are shown in Annexe 4, Table A4.3. The infrastructure detailed include canals, sub-canals, gates and check dams.

Infrastructure has, in some cases, not functioned for fifteen or twenty years. Much damage has occurred from heavy rainfall events leading to floods, which were then not repaired or rebuilt due to factors outlined above. Heavy rainfall in 2021 led to floods that impacted much of Abyan, and further damaged water infrastructure. Smaller structures like sub-canals and small weirs have been buried by the build-up – either gradual or sudden – of sediment, which also affects the performance of larger structures such as canals. This failure of infrastructure has become a downward spiral, where the deterioration or destruction of structures that were designed to protect against erosion and flooding has contributed to further flood damage. As an example of longstanding damage, see photos 3.1, 3.2a and 3.2b.

Photo 3.1 Damaged control gate and gates frames Wadi Bana, Abyan | Photo Credit: UNDP, March 2022

Photos 3.2a and 3.2b. Sediments and damages in irrigation canals and sub-canals, Khanfar district, Abyan | Photo Credit: UNDP, March 2022

It appeared during interviews and discussions that locals do not foresee that infrastructure will be rebuilt or improved by any authorities in the near future.

Because of the lack of functioning infrastructure, only those farmers with lands close to working or semi-working canals can utilise spate waters, by improvising their own structures to capture it. Those that do are often perceived to then reduce the water available to downstream farmers. A related issue flagged by key informants is conflict and dispute over the ownership of or access through lands nearest to canals and

other irrigation infrastructure.

These contexts mean that few new or active water conflicts in Khanfar were discovered through interviews and focus group discussions. However, they are longstanding, high levels of tension that may be calmed by project activities - or may easily flare into disputes if interventions are perceived as unfair.

One dispute reported by respondents perhaps summarises tension in Khanfar. One family reportedly removes irrigation infrastructure every flood season, in order to capture irrigation water without it being shared with downstream users. The respondents recounting this situation feared that one season, this ongoing situation may lead to armed conflict, causing injury or deaths in the parties to this conflict. They identified drivers of this situation as the damage to infrastructure, which includes damage to the main canal and blockage of sub-canals by sedimentation, waste and vegetation; a lack of funds and a lack of institutional capacity to repair structures; a lack of security, and the absence of the government.

> "*A recent project cleared sub-canals and canals. However, cleaning canals that have not held water for up to twenty years does not mean that water will flow in them again. Upstream connectivity with the rest of the irrigation system was neglected and therefore the project was ineffective*." – Key informant

A key issue raised by respondents who discussed the repair of infrastructure is the design of the whole system of that infrastructure.

> "*This project will only be able to avoid negative impacts if it targets the already damaged key irrigation structures starting upstream of the wadi throughout the wadi toward the downstream*." – focus group discussion member

Following the theme of unintended negative outcomes of past projects, there have also been cases of violence emerging from rehabilitation projects in Khanfar. One conflict occurred when youth from one village were clearing canals in a CfW scheme. They were prevented from working by another group of youth, when the second group perceived that the work was taking place too close to their village. The conflict was based in the assertion that the youth in the second village thought that they should be paid for clearing the canals near their homes, not the youth from further away. Informants reported that this conflict was an outcome of a lack of livelihood opportunities for youth, but also poor coordination and beneficiary selection on the part of project managers. In this case, the head of a local women's association mediated between the two groups.

Another dispute in a cash for work scheme involved the Sheik of a village, who wanted his own labourers to be assigned the CfW. The impacts included a delay in implementation and the unfair allocation of CfW benefits. The key causes of this dispute were seen to be local power dynamics and the absence of state and security in the village, as well as poverty.

Further, water laws and traditional laws can mainly be applied to surface water, which is largely in the public sphere. Laws lack the same rigour and relevance to groundwater use, which in Yemen, is generally carried out privately. Many respondents reported that there is little real control over groundwater exploitation either from the national government or from local authorities.

Although traditional laws differ across different parts of Yemen, the FAO summarised wells in traditional context: *According to custom and Islamic law, every landowner is entitled to construct or dig a well on his land or "mawat" land intended for development. Thus, 'legally' in many places, the extraction of groundwater is at the owner's discretion. However, continued use of a newly dug or drilled well is prohibited if it proves to be detrimental to an already established well. In other words, the owner of the first well has the primary right to use and can own the water he withdraws, but the groundwater system remains common ownership.*

It is clear that **most farmers in Khanfar are using wells to irrigate their lands.** This is the last water source open to farmers who are not close to the remaining canals or wadi channels. Important disputes related to wells are seen to occur when new wells are drilled too close to existing wells, in contravention of central or traditional laws, or in locations that are seen to impact surface water availability.

In summary, there are many formal and traditional mechanisms for resolving water-related conflicts in Yemen; but in Khanfar, these mechanisms are weak and lack the capacity to resolve water-related conflicts. Under current conditions, all existing mechanisms were rated by respondents as poor to very poor in dealing with water-related conflicts due to a lack of technical, financial, logistic, social and political supports, as discussed in the next section on stakeholders.

3.3 Khanfar Stakeholder Analysis

Critical actors who influence or who are affected by water-related conflicts have been identified for Yemen overall. The roles of these stakeholders are described in Appendix 3, Table A3.1 and these are largely reflected in Khanfar. The below discussion expands on local situations.

All in all, there are few institutional capacities to promote water-related peace in the district. **WUAs have that potential, but they need to be reactivated** – as outlined in the project documentation through involving them in training, providing support and building their technical and instructional capacities as well as seeking mechanisms for their sustainability.

3.3.1 Local influencers

Key stakeholders in agricultural water use in Khanfar are the most powerful farmers and the largest local water users. Although individual farmers were not systematically identified as part of this analysis, there tended to be one or two more powerful families in a district.

Due to the lack of enforcement of relevant laws and bylaws as well as traditional laws and agreements, larger farmers and other powerful locals can claim water rights and are able to withstand objections or resistance by others. This is particularly demonstrated by individuals who improvise their own spate water diversions and/or drill their own wells without considering the water and other laws and bylaws, including the required legal distance between wells. In this way, these stakeholders can be key parties to water-related conflict.

Some respondents also noted that local famers, as individuals, local leaders or members of water groups, may contribute to water dispute resolutions in a way that benefits themselves.

IDPs and other newcomers were often seen as disruptive influences, as they could develop private water supplies with little understanding of – or respect for - local traditional systems, norms and customs. They were seen as a group who have violated traditional water rights and systems, which has consequences on downstream communities.

At the same time, farmers and local leaders are flagged as key actors that contribute to peace, through the desire to share water fairly. However, when asked on their contribution to resolve water-related conflicts in focus group discussions and interviews, some farmers reflected that they did not contribute to resolving water-related arguments and disagreements in their local areas because they lack the required skills and financial, technical and logistic support. In addition, they needed more support from relevant authorities to enforce the decisions made.

3.3.2 Government

The governance structure in Abyan is summarised in Appendix 4, Table A4.1.

The MAI Irrigation Department and the NWRA were ranked by key informants as having poor results in the context of solving water-related disputes or challenges. The MAI and MoWE were seen as not currently contributing or weakly contributing to efficient water management or conflict resolution, and the NWRA and local government were seen to contribute weakly. A key issue flagged by some respondents was the inability to hire and retain qualified people who had the skills to work in conflict resolution, as well as other repeated issues including a lack of funding.

3.3.3 Legal actors

Legal institutions were both seen as having moderate results in terms of water-related conflict resolution. One respondent commented that the judiciary is very slow – some water-related conflicts they knew of had remained in the legal system for more than a year.

3.3.4 INGOs, donors and external actors

More than one respondent indicated that with years or decades of damaged infrastructure that cannot be rehabilitated and managed by central or local governance structures, many local people are waiting for external actors to step in and provide solutions.

> "*INGOs and donors' are implementing projects without considering the real and actual needs of target communities. In almost all cases, they don't consult with target communities and if they invite some targeted people to participate in the launching workshops, they don't consider their recommendations in the project design. They don't coordinate with government institutions and implement their interventions through other institutions. INGOs and donors' projects implement projects without a knowledge of the local context*." – key informant from Khanfar

3.3.5 Sheikhs and traditional local leaders

Sheikhs and traditional local leaders are among the existing mechanisms for resolution of water-related conflicts. Sheiks participate as both a conflict party and as a conflict resolution facilitator. However, they often lack political and government support as well as, in many cases, proper knowledge of local customs and traditional laws.

Sheikhs' political activities have, in some locations, weakened peoples' trust in them, as has occurred with other state officials and institutions. Sheikhs often compete with other locals for water resources as they are usually large users of both groundwater and surface water themselves. A lack in knowledge of local customs and traditional laws together with their participation as conflict parties, can create a conflict of interest which reduces both the credibility of their impartiality and their ability to make fair judgments that can satisfy all conflict parties.

However, water related conflicts are still solved by authentic sheiks who do so in accordance with the correct customs or, if needed, with advice from NWRA experts or judicial experts.

3.3.6 Mediators

Water related conflict mediators are an option open to many people for resolving water-related conflicts peacefully. The parties to water-related conflicts may choose common conflict mediators from among a broad range of actors, including state and customary authorities or religious leaders. Mediators provide an alternative path to sheiks for resolving water-related conflicts peacefully.

However, mediators often have difficulties in gaining the trust of all conflict parties. This in part due to the lack of knowledge, skills and capacities of the local mediators in the resolution of modern water related conflicts.

3.3.7 Water Groups

Khanfar has **11 WUAs**, listed in Table A4.2. In Khanfar, although water user groups and committees are seen by some local respondents to be a part of water-related conflict mitigation and resolution, the groups that were established are not functioning, due to a lack of capacities and finance. They can reactivate to implement projects that can provide funding, but typically suspend their activities as the projects and programmes that sponsored them close.

The relationships between WUAs and other local institutions were also seen as poor, according to key informants.

3.3.8 Women

In a focus group discussion conducted with women in Khanfar, women indicated that the Al-Gawl Women's Association was established in 2000 and its water-related activities include different kinds of training; awareness campaigns and agriculture extension services; the implementation of clearing irrigation canals (see Photo 3.3); and mobilising resources for modern tools and equipment for the cleaning of canals and sub-canals.

Photo 3.3 Women Participation in CfW cleaning irrigation sub-canals, Kanfar district, Abyan | Photo Credit: UNDP, March 2022

However, women were not seen by respondents to have a role in managing or resolving water-related conflict. As noted by one respondent "*that role belonged to other institutions and individuals including MAI, the police or security authorities*".

3.4 Zinjibar Context

The area of agriculture in Zinjibar is much smaller than in Khanfar, but interviews and discussions show that the context and problems around water management are very similar between the districts. The non-functionality of most infrastructure is a central issue, as it was in Khanfar. Details of existing spate water structures in Zinjibar and, where possible, their level of functionality, are shown in Annexe 4, Table A4.3.

Interviewees from Zinjibar do add additional insights. One respondent, a farmer, noted that farmers who live near a working or semi-working canal and improvise their own diversions for spate water capture risk

exacerbating damage on their own properties or those downstream because their informal structures do not comply with design and implementation guidelines and minimum standards. If they capture water that they cannot then control, it can flood into adjacent farms and damage them. Another farmer added that although some canals are operated during spate floods, this flow can cause damage including erosion to farmer's lands as they lack controlling gates and frames (which is a local term for small dams).

In addition, it was seen that some newcomers had exacerbated disputes. In one village in Zinjibar, conflict had arisen because a group originally from outside the community had built sheds, barns and yards for livestock in the middle of a canal. This deprived others of using the canal, but without legal enforcement the affected farmers had not been able to shift the builders.

Because of almost total damage or destruction of spate infrastructure, respondents reported that most farmers use well (bore) water for irrigation. However, respondents noted that in the absence of water governance, laws and bylaws relating to drilling and using bores were commonly not followed. This was a situation of note, as respondents reported disputes occurring over the distance between wells. Further, it was noted that some people who drill wells without licenses have coordinated with local police to have their drilling 'allowed' and protected.

Another respondent highlighted the use of solar power to run groundwater pumps. Although this is often seen as a positive development by stakeholders, the use of solar pumps was noted in interviews as enabling some farmers to withdraw more water than they needed, which was seen to affect the quality and quantity of water for the whole area.

When asked about local water-related impacts, farmers in Zinjibar said that there is a lack of employment; an increase in food prices; poverty and overall bad economic conditions; and in extremes, farmers are abandoning their lands due to a lack of water for irrigation. Youth were also leaving farms and, in some cases, joined parties to the conflict to earn money.

In all, farmers saw the situation in their area as worsening because of the ongoing conflict and use of weapons, the lack of law enforcement, and the failure to manage, maintain or repair irrigation infrastructure fairly.

3.5 Zinjibar Stakeholder Analysis

Critical actors who influence or who are affected by water-related conflicts have been identified for Yemen overall. The roles of these stakeholders are described in Appendix 3 Table A3.1 and these are largely reflected in Zinjibar. The stakeholder assessment in Zinjibar is largely aligned with that described for Khanfar, with additions or distinctions only described here. Similarly, to Khanfar, few institutional capacities to promote water-related peace were apparent.

3.5.1 Local influencers

Similarly to Khanfar, key stakeholders and actors were "powerful people", those local farmers with the larger or wealthier farms as well as others who can exert considerable social, political or economic influence over irrigation water management and play key roles in either conflict or peacebuilding around water – or both.

3.5.2 Government

The governance structure in Abyan is summarised in Table A4.1.

Out of all farmers interviewed, most had not heard of the NWRA. This is related to information provided by many respondents that confirmed government institutions including the NWRA typically do not have a field level presence. Two farmers in Zinjibar did respond that they were aware that the NWRA were in charge of water law, but they commented that the law wasn't enforced and that people continued to drill wells without considering the required distance between wells.

The NWRA was ranked by key informants as having very poor results in the context of solving water-related disputes or challenges, and as not currently contributing to efficient water management or conflict resolution. The MAI irrigation department (poor, with weak contributions) and legal institutions (very poor, with no contributions) were perceived similarly. In response to this, NWRA indicated that, over the last ten years, they have lacked the resources, including funding, needed to conduct their mandates, implement their plans and activities, and monitor and evaluate water resources.

3.5.3 Water Groups

Zinjibar Water User Associations are listed in Table A4.2.

In a focus group discussion of women and men in Zinjibar which included members of water user groups, many WUA members indicated that they have been party to a water-related conflict or have mediated conflicts. However, members said that they lacked the ability to enforce laws; lacked support from government and local authorities; and lacked tools including modern conflict analysis skills and methods.

They also commented that the WUAs needed more training and sustained support – they have received support in the past, but it ended when the project closed. This dependency on temporary projects does not empower them as stakeholders in the long term.

Key informants ranked the capacity of these WUAs to deal with water-related arguments and disagreements in their respective areas as weak.

3.5.4 Women

In Zinjibar, **women were reported to be involved in decision making in the water user association.** Women's' groups adopt and implement female-related activities within the WUA and supervise some female-related activities such as training and awareness raising, and sometimes financial management.

However, women did face unique challenges in working within WUGs. The following were identified by female respondents:

- Lack of awareness at community level of how women may play a role.
- Weak awareness of women's contributions and activities by central, regional and district institutions.
- Absence of the state and lack of larger projects and activities in the women's sector at local levels.
- Poverty and poor family financial situations.
- Lack of time. Respondents reported that 60 per cent to 70 per cent of agriculture work is carried out by women in addition to their responsibilities as housekeepers, breeding livestock, taking care of their children and other household obligations.

Within government offices, women were employed as professional, technical and administrative staff in agricultural and water-related roles.

Despite these roles in the water sector, women were not seen by respondents to have a role in the resolution of water-related conflicts, a situation described in several interviews and focus group discussions as an outcome of their traditional roles and the limitations of those roles, as well as a lack of relevant capacities, knowledge and skills. Key informants also noted the low community awareness of the importance of involving women in these contexts.

3.6 Khanfar and Zinjibar Trend/Factor Analysis

This trend analysis aims to synthesise information so far presented on Yemen and Abyan into key points that focus on minimising any potential negative impacts and maximising positive impacts in Khanfar and Zinjibar. The analysis was designed to assist in identifying programming strategies and entry-points as well as potential risks and how to mitigate them based on the circumstances. In order to make this section as

relevant as possible, planned project works are referred to. An understanding of these works is primarily drawn from discussions with and information provided by project leads, the FAO document *Assessment of water infrastructure and use: Part 2/3: Khanfar and Zinjibar Districts, Abyan* and the *project proposal* prepared for this larger project from the perspective of the project aim of reducing or mitigating water-related conflict. These documents will no doubt not cover all the work that will be done comprehensively, so this section may recommend approaches or activities that have already been adopted.

In Abyan, drawing on interviews and focus group discussions, it is clear that the majority of respondents thought that the context of water-related disputes was worsening in the local area. Reasons given for this included the absence of the state, the lack of enforcement of laws, and corruption.

According to the FAO assessment report for Abyan, key challenges from a water management point of view are the decline of groundwater levels due to over-abstraction, increasing water shortage, poor flood control and management, and poor water quality. Other risks including the potential for groundwater pollution, are likely to substantially worsen over time.

A summary of water-related conflicts reported by participants is shown in Table A4.3.

Key informants from Abyan identified key drivers of risk. Information has been summarised in Table A4.4 – please see this table for details. In short, these drivers in Abyan are summarised in Table 3.1. The number of Key Informants who indicated different drivers are shown in Figure 3.1.

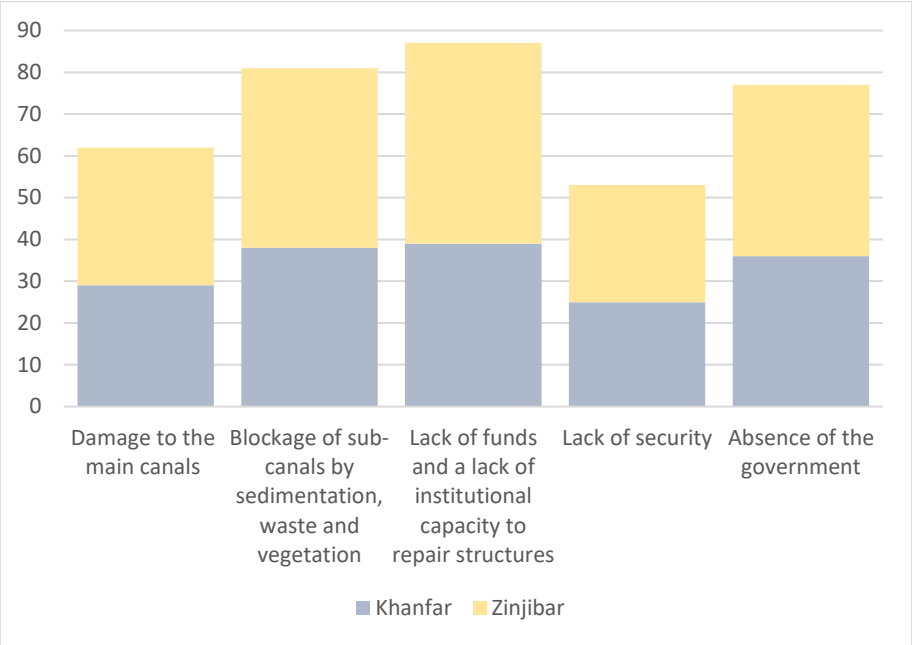
Table 3.1: Summary of risks, Abyan

1. Governance	- Inadequate water policies and strategies
	- Inadequate service provision
	- Decisions on water disputes not being enforced
	- Inadequate, or lack of, traditional water management
	- Lack of knowledgeable and experienced leaders to manage water well
2. Social Drivers	- Power dynamics (unfair access to water for some people, etc.)
3. Resources	- Unfair allocation of water
	- Lack of money to manage water
4. Infrastructure	- Poor or declining quality and conditions
	- Poorly or non-functioning water infrastructure - not doing what it was meant to do
	- Families or villages illegally building water infrastructure
5. Environment	- Worsening water quality
6. External Interventions	- Unpopular or unfair projects being implemented by government or agencies

Local respondents did not look to larger issues of water scarcity, but this is certainly a potential driver of future – near future rather than far future – conflict. Essentially, traditional water management often treats water as if it were an infinite resource – despite growing evidence to the contrary. Improving irrigation structures in Khanfar and Zinjibar is important to more equitably share irrigation water in the present, but will not ensure equity into the future.

These drivers, and others that have been raised by other interviewees, project leads and the desktop reviews, are discussed here in terms of first, second and third order scarcity, risks and responses.

Figure 3.1. Key drivers of water-related conflict according to Key Informants- number of KIs, Abyan



3.6.1 First order/ physical

From the perspective of the interviewees and discussants in this analysis, inoperable infrastructure is key to their water challenges and their longstanding water-related tensions. In one Focus group discussion, a participant said "*the project interventions have the potential to promote peace, particularly if the interventions are comprehensive and focus on the key structures that are damaged. This spontaneously will resolve many of the long-lasting water-related conflicts. The implementation of planned interventions will operate many of irrigation canals and sub-canals which are the main causes and drivers of the conflicts*."

Over time people in these districts have resigned themselves to the lack of irrigation infrastructure as they do not have the capacity to change the situation. In this sense, the focus of the project on infrastructure rehabilitation will be key to reduce the source of tension and inequality in water management in the districts covered, as is well recognised by project planning and action so far.

In total, 43 infrastructure reconstructions are planned for the two Abyan districts in this project.

When beginning work in Khanfar and Zinjibar, project staff will need to ensure that the project is perceived to be fair and will be effective, and that it meets any expectations that are built. This is already well understood by UN agencies, and the participatory processes that have already been undertaken to select which infrastructure will be repaired and who will benefit from this project in Abyan are positive expressions of this.

It will be particularly necessary in these districts to continue to demonstrate to these populations that their input is actioned, partly due to the negative experiences some people have experienced with external projects in the past. As key informants noted – as shown in Table A4.4: "*INGOs and donors' projects are implementing projects without considering the real and actual needs of target communities. In almost all cases, they don't consult with target communities and if they invite some targeted people to participate in the launching workshops, they don't consider their recommendations in the project design*"; and "*INGOs and donors' projects implement projects without a knowledge of the local context. Therefore, rarely do these projects achieve their objectives nor serve farmers and due to the long-standing lack of irrigation management and the likelihood of disputes arising as some farms and families benefit from its restoration, and some do not.*"

This project prioritises work based on the most equitable of selection criteria. However, it cannot offer water to all in the current context, which is recognised in the project documentation. With beneficiary selection and CfW supervision outsourced to partners and re-activated or new WUAs, it is already recognised that malpractices at local level should not be allowed to influence processes, and that project managers will maximise the peaceful outcomes of this project by continuing to manage this closely.

The risks of not doing so are clear: in one focus group discussion, a participant said "*if the interventions are biased and cover some structures and neglect other areas and structures [it could worsen conflict]. For example, if some structures above the wadis are targeted that will result in depriving farmers downstream of the wadi, this will cause conflict between the communities up and downstream of the wadis."*

If not already done, sensitising all staff to understand how selection and choice in planning, even based on very fair criteria, may be perceived by those inside and outside the target districts should be emphasised through the life of the project including, importantly, during project closure. Keeping wider communities – beneficiaries, neighbours who will not benefit, upstream communities and, most importantly, downstream communities – informed and engaged will be important to reduce disputes and disgruntlement, within the communities and districts or between districts. In a project workshop, FAO indicated that 'peer' engagement and learning is utilised, bringing beneficiaries or participants from one project area to their neighbours to share knowledge about projects. If this is planned for Abyan, it may be very useful, especially to engage with downstream neighbours who may perceive – correctly or incorrectly – that project works will reduce their opportunities to capture water.

It will also be important to be explicit about what infrastructure will achieve, in order to reduce future dissatisfaction with any works carried out. This is important in Abyan partly because of the experience of some respondents who have had already seen an external project that did not benefit them, except in short term gains through cash for work, as **the project did not connect the infrastructure under repair with the larger irrigation system.** It is important to choose infrastructure to rehabilitate not only on the basis of beneficiary selection criteria, but on what work will deliver water effectively, and to communicate both expected benefits and caveats – or risks – to people in and downstream of any project areas. Although, no doubt, the irrigation infrastructure has already been assessed as a whole and no works will be carried out that fail in this same way, this will be a point on which to specifically inform and reassure communities.

It is also important to consider potential dispute, dissatisfaction or conflict that may play out in the future. One first point is with regards to the specification of the works that will be carried out. For example**, flood mitigation works** are a large part of the planned works in Khanfar and Zinjibar. These works seem to be dominated by 'hard' and 'grey' (not green or hybrid) infrastructure comprising gabions and other flood protection measures, which are well considered for the context. However, no flood mitigation work is ever proof against every flood, and if it has not already been done in Abyan, it will be important to inform each community about the expected specifications. For example, were the works designed to prevent impacts from a one-in-ten-year flood, or a one-in-one-hundred-year flood? The 'hard' works of gabions and so on will inevitably fail during a flood that is larger than the return that they were designed for, and it is therefore also important to support each community with 'soft' solutions in parallel. This would aim to avoid a situation where beneficiaries expect to be protected from all floods and then are impacted by an extreme flood unexpectedly. If this occurs, it is likely that project agencies will not be well regarded in the future by some community members, with future project proposals creating more tension or dispute.

A part of the project addresses this: activities output for objective 3.1 include *training of governorate and district authorities, as well as Water User Associations on disaster risk reduction and establishment of community-based flood early warning system*. In the project document description, it is noted that the same audiences will be targeted for training in disaster risk reduction to adapt known DRR good practices to the local context and ensure that communities, including women and youth, are capable of mitigating risks created by climate change at the local level. In light of the specific infrastructure works planned, it would be useful to expand this and similar activities to focus on community, village or town level DRR planning in a way that specifically includes an understanding of the specifications and roles of any new protection infrastructure. For example, it may be wise to support the creation of simple community-level

flood and, preferably, other hazard mapping, which can then support participatory preparation and response plans in each town or village in which they do not already exist.

Hard flood mitigation measure also typically 'transfer' risk. For example, if gabions are built to retain the flood water within the channel or canal, this flood water must continue to flow downstream and, in that case, flood risks to populations downstream of the end of each gabion or protective structure may increase. The same is experienced all over the world with regard to dykes, walls and so on that are designed to contain or divert floodwater. It would be preferable to take a precautionary approach and engage with downstream communities and leaders in a discussion on this risk scenario even if the risk is perceived to be small, to prevent any disgruntlement later arising. The downstream communities and farmers could be prioritised for future support, in a next project phase, with low-cost flood risk mitigation measures.

Future risks of dispute and disgruntlement also include larger trends introduced in the first sections on this report – increasing competition for water, including urban-rural competition under a growing population; climate change impacts; and declining groundwater reserves in Abyan. More specifically, although rehabilitating spate irrigation infrastructure is a key priority, it is clear that water that can be delivered via this infrastructure will likely not be sufficient in the long term. Any behaviour or management that treats water as an infinite resource will not prevent, and may even contribute to, water disputes and risks in the future.

As part of this issue, it would be useful to understand whether efforts in Abyan will contribute to national strategies that have been endorsed and promoted, including IWRM and basin-wide planning.

It would also be useful to understand if there are proposals to create or supplement alternative water sources – for example, rainwater harvesting or grey water use for agriculture – to prolong more peaceful water sharing as long as possible.

Related to this, a recommendation in the assessment report for this project in Abyan indicates a priority of **introducing the solar water pump to reduce the high cost of fuel unavailability** can help in increasing the capacity of farmers but should be only within the sub-surface water scheme (shallow wells).

It is understood that solar pumps may be provided as part of the project in Abyan, to reduce the impacts of the high cost of fuel for pumping water, which is certainly a problem for farmers. It is also understood that these are only intended to be used for shallow wells, so as not to contribute to overexploitation of deep groundwater. Without being able to recommend the distribution or not of solar power technology or tools, it is important to acknowledge here the tension between increasing access to agricultural water and seeking to reduce water overexploitation that is ongoing in Yemen. Despite sophisticated drilling technology and experience, and the growing proliferation of solar power for pumping, some areas including Abyan may experience increases in expense and other difficulties in accessing deeper groundwater in the near, rather than the far, future. This may be the kind of change that creates triggering points for dispute or conflict in the simmering water situation experienced in these two districts.

The provision of irrigation advisory and extension services for WUAs and farmers to both enhance crop yield and maximise water use is highlighted in the project proposal. The discussion in Section 3.1.8 on extension is important to refer to here.

3.6.2 Second order

In terms of infrastructure, the FAO assessment report indicates that three second order style interventions are prioritised, with a need to:

- Introduce modern irrigation technology to save water and reduce the cost of water pumping from groundwater.
- Provide Irrigation Advisory Services for the targeted WUAs and farmers to enhance the crop yield and maximise the water use in agriculture.
- Introduce greenhouses to have more production (more crop per drop) and maximise the incomes of the targeted beneficiaries

Natural resource safeguarding is important to ensure that lands and waters are not negatively impacted by any changes to irrigation. A natural resource safeguarding assessment is included in project proposal documents. It would be useful to distil the results of this to assure any disgruntled community members that activities including irrigation will not damage lands or soils, or lead to other negative impacts.

In a more delicate balance, it will also be important to influence behaviour so that any water savings with improvements in irrigation efficiency do not translate into agricultural expansion that does not take current and future water scarcity risks into account.

Other priorities identified are:

- Creating Water User Groups in areas that do not have WUAs should be developed in the project period to be a Water User Association.
- Activating the WUAs to play their roles in water resource management is always a promising option, especially in a fragile state. Further, the enhancement of the relationship between farmers (horizontal learning) and WUAs as well as the government officials is key for sustainable interventions.

It is always a key aim that positive project impacts continue past their project closure date, and in the case of Abyan, this may centre on concerns of how the infrastructures that is built or rehabilitated can be maintained. It will be important that this is made clear to prevent future disputes over costs and payments.

As part of this, the activation/reactivation and capacitation of water user groups are key aims from this project. These groups are recognised to be important to the sustainability of this project and the longevity of its impacts. However, respondents made clear that in the past, **groups had been formed during a project and then disbanded or suffered collapse after project funding ran out,** leading to a vacuum in water management and water-related conflict mitigation.

Project documentation states that "institutional financial sustainability will be critical for the continuation of the implementation. This will be established together with the users in which payment for services will be justified and supported by the basin committee's relevance and service delivery". This well recognises the project sustainability issues. From information gained so far, it is not clear when plans for payment of services will be made, what exact approach they will take, who will be paid and who will be involved. However, if it has not already been planned, it is recommended that these plans are made in participation with key stakeholders at district and governorate level in parallel with other preliminary activities, including the identification of beneficiaries and the selection of infrastructure to be built. This is because the details of who will pay what, and to whom, may influence how much confidence and legitimacy the (re-)activated water user groups gain, and should also influence what is built, where.

3.6.3 Third order

The absence of any institution managing water-related conflict and, in most cases, broader water management was a recurrent theme of respondents and participants. This has been emphasised by the recognition in stakeholder analyses in Khanfar and Zinjibar that farmers and powerful water users are key stakeholders in water conflict and water peacebuilding in these districts, with public governance not providing a strong influence or support.

However, as the introductory discussion of this report noted, there are no easy answers in Yemen as to how to improve issues that relate to a lack of strong overlap between public and private water interests and management.

This project will focus on the reactivation or activation of groups including Water User Associations, a priority which was repeatedly championed by respondents (more strongly in the Hadhramout districts, but also apparent in Khanfar and Zinjibar). However, it was clear from information gathered that even when fully active, **water group members did not have the power to enforce their decisions without support from a government structure,** which was absent; and without continuous funds which lasted beyond a project lifespan. Although it is difficult to discern what the current project can do to influence the former besides exert power as the funder and project manager, it is an important point to recognise. As

recommended in the previous section, this latter point will be important to ensure – particularly as it also impacts, in a circular manner, on the ability of the re-activated groups to enforce decisions and the project document statement that "*the reactivation of existing water user associations is essential to ensure the sustainability of interventions and enhance community participation and bottom-up water resource management*." The necessity of trying to ensure post-project longevity is also important to apply to *the community-based and inclusive conflict prevention and mediation mechanisms* that this project will establish.

The activation of new, or adjustment of existing, WUAs to require 30 per cent women's participation and 20 per cent female engagement on any boards is noted in the project proposal as a new initiative in Yemen, and may also impact the way in which WUAs function or are perceived to work. Without being able at this stage to make any clear recommendations, it is simply highlighted here as a potential point of dissatisfaction for some parts of the community. If not already done, consideration of **how to raise awareness of the positive aspects and, no doubt, hugely positive outcomes of this adjustment should be emphasised sensitively by project staff and partners who are also well briefed on the topic, before changes are given as a fait accompli.**

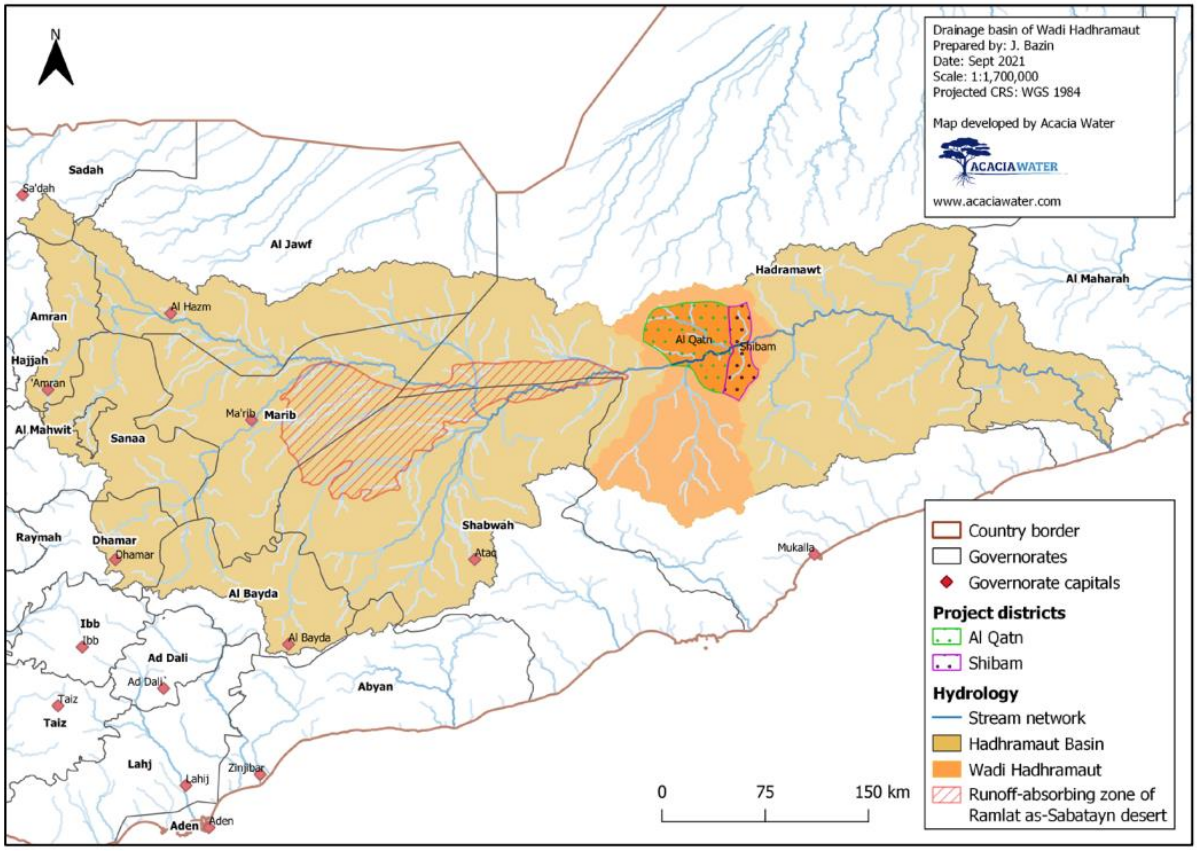
Another third order point was raised by an expert informant, who emphasised that an IWRM approach, in alignment with key national and governorate level strategies and policies, should be adhered to by all projects. They noted that considering water basins as a whole would facilitate IWRM at district and local levels.

This is, in some ways, related to the points raised by other respondents who noted that irrigation networks could not be repaired piecemeal without considering the whole system and how it worked.

Although all aspects of IWRM cannot be considered within scope of this project, it is an approach that may assist in reducing disputes related to who will benefit more and who less in this project. Some activities that may be emphasised as supporting an IWRM or holistic framework and still focus on the key priorities of this project could include:

- Updating water resources studies with action research taking place alongside implementation. It is not clear whether supporting the NWRA to repair existing but non-functioning hydrometeorological monitoring stations is already planned as part of reviving early warning systems, but if not, it could be a way to improve coordination relations not just with the NWRA but with local stakeholders, if locals are provided with the information regularly.
- Regular monitoring of water quality in the project areas could also avoid any disgruntlement in the future if water influenced by the project is found to be below safety standards. Although water quality standards are primarily of concern when working with drinking water, it is an aim of this project to improve water quality, so monitoring that supports IWRM policies, and water monitoring capacities that extend beyond the life of the project, may be well received and improve the perception of the project. Water monitoring could be a task that female members of WUAs could be trained to undertake, for example. Ensuring satisfactory levels of key water quality indicators would follow a precautionary principle, and is relatively cheap to equip.

3.7 Hadhramout Governorate: Al-Qatn and Shibam district overview



Wadi description: The Sur and Hainen Wadis cover the Shibam and Al-Qatn districts. A more focused map is shown in Appendix 5, Figure A5.1. Wadi Hadhramout is located in the southern east of Yemen and is a key agricultural area. The catchment area includes a number of important tributary wadis in which water flows more regularly than in most parts of the main wadi. The main wadi bed only carries water during heavy rains, resulting in flash floods leaving little opportunity time for water to infiltrate or recharge shallow groundwater. Despite this, in Wadi Hadhramaut, the majority of agricultural water use takes place in the main wadi valley. The climate is hot and arid with average annual rainfall between 40 - 80 mm or even less.

Spate water infrastructure were heavily damaged by major flash floods in 2008, with an estimated loss of 1.64 billion US$, irrigated agriculture changed to rely heavily on wells and bores for groundwater resources. Major flooding hit Hadhramout again in 2020 and 2021. These destroyed water infrastructure including weirs and check dams, with most sub canals and small weirs buried by sedimentations. Agricultural land, homes, animals and crops were washed away, and local food security was threatened.

Groundwater description: Water balance analysis shows that groundwater is being abstracted about ten times faster than natural groundwater recharge rates. Trends in precipitation deficit (the difference between precipitation and evapotranspiration) between 2009 and 2020 exhibit a decrease, especially from 2015 onwards, suggesting groundwater availability is decreasing at the same time as agricultural demand is increasing. Various sources report declining groundwater levels in the order of 0.6 m/y or more as a result. The rapid increase in groundwater abstraction has caused highly saline water taken from saline aquifers to downward leak into the principal aquifer. Increased salinity levels in the principal aquifer system have led in recent years to many water wells being abandoned.

Agricultural water resources in Al Qatn: The wadis supply agricultural water through spate irrigation over 2,980 ha. The only other significant irrigation source is groundwater (1,627 ha), irrigating approximately 4,607 ha in total. Cereals and vegetables are the main crops, with less area given to fodder, fruit, cash crops and pulses, in order.

Agricultural water resources in Shibam: In Shibam, around 1,972 ha are cultivated by wells (1,474 ha), floods (379.7 ha) and rain (117 ha). The crop proportions are similar to those in Al Qatn.

3.8 Al-Qatn and Shibam Context

Customary conflict management mechanisms have existed in Wadi Hadhramout for thousands of years, and include the Al-Raddah System of irrigation practices. These have become largely neglected. Despite this, water rights are well rooted in Hadhramout. Across the many wadis in Hadhramout governorate, water rights as well as modern irrigation systems and the maintenance and operation of irrigation schemes are similar, to a large extent.[9]

In the Shibam and Al-Qatn districts, water management and water rights are known by a traditional custom called Alaadat. This tradition has not been well documented, but is well known and is used to solve water-related disputes. For specific locations, there are specific regulations of Aadats; for instance, Aadat Alhajrain, Aadat Jomaileh, and Aadat Shibam.

From a central perspective, water is primarily managed by the Irrigation Department of MAI. However, the services offered by them are very limited. WUAs and water committees were also responsible for operating water infrastructure. In the past, members contributed financially to WUAs, who then financed infrastructure maintenance with a percentage of their resources. Other funds were divided amongst the beneficiaries (landowners). Resources were provided primarily by three projects: the Hadhramout Valley Project; the Rural Development Project; and the Groundwater and Soil Conservation Project (GSCP).

As all of these projects closed and groups lacked the resources to continue, infrastructure maintenance and repair ended, and water competition and disputes increased.

> "*Overall, despite the efforts of these institutions and groups, many spate irrigation structures are partially or completely non-functional in the Al-Qatn and Shibam districts. A fair and equitable distribution of spate water is therefore not currently possible*." – focus group discussion member

As reported by focus group discussants, important water-related disputes around flood irrigation are based in disagreement over water quotas during spate floods, which are limited due to the damage to or destruction of irrigation infrastructure. Other areas of dispute include the fact that some farmers sell their soil for construction purposes, and as a result, their lands are then at a lower level than neighbouring lands. This means that more than their fair share of spate water flows onto their lands. This is seen to deprive the next fields of water. Other causes for dispute were seen to be over water quotas during spate floods; over the selling of agricultural land to non-local people who do not know the traditional irrigation system, locally known as Raddah; over the building of houses and other buildings on the beds of the wadi channel, which can change the flow of spate water and potentially cause flood damage to other's lands.

Important disputes related to wells are seen to occur when new wells are drilled too close to existing wells, in contravention of central or traditional laws, or in locations that are seen to impact surface water availability. Respondents also report tension around the inheritance of water quotas after a father passes away and land is divided. There have also been disputes between the local electricity corporation and farmers who make an illegal connection to public electricity to operate their water pumping – which can lead to overexploitation of water, as the energy is 'free'. Tension around the fact that some farmers have access to solar energy to pump water was also apparent, **with a recognition that when solar power was used, water was often over-exploited.**

[9] When the water flows in the wadi, it enters the main channel (Sakia) and then is distributed to the entrances (Alharat) and openings (Albodod) at the same time. The first fields near the openings and entrances are then watered and when it receives sufficient supply, water is diverted to the next fields through openings known as Manaki that are about 45 cm high. This irrigation system is applied for the lands cultivated with annual crops, but for the lands cultivated with perennial crops such as date palm, different Manakis are used with a height of 75 cm.

As reported by FAO and IOM, along with these emergent conflicts, authorities also noted long-term, entrenched water tension and even conflict rooted in historical and tribal relations.[lviii]

In terms of water quality, water pollution from the petrochemical industry was noted. Before the war, Hadhramaut supplied about one third of Yemen's oil production. With weakened governance, the potential for industrial accidents is likely to have increased. A key informant reported that during flooding in 2008, spills from a petroleum company made the waters run black. It is politically as well as technically difficult to ascertain how well industry is prepared to prevent emergency spills and how stringent their environmental safeguarding is on a day-to-day basis. If another big spill happens, there is likely to be protest from local populations and a demand for clean-up and remuneration without clear planning, the results of this scenario and the likelihood of tension or even violence is unknown.

Finally, there are indications that salinity is increasing in some parts of the Al-Qatn and Shibam. Without comprehensive monitoring, it is difficult to understand the scale of the problem. However, it is a problem that is likely to increase if deep aquifers are overexploited and deeper groundwater of poor quality is used for irrigation. Saline groundwater will salinise soil profiles if used too heavily, a process which is largely irreversible in a lifetime. There is evidence that deeper groundwater can also contain other contaminants in Hadhramout, as shown in some isolated studies, though comprehensive testing has not been done.

Experts responding to a previous study[lix] indicated that lands along Wadi Hadhramaut are becoming less fertile. It has been recognised by several previous studies that overall, most of Yemen's agricultural lands are subject to various degrees of degradation, that soil productivity is on the decline and that desertification is accelerating in some locations. This is due to a number of interlinked causes, including in part due to floods and other natural hazards that erode lands, declining water quality in irrigated areas, overgrazing and other malpractices, deforestation and so on.

3.9 Al-Qatn and Shibam Stakeholder Analysis

Critical actors who influence or who are affected by water-related conflicts have been identified for Yemen overall. The roles of these stakeholders are described in Appendix 3, Table A3.1 and these are largely reflected in Al-Qatn and Shibam.

Stakeholder dynamics were found to be similar in Hadhramout to those found in Khanfar and Zinjibar. Again, all in all, there are few institutional capacities to promote water-related peace in the district. The below points will only re-emphasise key points, or cover information additional to or different from that already presented in the stakeholder analysis of the Abyan districts.

3.9.1 Local influencers

As in Abyan, key actors in water-related conflicts are farmers and the largest individual water users who are interested in capturing water with little understanding or consideration of the impact on other farmers.

In parallel, farmers also, for the most part, have a strong interest in being able to use water peacefully and, as members of water user groups or as individuals, can be mediators for or mitigators of water-related conflict.

3.9.2 Government

A summary of governance roles is included in Table A5.1.

The services offered by the Irrigation Department of MAI are very limited. The NWRA, MAI and local government are ranked by key informants as only weakly contributing to water management and conflict resolution, and the MoWE as not contributing. More than one key informant said the role of the NWRA was limited to providing advice on the legal distance between wells.

This weakness is due primarily to the same reasons of weak governance in Abyan, which include a lack of funds and the absence of the state at district level.

Police and courts were evaluated as poor achieving poor results in water-related conflict management.

3.9.3 Sheikhs and traditional local leaders

Hadhramout has a historic and customary conflict management mechanisms which are still accepted by many. This system included *Khayals*, individuals who were responsible for operating irrigation structures. However, decisions are often not able to be enforced in current conditions and traditional systems have become less prominent.

In addition, local leaders were not always seen as unbiased. One respondent said, "*The local customary practices are fair in most cases, except when the Sheikhs or community leaders are part of the conflict or relative to one of the conflict parties [and are involved].*"

3.9.4 Water Groups

A summary of WUAs is included in Table A5.2

Under current conditions, WUAs and water committees often have responsibility for operating water infrastructure and resolving disputes and conflict. There are more than 30 WUAs and WUGs for users of flood water and groundwater. However, 18 WUAs were scanned during this study. **Almost all of them were established within the Groundwater and Soil Conservation project of the World Bank.**

However, water groups have largely been inactive since the closure of the projects that supported them. A typical story was told by respondents of the WUA in Shibam called the Ghaith Association. It was established around 2007, was supported by the lead project with support including training, and members worked to solve many water-related conflicts – but struggled to keep operating when the project ended. Another focus group discussion participant stated "*The Al-Rabba Association is one of the associations in Shibam district concerned with the flood irrigation system, and its membership includes more than 100 farmers... We try to resolve water-related conflicts amicably, considering our limited capacities in terms of training, logistic support and other capacities*."

Because of limitations, Water Committees and WUAs were ranked as achieving 'moderate' results in water-related conflict management. In order to be effective, members indicated many needs: for more money, better skills, more power to manage water-related conflicts, more time to work on conflict issues, and more partners who coordinate well and together.

3.9.5 Women

In Shibam, similar to other districts, it was noted that women participate in the management of irrigation water by participating in the water committees. However, local and religious traditions limited women's participation in conflict resolution. There was recognition by some respondents that raising the awareness of the importance of women's participation is needed.

In a focus group discussion, women gave information on parts of a project which they could best take part. These activities comprised some activities that have already been planned, but some of which may be new:

- Support to home cultivations such as herbs and vegetables.
- Support to livestock and poultry farming projects.
- Training in agricultural practices based on a scientific and sound manner.
- Greenhouses and related protected agriculture activities.
- Involving women and girls in the cash-for-work program including in cleaning of irrigation canals.

Interestingly, these women made links between improvements in government enforcement of water and related law. They saw that more effective governance would support the water-related conflict management and decision of women and girls.

3.10 Al-Qatn and Shibam Trend/Factor Analysis

This trend analysis aims to synthesise information so far presented on Yemen and Hadhramout into key points that focus on minimising any potential negative project impacts and maximising positive impacts in Al-Qatn and Shibam. The analysis was designed to assist in identifying programming strategies and entry-points as well as potential risks and how to mitigate them based on the circumstances. In order to make this section as relevant as possible, planned project works are referred to. An understanding of these works is primarily drawn from discussions with and information provided by project leads, the FAO document *Assessment of water infrastructure and use: Part 1/3: Shibam and Al-Qatn Districts, Hadhramout,* and the *project proposal* prepared for this larger project from the perspective of the project aim of reducing or mitigating water-related conflict. These documents will no doubt not cover all the work that will be done comprehensively, so this section may recommend approaches or activities that have already been adopted.

The priority recommendations in the FAO assessment report referred to are the same as those given in the assessment report for the Abyan districts, so the following sections will draw on the synthesis for Abyan.

The key challenges highlighted by the assessment report from a water management point of view are poor flood control and management, the decline of groundwater levels due to over-abstraction, increasing water shortage, and poor water quality exacerbated by the abstraction of brackish groundwater. The report noted that other risks including the potential for groundwater pollution, will likely substantially worsen over time.

> Overall, respondents thought that water-related disputes, tension and conflict were getting worse in Al-Qatn and Shibam. "*The situation is getting worse every day due to the absence of the government*." – respondent to the questionnaire

A summary of water-related conflicts reported by participants is shown in Table A5.3.

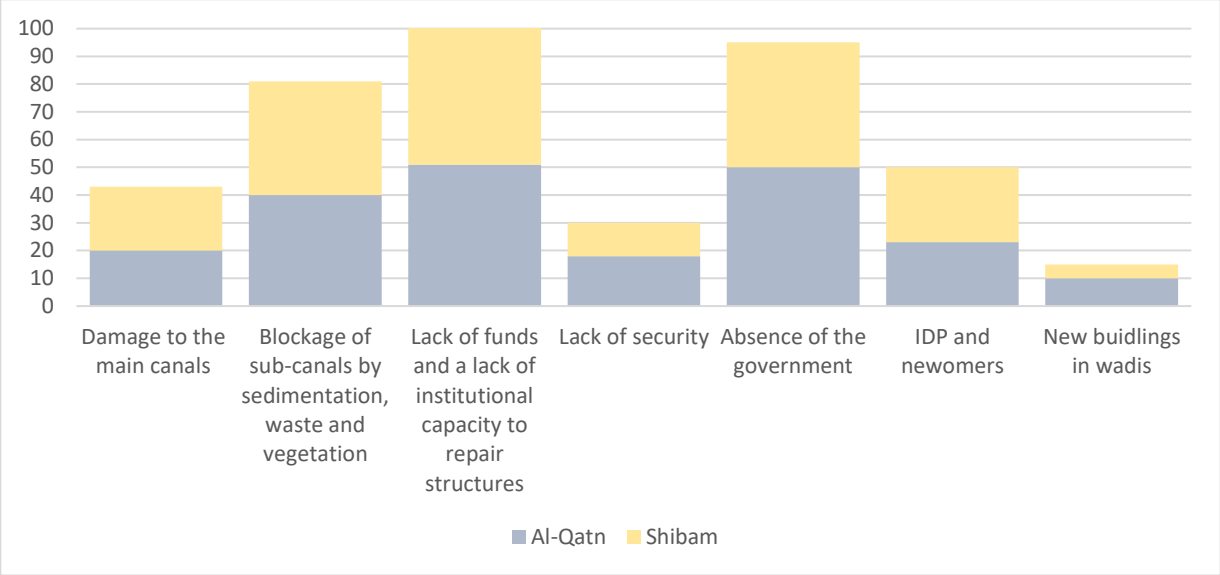
Key informants from Al-Qatn and Shibam identified key drivers of risk. Information has been summarised in Table A5.4 – please see this table for details. These drivers are summarised in Table 3.2 and the number of KIs who indicated each driver is shown in Figure 3.2.

Table 3.2 Summary of drivers of risk in Hadhramout

1. Governance	- Inadequate water policies and strategies
	- Inadequate service provision
	- Unfair decisions on water disputes being made by the government
	- Decisions on water disputes not being enforced
	- Inadequate, or lack of, traditional water management
2. Social Drivers	- Demographic changes
3. Gender	- Water and dispute decisions being made only by men
4. Resources	- Unfair allocation of water
	- Lack of money to manage water
	- Unfair access to water
5. Infrastructure	- Poor or declining quality and conditions
	- Poorly or non-functioning water infrastructure - not doing what it was meant to do
	- Families or villages illegally building water infrastructure

6. Environment	- Worsening water quality
	- Water source running out
7. External Interventions	- Unpopular or unfair projects being implemented by government or agencies
	- Unfair decisions on water disputes being made by courts

Figure 3.2. Key drivers of water-related conflict according to Key Informants- number of KIs, Hadhramout



The drivers of conflict and barriers to conflict resolution determined in the previous study of Hadhramout by FAO and IOM[lx] are shared in Table A5.5. In short, the drivers in that report covered structural, behavioural, attitudinal and historico-cultural drivers. Drivers additional to those found in the fieldwork for this analysis include disputes over lands near torrent pathways; the indifference, and consequent lack of position taking, of the community related to community-harming interventions; and the nationalisation of farmlands and issuance of the Agricultural reform law, that replaced traditional torrent pathways regulating mechanisms.

These drivers, and others that have been raised by other interviewees, project leads and the desktop reviews, are discussed here in terms of first, second and third order scarcity, risks and responses.

3.10.1 First order

In Wadi Hadhramout, the over-extraction of groundwater is severe – with extraction around seven times the rate of recharge. However, the aquifer is extremely large[lxi] and it is important to calculate the economic lifespan of the water remaining in the aquifer and base action on this.

The first order issues identified in Khanfar and Zinjibar are almost all relevant for Al-Qatn and Shibam as well. These include:

- Inoperable infrastructure being key to water challenges and longstanding water-related tension

Infrastructure rehabilitation will be a focus of this project in Al-Qatn and Shibam. Rehabilitation of weirs, protection walls and canals will occur at 112 sites across both districts.

- Past negative experiences in the selection of beneficiaries for external projects and their effectiveness leading to negative perceptions

One key issue raised even more clearly here was the matter of who would benefit directly from this project, and who would not. Despite the reality that one project cannot ensure water for everyone within multiple districts, more than one participant raised this concern. One stated "*This project as explained seems to all categories of community members, but in the reality, this will depend on the proper selection of sites for interventions, the people to involve, and mechanism for implementation of these interventions. If the interventions are not fairly distributed that don't serve all needy farmers, it is expected that conflicts between the targeted and not targeted farmers/communities will arise*."

The related issue of the ineffectiveness of only rehabilitating part of a linked irrigation system was also made strongly. "*It is important to rehabilitate irrigation infrastructures all over the wadi … This is because the irrigation structures constitute a complete irrigation system that can't be operated appropriately unless all the system is restored and rehabilitated*." – respondent to the questionnaire

- The importance of being explicit about what infrastructure will achieve, and supplementing 'hard' DRR solutions with 'soft' ones including the support of village or town level hazard mapping and disaster preparedness and response plans, and an understanding of risk transferred by any prevention and protection works.
- Preparing communities for near future water changes, stresses and shocks by supporting behaviours and management traditions that assume water will never run out.
- The importance of working within best practices including integrated water resource management and basin-wide approaches.
- The necessity of searching for new or alternative water sources.
- The provision of advisory and extension services to change 'business as usual' behaviour to lead to more climate smart and resilient choices, within the relatively narrow options available in rural Yemen.

3.10.2 Second order

It was clear that it would be beneficial to reactivate WUAs in a way that decoupled their survival from project-based funding.

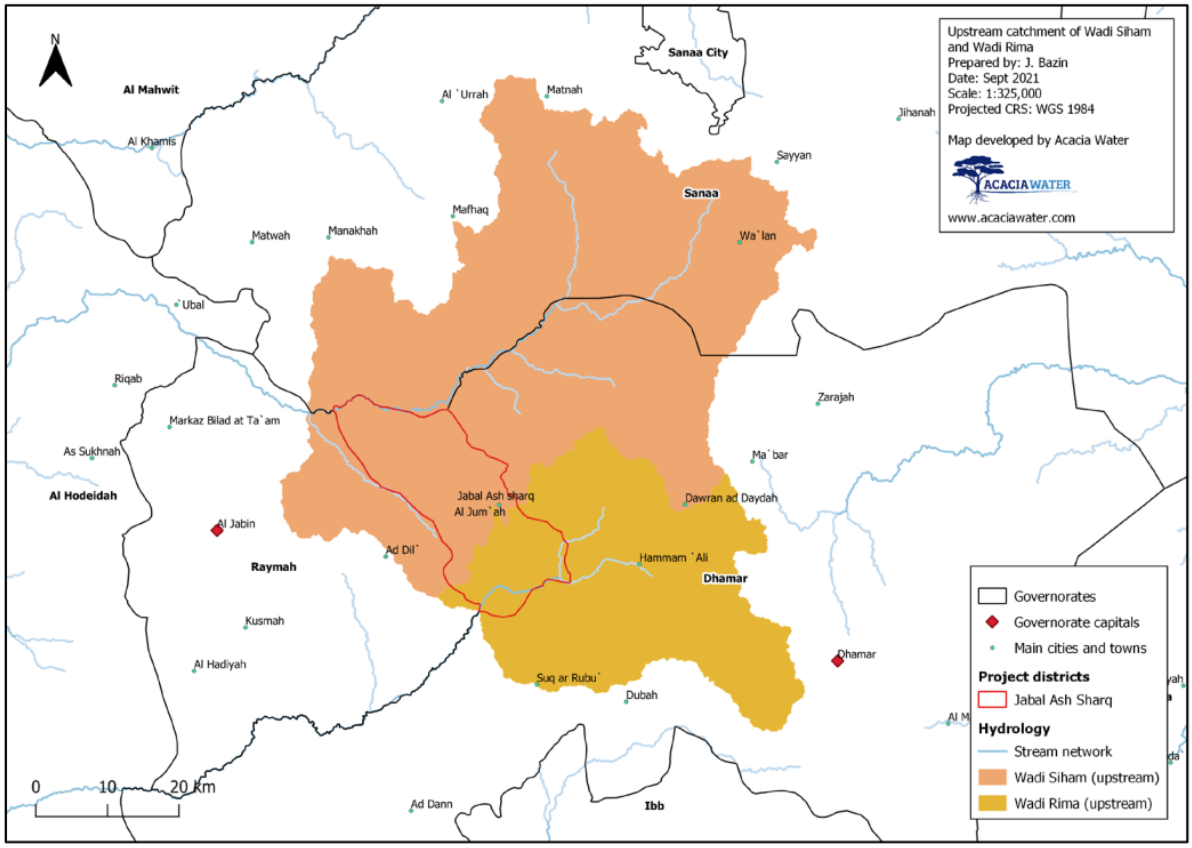
3.10. 3 Third order

In Hadhramout in particular, **the potential strong role of WUAs was emphasised. They were seen to be able to support the role of local institutions dedicated to water resources management, particularly if they were well trained and supported.** This was reportedly at least in part because WUA members are also community members and farmers who know the details of different issues and owners of lands.

There were also suggestions from some respondents that it was important to revive the Al-Rabbah system of irrigation through developing specific organisational structures and tasks for all the community committees responsible for the flood irrigation system. These would include identifying and recording all irrigation canals and the Al-Khala (the traditional irrigation officer) responsible for each irrigation canal and sub-canal. This would need technical and financial support including training on traditional irrigation customs, traditions and norms, and other relevant advisory services.

However, it was not clear how much support this traditional revival would have through the districts. It was also made clear that it could only be successful if committees, WUAs and WUGs were sustainably supported – beyond the end of a project - alongside other groups, which should include youth and women.

3.11 Dhamar Governorate- Jabal Al-Sharq District Overview



Wadi description: Jabal Al-Sharq is one of the districts located in the catchment area of Wadi Siham and Wadi Rema'a, two of the largest wadis in the Tihama Plain in the Al-Hodeidah governorate, with a catchment of about 2,500 km^2. A more focused map is shown in Appendix 6, Figure A6.1. Mean annual precipitation is highly variable both in time and in space, with an average annual rainfall of 407 mm per year across the governorate.[lxii] The Central Highlands drain internally. Surface drainage patterns can be observed, but the wadis are small and often discontinuous. Some of them may remain entirely dry for years. The sloping and highly dissected areas of the east and west contribute to quickly rising flows in the main wadis. Despite steep slopes, a major part of the rainfall is intercepted at the surface and evaporates. This terrain means that farmers have intensively terraced hillslopes in the southern and western parts of the Governorate.

Recent modelling concluded that with climate changes, there has been an increase of temperature in the summer and decrease in the winter, as well as a decrease the amount of rainfall, with increasingly delayed seasonal rains and an increased frequency of the dry cycle.[lxiii]

Groundwater Description: The number of wells in Dhamar Basins is about 3,200, with an average depth of about 180 m. Across Dhamar governorate the proportion of agriculture that is irrigated by groundwater as compared to surface water and rain is increasing – on average, from about 27 and 73 per cent from groundwater and surface water respectively in 2013, to 39 and 61 per cent respectively in 2015.

Analysis confirms a water balance deficit amounting to twice the natural groundwater recharge rate. Local groundwater depletion could lead to local groundwater decline in the order of 0.5 m/y, assuming that the losses to groundwater and surface water are 20 per cent. In other studies in Dhamar, it was estimated that groundwater tables have declined in the last 40 years at a rate of 2.0 to 2.5 m/year, and that if there is an annual increase of 2 per cent in water abstraction, which is normally expected in a developing economy, it has been estimated that the shallow groundwater will be exhausted within 30 years.[lxiv] There are some concerns about water quality: although data are scarce, one study found Dhamar Basin groundwater to have excessive nitrate levels, at 100 mg/l.

Agricultural water resources in Jabal Al-Sharq: It is estimated that 3,412 ha of agriculture is irrigated by rain (2,431 ha), springs (755 ha), wells (158 ha) and floods (19 ha) or other sources (42 ha).

This study did not receive permission to travel to Dhamar. Combined with the relative lack of accessible information published for the district, the analysis presented here is limited.

3.12 Jabal Al-Sharq Context

A report by Acacia Water, titled *Water Availability in Yemen* and published in 2021, wrote that the Jabal Al Sharq District is part of the Wadi Rima and Wadi Siham basins, both of which originate in the western highlands and drain in the Tihama plain. A map of land use in the upper catchments is shown in Figure 6.1.

Acacia Water noted that these wadis, and especially the upland areas, have been poorly studied, which makes analysis challenging. They do note that agricultural activities are clustered around a few localities only, with the majority of the district comprised of shrubland (>50 per cent) and grassland (35 per cent). A recent study identified the expansion of qat cultivation areas in the Western mountains, most probably increasingly relying on groundwater reserves, though on-the-ground monitoring data to support this is unavailable. One difficulty for farmers is that throughout Dhamar, the depth to groundwater is highly variable, and many drilling attempts have resulted in dry or poorly productive wells.

Hydrological analysis done by Acacia Water confirms a water balance deficit amounting to twice the natural groundwater recharge rate. Local groundwater depletion could lead to local groundwater decline in the order of 500 mm/y, assuming that the losses to groundwater and surface water are 20 per cent.

Acacia Water were unable to find any information on the water supply for domestic use in the upper catchment area of Wadi Siham and Wadi Rima, so the significance of competition between domestic and agricultural water is unknown.

Acacia water have presented a table of recommendations for strengthening water management across Wadis Rima and Shibam. As water management can contribute to decreased water conflict and peaceful water sharing, these recommendations are presented in Table A6.1.

The *Assessment of water infrastructure and use: Part 3/3: Jabal Al-Sharq, Dhamar* report by FAO reviewed conditions in the district, which are summarised here.

Overexploitation of groundwater in several parts of the Montane Plains is seriously threatening domestic water supplies and groundwater-fed irrigation. If over-exploitation is not stopped within a reasonable time frame, wells will dry up, costs of pumped water will become higher, and eventually, some aquifer zones will be exhausted. To detect such problems in an early stage, groundwater levels should be monitored; next, adequate measures should be designed and implemented to control groundwater abstraction in the Montane Plains.

Conservation of hill-slope terraces deserves special attention. The rural labour force has become much more mobile than it used to be. This means that necessary maintenance of the terraces during and after the rainy seasons is neglected to some extent, which may lead to permanent losses of valuable land. It has been also noted that an experience in water harvesting and management, as well as the maintenance of the irrigation structures systems, have nearly disappeared due to the inability of the community to finance them over the last decade. The MAI also lacks the funds and resources to support these activities. This situation has led to the deterioration and damage of most of the water harvesting systems such as terraces, harvesting tanks, ponds, and wadi bank protection.

Notably, the local communities look to external support or donor funds. As yet though, attempts to keep infrastructure in good repair are strongest within the framework of existing traditions. Traditional approaches consider community water allocation regulations, water rights, and community-based conflict resolution customs. Restoration of such proven approaches gives back the maintenance and management responsibilities to the local communities and farmers, using their

indigenous knowledge, with some technical improvements that enhance the sustainability and stability of water infrastructure against climate fluctuations and unexpected floods.

Other studies reinforce this point. One noted that traditional rules around groundwater extraction were active: Taher et al. reported that, for example, in Hejraht al-Asham, Jabal al-Sharq, local leaders restricted well drilling and created a protection zone.[lxv]

Another study cautioned against seeing community solutions as a panacea, however. In 2008, Policy and Operations Evaluation Department (IOB) of the Netherlands Ministry of Foreign Affairs wrote "the population of villages in the rugged mountains of Dhamar have what outsiders would consider an independent attitude. The challenges of community institution building, for such purposes as the governance of water supplies, are particularly severe in this governorate."[lxvi]

In one interview of a key expert, drivers of water-related conflicts involved disputes over inheritance of lands and the related wells when a father passed away. There are also ongoing disputes related to wells that are shared between farmers, who contest which farmer has which share of water during different seasons.

Although the main drivers of conflicts such as these are water scarcity and poverty, other contributing factors were seen to include a lack of awareness of laws – local and central; personal interest; a lack of knowledge on the part of parties to the disputes; and the absence of the state in the current war condition.

3.13 Jabal Al-Sharq Stakeholder Analysis

In Jabal Al-Sharq, the NWRA and other government bodies were seen by key informants to have poor results related to water-related conflict management. Local authorities, security forces and courts were seen to have moderate results and local leaders and community figures to have largely good results.

The MAI was perceived to not contribute to efficient water management and conflict resolution. The contributions of the MoWE were seen to be weak and the NWRA and local authorities to be moderate. Tribal and local leaders were also seen to have moderate contributions.

The reasons for weakness in these bodies reflected those given in other areas of Yemen, and in Jabal Al-Sharq, the most needed improvements or resources for government bodies were seen to include:

- Technical and financial support including capacity building and training.
- Support from security and government authorities in the enforcement of water law and other relevant laws.
- Awareness and extension services including training and education of farmers in areas related to efficient use of scarce water resources.
- Reactivating and providing technical and financial support for water monitoring activities and programs at district and basin level.

For local Sheiks and leaders, it was recommended that they receive training in how to consolidate central water laws with the local customs and laws around water.

A list of Water User Associations in Jabal Al-Sharq is shown in Table A6.2.

3.14 Jabal Al-Sharq Trend/Factor Analysis

This trend analysis aims to synthesise information so far presented on Yemen and other districts into key points that focus on minimising any potential negative impacts and maximising positive impacts in Jabal Al-Sharq. An understanding of these works is primarily drawn from discussions with and information provided by project leads, the FAO document *Assessment of water infrastructure and use: Part 3/3: Jabal Al-Sharq District, Dhamar* and the *project proposal* prepared for this larger project from

the perspective of the project aim of reducing or mitigating water-related conflict. This analysis cannot be completed due to the limited fieldwork allowed.

The main challenges of the target areas identified in the FAO assessment report are the decline of groundwater levels due to over-abstraction, increasing water scarcity, poor flood control and management, and poor water quality. Other risks including the potential for groundwater pollution, are likely to substantially worsen over time.

69 structures will be built in Jabal Al-Sharq.

In the district, the mitigation measures that focus on water infrastructures and sub canals in Jabal Al-Sharq can be categorised into five main types of infrastructure interventions for the project:

- Rehabilitation/ reconstruction of terraces.
- Rehabilitation of sub canals.
- Rehabilitation/ construction of protection walls.
- Construction of new harvesting tanks.
- Rehabilitation of old harvesting tanks.

The beneficiaries will be identified and selected using the same process as in the other districts, with a similar priority placed on forming or re-forming water use associations.

Many issues and points from previous districts appear to be relevant in Jabal Al-Sharq, including low capacities and presence of leaders and institutions, non-functioning spate water irrigation structures, overexploitation of groundwater and poor data availability.

4. Recommendations

Drawing on the whole content of this report, several recommendations are synthesised.

Overall, activities designed under this project are well considered and are well suited to building resilience and peaceful water sharing across all districts.

The following recommendations would not require major restructuring of any part of the projects. However, if taken up, they would require additional time to plan, some reconceptualisation, and some re-prioritisation.

1. **Which areas of the current project interventions might need to undergo revision given potential risks of fuelling conflict around water?**

   i. If water sharing and distribution is changed, local and traditional agreements and rules may also need to change. However, for international projects, revising traditional rules and plans often only happens after the first disagreement occurs. Best practice would be to consider this at the design and preparation stages. Initial implementation could include sitting with key stakeholders, including downstream, upstream and beneficiary farmers to discuss any updates or adjustments to traditional water sharing law that may be needed after interventions are complete.

      Revising traditional rules is discussed in Section 2.1.8.

   ii. No flood mitigation work is ever proof against every flood. If it has not already been done, it will be important to document the specifications of all works clearly, and then inform each community about the expected risks. For example, are new structures designed to prevent impacts from a one-in-ten-year flood, or a one-in-one-hundred-year flood? The 'hard' works of gabions and so on will inevitably fail during a flood that is larger than the return that they were designed for, and if local people are not prepared for this, it may create dispute or dissatisfaction after an extreme event.

      In this context, it is important to support each community with 'soft' solutions, including community-led disaster preparedness and response plans. If not already included, adding this aspect to the project would improve community-level preparedness for a disaster, including floods and droughts, and raise awareness of hazards and risks. Hazard mapping in particular can also stimulate stakeholders to add their own efforts to those of project staff and partners to reduce their own risks and protect their assets. If this occurs, it is likely that project agencies will not be well regarded in the future by some community members, with future project proposals creating more tension or dispute.

      Enhancing flood protection infrastructure is discussed in Section 3.6.

2. **Which areas of project interventions are recommended to be strengthened, given their potential to exploit opportunities for stability/peace?**

   i. Technically and socially, water projects should not only consider the relatively small area of intervention, but the whole hydrological system.

      Upstream and downstream competition and disagreement is widespread in Yemen. For surface water, water that is captured affects the availability of water downstream. The further upstream an intervention is, the more downstream users may be affected. It is therefore important for this project to clearly articulate to all stakeholders what the hydrological impacts of activities will be, focusing on downstream water availability and accessibility.

Further, water resource monitoring should be put in place not only in the locations of interventions, but downstream from them, in order to track any detrimental changes that may occur so they can be mitigated over the term of the project and beyond.

This priority reflects an IWRM or basin-wide approach that is required and endorsed by government policy.

Upstream and downstream dispute is discussed in Sections 2.1.2 and 3.6, as well as other parts of Section 3 for different districts.

ii. Community-based dispute resolution can decrease the risk of water-related violence. However, the challenges in empowering, sustaining and maintaining these structures are significant in Yemen. In this project, water user groups, associations and so on are a focus (collectively referred to here as WUGs), together with conflict resolution committees.

Secondary, economic water scarcity issues are particularly weakly addressed in this context. This is partly because throughout Yemen, primary scarcity is a very significant issue and must be dealt with first. It is also because economic water issues are challenging in the context of widespread poverty and lack of national funds. However, unless WUAs are economically self-sufficient, they will not be able to contribute to the maintenance of many of the gains this project will deliver.

- WUGs and other groups typically deactivate when projects close, and ways to prevent this must be addressed transparently from the beginning when they are re-activated or formed. Project documentation states that "**institutional financial sustainability** will be critical for the continuation of the implementation. This will be established together with the users in which payment for services will be justified and supported by the basin committee's relevance and service delivery". It is recommended that clearly defining these plans are key, and that clear detail on how WUAs will be sustained by payments beyond the end of the project are shared with communities, so they have confidence in the longevity of positive project impacts and are prepared to pay.

  Sustaining WUGs are discussed in Section 2.1.8 and noted in Section 3 in different district discussions.

iii. Legal force alone will not succeed in bringing necessary changes in local attitudes and knowledge. The provision of irrigation advisory and extension services for WUAs and farmers to both enhance crop yield and maximise water use is highlighted in the project proposal, however, little information is available about what other messages should be conveyed relevant to water-related conflict, and how extension will be linked to conflict mitigation. If local institutions are to be mobilised to solve local water disagreements, the foundation for their actions should be an awareness of how much water they have, where is it going, and what current trends in water availability are – for example, what the projected life of the locally utilised aquifer is. Supporting agricultural extension to issues that might change behaviour from 'business as usual' to more climate smart and resilient action, albeit within the relatively limited options available in rural Yemen, will be critical at local level. This extension could also emphasise the need for careful use of solar power in the context of the long-term risks versus the short-term gains of groundwater overexploitation. Extension and training implemented sooner rather than later may be useful to settle any disgruntlement or disputes made early in the timeline.

iv. There must be additional efforts to turn awareness raising and extension into behaviour change. If not already completed, there may be opportunities to establish social mobilisation teams, and training them as "champions" or "insiders" for water peacebuilding. Less formal that WUGs or conflict resolution committees, these teams could include youth, women and girls.

Extension, insiders and peer learning are discussed in Section 2.1.8 and Section 3.6.

v. Improving irrigation efficiency is a focus of the Government and many agencies and is included as a priority in this project. Although it is an important component of peaceable water saving and sharing, technological solutions such as drip irrigation can be difficult for local farmers to use and maintain in Yemen. If not already considered, some methodologies that have been successful in the past:

- Implement the lowest technology solutions that will fulfil the aim of the intervention.
- Before introducing new technology, start by mapping and developing the support available- including spare parts supply chains and mechanical skills training.
- Ongoing support services including dedicated, regular expert visits, farmer field schools and peer to peer learning and continuous knowledge exchange.
- Supporting technology with activities aimed at behaviour change. For example, experience shows that improved water efficiency can lead farmers to expand their irrigation coverage which again increases the demand for water, with no total benefit.

Irrigation technology is introduced in Section 2.1.6.

3. Are there areas of intervention that should be included but are not yet considered in the current Project document to ensure greater effectiveness and/or impact of the project?

i. It would be useful to understand how the project activities will contribute to IWRM and basin-wide planning monitoring, research and knowledge improvement. IWRM is a national priority for peaceable water management, but more knowledge is needed to be able to implement it. Some activities that may be emphasised as supporting an IWRM or holistic framework could include:

- Updating water resources knowledge with research taking place alongside implementation. An understanding of basin-wide hydrology is necessary to plan infrastructure and other interventions – poor planning can lead to ineffective water interventions, as has happened in the past, and disgruntled beneficiaries.
- It is not clear whether supporting the NWRA to repair existing but non-functioning **hydrometeorological monitoring stations is already planned as part of reviving early warning systems,** but if not, it could be a way to improve coordination relations not just with the NWRA but with local stakeholders, if locals are provided with the information regularly.
- Regular monitoring of surface and ground water quality in the project areas could also avoid any disgruntlement in the future if water supplied by project infrastructure is found to be below safety standards. In addition, it is an aim of this project to improve water quality, so monitoring that supports IWRM policies, and water monitoring capacities that extend beyond the life of the project, may be well received and improve the perception of the project. Ensuring satisfactory levels of key water quality indicators would follow a precautionary principle, and can be relatively cheap to equip.
- **Water monitoring could be a task that female and young members** of WUAs could be trained to undertake, which will enhance other gender and age aims of the project.
- It is not clear where early warning systems will be established, but including systems in the main wadis of each district will be important technically.

Monitoring and technical assessment are introduced in Sections 2.1.1, 2.1.2 and 2.1.7 and discussed at district levels in Section 3.

ii. In Yemen, there is often a weak overlap between public and private water management. This can lead to different types of water-related conflict issues between spate irrigation and groundwater irrigation, and different mechanisms for conflict resolution and mitigation depending on the source of water. It is not clear how well this is recognised and planned for in the project.

   - Related to this, both central and traditional water law is often weaker for groundwater, and central and local rules may conflict. For example, under water law farmers are not allowed to drill wells without central permission, but they may be given permission under local water agreements. This leads to the need for every project to consider how they will recognise and potentially deal with "illegal" water structures, and how project managers work with potentially conflicting local agreements. Declaring this transparently from the beginning with all stakeholders can avoid creating conflict and building peace with all stakeholders.
   - This project aims to rehabilitate shallow water wells, which in some locations may straddle the public-private divide. Leveraging work with shallow water wells may help to enhance dialogue between different stakeholders at a local level.

Private and public issues are introduced in Sections 2.1.2 and 2.1.7.

iii. Although infrastructure rehabilitation and repair are critical, it is clear that existing water resources in Yemen cannot meet rising demand equitably and, likely, peaceably. Therefore, the search for alternative or 'new' water sources is important. New water may include rainwater or recycled wastewater for irrigation. The treatment of domestic or irrigation wastewater in decentralised, low-technology and nature-based processes that allow less contaminated water to be reused for agriculture is conceptually feasible.

   Alternative water sources are introduced in Section 2.1.3 and noted in Section 3 in different district discussions.

5. Summary and Recommendations: Women and water-related conflict

Two recommendations relate to women and water-related conflict. To preface these, a summary of findings on this topic drawn from primary data collection in each district is shown in Table 6.1.

In most districts, women were reported to be involved in decision making in the water user association or similar groups. Women's' groups adopt and implement female-related activities within the WUA and supervise some female-related activities such as training and awareness raising, and sometimes financial management.

Within government offices, women were employed as professional, technical and administrative staff in agricultural and water-related roles.

Some challenges were identified by female participants in interviews or focus group discussions, mostly related to WUA activity. These points are summarised and potential solutions that the women noted are paraphrased in Table 6.1.

Table 6.1: Summary of issues raised on women and water-related conflict at local levels

Issues highlighted by female stakeholders	**Received perspective, opinions and advice**
Local and religious traditions limited women's participation in water-related conflict resolution.	Women participate in the management of irrigation water by participating in the water committees. Expanding and supporting their membership and voice in these fora are important priorities.
	Raising the awareness in communities of the importance of women's participation is needed.
Women may prefer, or find it more comfortable, to begin with certain tasks, roles and areas of action within a project.	Water-related initiatives that include home gardens, cash for work, awareness campaigns and agriculture extension services and so on build on past experiences of women and girls. They could be emphasised as initiatives used to engage women and could be expanded into non-traditional areas over time.
More effective implementation of water laws, bylaws and regulations that support gender equity	In efforts that link to institution capacitation and legal strengthening, aspects that support gender equity can be emphasised.
Challenges in working within WUGs.	Raising the awareness in communities of the importance of women's participation, and the contributions they already make, is needed.
	Involving central institutions, including potentially female professionals, in coordinated and collaborative implementation, training and awareness raising in projects at local level.
	Ensure women can afford to attend meetings, or are not financially disadvantaged by doing so.
	Support women's attendance at meetings through childcare arrangements or other labour support incentives.

Other challenges were identified during the desk review. In Section 1.2.18, discussion from the FAO concluded that there has been a slow and subtle change in the roles of women in rural livelihoods, with women more often now earning money and continuing to contribute significant, though usually unpaid, agricultural labour. As the role of women changes, there may be more opportunities for them to be more, and officially, included in water-related decision making. These roles could be enhanced in formal institutional settings as well as community-led or informal water use and management.

However, change can be slow. For example, although respondents highlighted that women did work in a professional capacity in central institutions, literature shows that there are relatively few senior female professionals at national, governorate or local level who could demonstrate their abilities in working with water-related conflict.

Based on these and related points, two final recommendation areas follow. Some of these are short as they reflect points already made in previous recommendations.

5.1 How to better enhance women's contribution to WUAs and water-related conflict resolution.

i. The activation of new, or adjustment of existing, WUGs to require 30 per cent women's participation and 20 per cent female engagement on any boards is noted in the project proposal as a new initiative in Yemen, and may also impact the way in which WUAs function or are

perceived to work. It may become a potential point of dissatisfaction for some parts of the community. Consideration of how to best raise awareness of the positive aspects and, anticipated positive outcomes of this adjustment should be emphasised sensitively by project staff and partners who are also well briefed on the topic.

Innovating WUG gender membership is discussed in Section 3.6.

ii. Women could be valuable project "insiders", peer facilitators or social mobilisation leaders (see recommendation 2.iii).

iii. Water monitoring could be a task that female and young members of WUAs could be trained to undertake (see recommendation 3.i).

iv. Awareness raising at local level is needed to increase recognition of the fact that women can play a role in water-related conflict reduction and mitigation. Several key experts noted that this falls within the mandate of the NWRA. Training, capacitating and resourcing local NWRA staff to take on this role may be beneficial, particularly if both male and female staff could be assigned to this.

The roles of NWRA are presented in Appendix 3 and discussed throughout this report.

v. It is clear that **women will be involved in CfW.** It is equally clear that training must be provided before unskilled persons can undertake CfW activities. This training may also provide longer term confidence in new skills. However, it is not clear from project documentation if female trainers and facilitators are typically provided to ensure female CfW beneficiaries are comfortably supported.

CfW challenges are discussed in Section 2.1.6 and examples of contributions from women's organisations in mediation of CfW conflicts are included in Section 3.2.

5.2 How could the proposed activities take an innovative approach in empowering women to play role in resolving conflicts to achieve community-born peace and stability?

ii. Female respondents identified several challenges in contributing to WUAs in one district, and these issues are likely to reflect challenges in all districts within this study based on other key reports done in Yemen:

- Lack of awareness at community level of how women may play a role.
- Weak awareness of women's contributions and activities by central, regional and district institutions.
- Absence of the state and lack of larger projects and activities in the women's sector at local levels.
- Poverty and poor family financial situations.
- Lack of time. Respondents reported that 60 per cent to 70 per cent of agriculture work is carried out by women in addition to their responsibilities as housekeepers, breeding livestock, taking care of their children and other household obligations.

If women are expected to play significant roles in WUAs and other groups, there must be agreement amongst all members as to how these challenges will be eased. For example, there may need to be changes in when, where and how meetings are run, the provision of child care during meetings, and flexibility in how perspectives and opinions are received and discussed in the forum.

Women's challenges in committing time to WUAs is presented in Section 3.5.

iii. When providing training and capacity building for reactivated or newly formed WUGs and conflict reduction committees, if it is not already being done, it would be useful to ask female members if they wish for specific training that may be additional to or different in some aspects

from that provided to the men.

Examples of female preferences are noted in Section 3.9.

iv. Outside formal groups, there may be opportunities to establish social mobilisation teams, and training them as "champions" or "insiders" for water peacebuilding. Women and girls could be trained as social mobilisers in order to contribute to water-related conflict mitigation in a formal or informal roles. This may allow them to contribute to peaceful water solutions despite some barriers to involvement in formal processes. As part of social mobilisation duties, training on conflict mediation may become more socially acceptable.

Extension, insiders and peer learning are discussed in Section 2.1.8 and Section 3.6.

6. Summary and conclusions

A discussion of physical, economic and structural water scarcity in Yemen has demonstrated that the project *Resilience Programme in the Irrigation and Agricultural Sector* has a strong component aimed at reducing water-related conflict and improving water management through awareness-raising and disaster preparedness at the local level. Additional strategies to reduce conflict have been identified throughout project documents and have been highlighted and discussed in this document.

Drawing from published lessons learned, project workshops, key informant interviews, focus group discussions and questionnaires directed at a range of stakeholders, this report has present recommendations for consideration.

While no foundational changes or redesign is seen to be needed, the project may benefit from some enhancements and adjustments, as recommended.

In the conflict-affected, poverty-ridden and complex context of rural Yemen, it is not possible to guarantee that no water-related conflicts will be exacerbated by international projects. However, in implementing the *Resilience Programme in the Irrigation and Agricultural Sector*, it is concluded that an outcome of more peaceful water sharing is far more likely in all project districts.

Appendix 1: Methodology in detail

The methodologies include foundation tasks, and primary and secondary data collection.

Two foundation tasks will be undertaken.

Foundation Task: Preliminary stakeholder mapping

A map of stakeholders derived from existing documents including UN reports, water assessments, research and government policies and strategies was developed. It was then supplemented by knowledge from UNDP, FAO, KfW and other partners. This provided a map that all partners contributed to and agreed on. It indicated some key characteristics of each stakeholder group, including whether they are likely to hold quantitative data related to water and conflict and which data will be collected from them. It was an important document because it helped to identify which actors need to be engaged with and why, and which actors were critical to the success of the analysis as a whole.

Foundation Task: Systematic discussion with experts and partners

i. **Advisory group meetings**

An informal advisory group, comprised of FAO, UNDP and KfW staff informed the analysis design and implementation through multiple meetings and revisions of draft data collection tools before fieldwork took place.

After foundation tasks were complete, data collection and analysis tasks began.

Secondary data collection and analysis

i. Desk Review

A desk review of existing documents related to conflict and water including government, UN, technical and analysis reports was undertaken. Topics of documents collated included water infrastructure, use and management, local conflict resolution mechanisms and other key issues. The key documents reviewed for this analysis are listed in Appendix 2.

Primary data collection

Primary data will be collected at governorate, district and village/water user group levels when gaps in secondary data are identified.

Qualitative data at community level were collected via surveys, questionnaires, focus groups and key informant interviews (KIIs). Different methods were employed for different reasons.

i. Questionnaires

Qualitative questionnaires enable the same questions to be asked of different persons in order to systematically build a comprehensive representation of fact, perception, and awareness on key topics. In this analysis, open and multichotomous[10] questions were asked of different categories of persons to gain nuanced information and perception of the context, drivers of, and trends in local, water-related conflict. The categories of persons interviewed using questionnaires in this analysis were:

a. Category A: Questionnaire 1, for project staff (UNDP and FAO) and Implementing Partners in HQs and Target Districts and INGOs.

b. Category B 1: Questionnaire 2, for farmers and other beneficiaries and community members.

[10] Questions of this type offer a range of possible answers, similar to a multiple-choice test.

c. Category B 2: Questionnaire 3, for project focal points located in the study areas, local mediators, committees, WUAs, WUGs, WWUGs, NGOs, Sheikhs, Aqels, etc.

d. Category C: Questionnaire 4, for Government officials in (MAI, MWE, NWRA, etc. and their offices in targeted governorates and districts) as well as governor's offices.

The number of persons interviewed in each district is shown in Table A1.1. The proportion of men and women interviewees or discussants are shown in Figure.

Questionnaires were undertaken in person between January and February 2022.

Questionnaires were supplemented by conflict scan forms. When a water dispute, argument or disagreement was mentioned, the enumerator completed to this form to ensure that all details of each experienced conflict were recorded in-depth.

Table A1.1: Sample sizes for questionnaires, Focus Group Discussions and Key Informant Interviews

	Sana'a		Aden		Hadhra-mout		Shi-bam		Al-Qatn		Abyan		Khanfar		Zinjibar		Dhamar		Jabal Al-Sharq		Total	Total Disaggre-gated	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M&F	M	F
Project Staff	4	2	2	1																	9	6	3
Donors	2																				2	2	0
IPs	2						1		1				1		1						6	6	0
Focal points							1		1				1		1						4	4	0
Farmers/ Beneficiaries							6	2	5	5			5	5	5	5	0[11]				38	21	17
Parties to identified conflicts							3		3				3		3						12	12	0
Government staff	2		4		3	1	3	1	1		5	1	1		1		2				25	22	3
Local council					1		2		1		1		1		1						7	7	0
Local Committees							0	1	1				1		1						4	3	1
WUAs							2	1	2	1			1	1	2						10	7	3
WUGs							2		2	1			1	1	1						8[12]	6	2
WWUGs								2		2	1										5	1	4
FGDs Men							17		14				6		16						53	53	0
FGDs Women								5		12				9		7					33	0	33
Local influencers							1		1				2		2	1					7	6	1
Other Stakeholders (NGOs)	1		1		1						1										4	4	0
Total	**11**	**2**	**7**	**1**	**5**	**1**	**45**	**5**	**46**	**8**	**7**	**1**	**32**	**7**	**41**	**6**	**2**	**0**	**0**	**0**	**227**	**160**	**67**
Conflict Scan form Mode 2															1	2					3	1	2
Conflict Scan form Mode 1																		9			9	0	9
TOTAL	**11**	**2**	**7**	**1**	**5**	**1**	**45**	**5**	**46**	**8**	**7**	**1**	**32**	**7**	**42**	**8**	**2**	**9**	**0**	**0**	**239**	**161 (67%)**	**78 (33%)**

[11] Permission to visit Dhamar farmers was not provided

[12] Some people in the FGDs participated as members of WUAs

ii. Focus group discussions

FGDs drew out respondents' attitudes, feelings, beliefs and experiences as a whole group, thus allowing answers to 'how', 'why' and 'who' questions in detail and in a participative forum. FGDs are particularly useful when there are power differences between the participants and decision-makers, and the method lends itself to examining sensitive subjects such as gender roles and conflict in more depth, as the facilitator can use certain techniques to discuss such issues without personalising them. In this analysis and in accordance with local customs and social norms, every effort was made to run separate women's and men's FGDs and have female facilitators at women's FGDs. The number of men and women who participated in FGDs is listed in Table A1.1 And show in Figure

iii. Workshops

Short workshops were run with project partners. The aims of the workshops were first, to gather information needed to complete key components of the water-related conflict analysis as part of the project Resilience Programme in the Irrigation and Agricultural Sector. Key components are a context analysis and trend/factor analysis, both focused on the drivers of water-related conflict in the project areas. The workshops also aimed to build an understanding of any gaps or weaknesses that may have occurred in the design phase when considering the importance of utilising a conflict sensitivity approach. Finally, the workshops aimed to better understand predicted project impacts, which actors could limit project impacts, and which actors who contribute to peace in the project areas should be leveraged or engaged more. This included a need to better understand water-related conflict and peace drivers in each project area. These aims were important contributions to the final output of the analysis, which is a set of recommendations for project adjustments that ensure any potential negative impacts on water-conflict dynamics, trends and factors are minimised and the widest possible range of positive impacts are maximised.

The workshop methodology follows the Facilitation Guide from the FAO Programme Clinic: designing conflict-sensitive interventions and has benefited from advice from FAO specialists.

Appendix 2: Documents and databases referenced in desk review

1. Acacia Water, 2021. Water Availability In Yemen: Final Report. Available at: https://en.acaciawater.com/nw-29143-7-3937413/nieuws/review_of_yemens_water_resources.html?page=0
2. ACAPS Analysis Hub, 2021. Yemen: Effects of the fuel embargo at Al Hodeidah port on fuel supply dynamics and fuel prices, Thematic Report, 17 August 2021. Available at: https://www.acaps.org/special-report/yemen-impacts-fuel-dynamics-and-fuel-price-structures
3. Embassy of the Kingdom of the Netherlands, 2005. Institutional and sectoral analysis of the water and environment sector in Yemen. Sana'a, EKN.
4. FAO 2021, Aquastat. Available at: https://www.fao.org/aquastat/statistics/query/index.html?lang=en
5. FAO 2021, Aquastat – FAO Country Profile Yemen. https://www.fao.org/aquastat/en/countries-and-basins/country-profiles/country/YEM
6. FAO, 2021. Global Information and Early Warning System (GIEWS) Country Brief Yemen https://www.fao.org/giews/countrybrief/country.jsp?code=YEM
7. FAO and IOM 2020, Context Analysis Report in support of the project Water for Peace in Yemen: Strengthening the role of women in water conflict resolution and climate change mitigation;
8. FAO and UN-Water 2021, Progress on Water-Use Efficiency – 2021 Update. December 2021. https://doi.org/10.4060/cb6413en
9. Gleick, P., 1996. Basic Water Requirements for Human Activities: Meeting Basic Needs. Water International, 21, 83-92.
10. Hassan, M. 2018. Assessment of water resources in Dhamar Governorate, Yemen Republic
11. Hellegers, P. et al. 2008. Incentives to reduce groundwater extraction in Yemen. LEI Wageningen UR, The Hague
12. Homer-Dixon, T. 1999. Environment, Scarcity and Violence, Princetown, Princeton University Press.
13. IOB - The Policy and Operations Evaluation Department of the Netherlands Ministry of Foreign Affairs, 2008, 2008. Support to Rural Water Supply and Sanitation in Dhamar and Hodeidah Governorates, Republic of Yemen, IOB Impact Evaluation No. 315, The Hague.
14. Ministry of Agriculture and Irrigation, 2012. National Agriculture Sector Strategy and Investment Plan 2012-216
15. NWRA - National Water Resources Authority, 2008. National Communication and Awareness Strategic Programme for Integrated Water Resources Management. Ministry of Water & Environment, Republic of Yemen.
16. Ohlsson, L. & Turton, A. R. 2000. The Turning of a Screw: Social resource scarcity as a bottle-neck in adaptation to water scarcity. Stockholm Water Front 1, 10-11.
17. The Hague Institute for Global Justice, 2014. The Political Economy of Water Management in Yemen: Conflict Analysis and Recommendations
18. The International Food Policy Research Institute (IFPRI), 2011. Climate Change and Floods in Yemen. Impacts on Food Security and Options for Adaptation. IFPRI Discussion Paper 01139. Washington D.C. Available at: http://reliefweb.int/sites/reliefweb.int/files/resources/ifpridp01139.pdf

19. The Hague Institute for Global Justice, 2014. The Political Economy of Water Management in Yemen: Conflict Analysis and Recommendations

20. Unicef, 2021. Humanitarian Situation Report Mid-year; Reporting Period: 1 January 2021 - 30 June 2021 https://reliefweb.int/report/yemen/unicef-yemen-humanitarian-situation-report-1-january-30-june-2021

21. UN Sustainable Development Group (UNSDG), 2016. Conducting a Conflict and Development Analysis Tool https://unsdg.un.org/resources/conducting-conflict-and-development-analysis-tool

22. UN-Water, 2020. SDG 6.2.1a: https://www.sdg6data.org/country-or-area/Yemen

23. Wolfe, S. & Brooks, D. B. 2003. Water Scarcity: An alternative view and its implications for policy and capacity building. Natural Resources Forum, 27, 99–107.

24. World Bank, 1997. Towards a Water Strategy: An Agenda for Action. Report No. 15718-YEM

25. World Bank, 2021. World Bank Data – Yemen. Available at: https://data.worldbank.org/indicator/SP.POP.GROW?locations=YE

26. WHO, 2021. Country files for SDG 6.3.1: "Proportion of wastewater safely treated" https://www.who.int/teams/environment-climate-change-and-health/water-sanitation-and-health/monitoring-and-evidence/water-supply-sanitation-and-hygiene-monitoring/2021-country-files-for-sdg-6.3.1-proportion-of-water-safely-treated

27. WWAP (World Water Assessment Programme). 2012. The United Nations World Water Development Report 4: Managing Water under Uncertainty and Risk. Paris, UNESCO

28. Zabara, B, 2018, Enhancing Women's Role in Water Management in Yemen. Brief 9, CARPO – Center for Applied Research in Partnership with the Orient.

Appendix 3: Stakeholders in the Yemen water sector

Source: Table 5.1: Stakeholders in the Yemen water sector

From: The Hague Institute for Global Justice, 2014. The Political Economy of Water Management in Yemen: Conflict Analysis and Recommendations, pp 80-84

The **comments** column is filled with perspectives gained in this analysis through fieldwork synthesis. Some stakeholders have been added to the table as an outcome of this analysis as well.

Table A3.1 Stakeholders

Institution / Organisation	Responsibility and interest	Comments	Influence/power
Ministries			
Ministry of Water and Environment	Founded in 2003 and supervises water resources management through the NWRA. Developing water resources on the basis of IWRM; providing clean drinking water and sanitation services, allocating water for other uses; and protecting the environment from pollution and desertification, conserving natural resources and rationalising their exploitation	The MWE attempts to implement more sustainable demand side-focused measures.	The ministry has low implementation capacity resulting in low bargaining power (Zeitoun, 2009)
Ministry of Agriculture and Irrigation	Responsible for formulating policies for water resources, for food security and for crops, livestock, and forestry production, and for coordinating public investment and services in the sector. Have an interest to maintain water allocations for Irrigation and Agriculture rather than other water users	The irrigation department of MAI are responsible for the operation and maintenance of irrigation at a catchment level, including the irrigation projects of Wadi Bana and Wadi Hassan in the Abyan governorate, and Wadi Hadhramout, among others, in accordance with the water laws and traditional irrigation systems. As result of the local conditions and the ongoing war, these departments lack the basic funds and capacity to fulfil their roles.	Better bargaining power than MWE due to vested networks (Zeitoun, 2009) and is responsible for the lion's share of (agricultural) water resources (Hübschen, 2011)
Ministry of Local Administration (MoLA)	Enforcing Law No.4 Regarding Local Authority (Hübschen, 2011)		Plays a decisive role in the process of decentralization and the establishment of the Local Corporations (Hübschen, 2011)
Ministry of Planning and	Responsible for sustainable development and poverty		MPIC headed the high---level Inter-Ministerial

International Cooperation (MoPIC)	reduction, and investment planning and programming (Hübschen, 2011)		Steering Committee in 2007 to coordinate and integrate the actions of ministries engaged in water management and prepare the 2008 National Water Sector Strategy (Hübschen, 2011)
Ministry of Finances	Responsible for allocating financial and investment resources. It also sets the diesel prices		Has the power to tax, and allocates financial resources to other ministries. The ministry has therefore relevant bargaining power in investments in water resources development (Hübschen, 2011)
Departments / District authorities			
National Water Resources Authority	Statutory body with autonomous financial administration, responsible for water resources planning, groundwater monitoring, legislation and licensing, water extraction regulation, property rights control and public awareness. They develop and implement the National Water Sector Strategy NWSSIP (Hübschen, 2011).	NWRA is responsible for integrated water resource management. They organise the drilling of wells including issuing the required licenses for drilling of wells, identifying the location for drilling of wells and sites for construction of dams and other water infrastructures. With regard to resolving water-related conflicts, NWRA mostly function as advisors. NWRA studies water-related conflict cases, particularly related to the illegal drilling of wells, and attempts to explain and enforce the law to the conflict parties. Where NWRA decisions are not implemented, NWRA refer the case to the court.	Although the Water Law (2002) identifies NWRA as the sole authority for WRM and law enforcement, the authority is not supplied with sufficient resources, power and autonomy. It has therefore limited implementation capacity, and is therefore donor dependent (Ward et al. 2007; Hübschen, 2011).
National Water and Sanitation Authority	Responsible for water supply and sanitation service delivery, O&M, and collecting revenues in communities with more than 30,000 citizens		Under influence of international donor community to increase effectiveness and efficiency. It is gradually replaced by decentralized LCs (Hübschen, 2011)
General Authority for Rural Water Supply Projects (GARWSP)	Responsible for planning, design and construction of water and electricity schemes for rural settlements with less than 30,000 residents		In the process of decentralization. 20 branches have been opened in all governates. Until 2008,

			11 branches were empowered to carry out the full range of activities. Capacity in personnel, facilities, finances, and administration is limiting the power of the local offices (Hübschen, 2011)
Local Corporations (LC)	15 LCs (in 2011) were responsible for app. 95 percent of the urban drinking water supply (Hübschen, 2011)		Increasing in influence as LCs are replacing the centralized authority of the NWSA (Hübschen, 2011)
Water Supply department	Implementing department under the MWE for coordinating rural water supplies		Limited power due to limited capacity
Regional development agencies (RDA)	Providing field services to farmers The division of responsibility between AREA and the RDAs with respect to water management is unclear (EOEARTH, 2008)		Limited power in relation to water resources management, also due to unclear responsibilities (EOEARTH, 2008)
Agricultural Research Extension Authority (AREA)	Providing farmers extension services		Limited power in relation to water resources management, also due to unclear responsibilities (EOEARTH, 2008)
Environmental Protection Authority	Reports environmental issues to MWE		Does not have real enforcement power
Knowledge institutes			
Universities	To develop knowledge about water resources and sustainable management of the available natural resources		Low influence (Zeitoun, 2009)
Vocational training centres	To educate professionals in sustainable water resources management, engineering and technology.		Low influence (Zeitoun, 2009)
International Donors			
International donors	Financing and investing in improved water resources management, providing technical assistance in development and implementation of programs Promoting principles of IWRM (incl. decentralization) and Water Demand Management Developing the Rada'a supporting decentralization of water resources		Due to competition rather than the promoted cooperation among each other, donors are susceptible to be "divided and conquered" by local leaders (Zeitoun, 2009) The Yemeni water sector is heavily dependent on

	management and principles of IWRM (Hübschen, 2011)		foreign donor support; donors are more powerful than the MWE (Zeitoun, 2009).
Political Stakeholders			
Parliamentarians	Political parties and individual parliamentarians have been supporting the irrigation water supply reform (Ward et al., 2007) Personal interest in remaining in seat, which can result in an interest to remain the status quo or in reducing rural poverty. It depends on the constituency (Ward et al. 2007)		Legitimacy granted by the people provides bargaining power (Zeitoun, 2009) The position of parliamentarians is strongly linked to patronage systems (Zeitoun, 2009)
Army and security officials	Can have personal interests in the conflict (land and water, financial interests), but also can have an interest to settle conflicts.		Force power, networks to parliamentarians, high officials, can be powerful in the local context
Security Stakeholders			
Local Police		At local level, the police may or may not offer help in resolving tensions; However, they are often perceived by respondents in the current study to exacerbate them through corrupt practices.	
Local Stakeholders			
Sheiks / tribal leaders	Water users, local leaders, influential in legitimizing customary rules or legal rules, monopolising water rights Contextually dependent Accuser, respondent, or mediator	Sheikhs and traditional local leaders are relevant as both a conflict party and as a conflict resolution facilitator. However, they commonly lack political and government support, as well as proper knowledge of local customs and traditional water laws. On the one hand, some recent sheikhs' political activities weakened peoples' trust in their sheikhs as well as in state officials and institutions. As parties to a conflict, sheikhs can compete with other locals for water resources as they are usually the largest users of both groundwater and surface water themselves in a locality. This can all create conflict of interest conditions which reduce both the credibility of their impartiality and their ability to make fair judgments that can	Non-compliance to legislation, bargaining power in development of infrastructure, force (gun power) (Zeitoun, 2009) Influence and power is related to networks with security officials, parliamentarians, etc. (Anon, 2009) and legitimacy granted by the people

		satisfy all conflict parties. However, in some localities, some water related conflicts are still solved by sheiks who try to do so in accordance with the respective customs and, if needed, the advice or judgement of NWRA technical experts.	
Mediators		The parties to water-related conflicts may choose common conflict mediators from among a broad range of actors, including state and customary authorities, or religious leaders. Mediators provide an alternative path to sheiks for resolving water-related conflicts peacefully. However, mediators often have difficulties in gaining the trust of all conflict parties. This is in part due to the lack of knowledge, skills and capacities of the local mediators in conflict sensitive development and resolution of water related conflicts.	
Water User Groups, Water User Associations and Water User Committees		Community associations including WUAs, and community water committees are also involved in resolving water-related conflicts. These can face challenges in keeping active due to lack of funds and capacities.	
Large (irrigation) farmers	Local water users, interest in resources development for irrigation, domestic water supply, and water for animals Responsible for daily water management and operation of irrigation systems		Have a true implementation power in water resources management. Are strongly supported by the MAI. As most water in Yemen is consumed by irrigation, this group has real power in influencing water use. ((Zeitoun, 2009; Hübschen, 2011)
Small farmers	Local water users, interest in resources development for irrigation, domestic water supply, and water for animals Responsible for daily water management and operation of irrigation systems		Provide authority to sheiks / tribal leaders. Limited bargaining power, because of limited resources. Poverty and wealth are important for the level

			of power and influence (Zeitoun, 2009)
Religious leaders)	Securing socio---cultural values and norms Contextual dependent, but involved in conflict settlement in the light of customary and Islamic rules		Legitimacy granted by the people, and based on the personal social network (security officials, parliamentarians, sheiks, tribal leaders
The very poor	The very poor have limited access to (irrigation) water resources, the bit more prosperous can have access to shared water resources/tube wells/water conservation technologies (Zeitoun 2009) Improved access to water resources, costs of water are very high because dependent on water vendors		Very limited, very dependent on more powerful stakeholders (sheiks, tribal leaders)
Women and girls	Women and girls spent in some cases many hours each day for water fetching and are therefore water managers		Women have the same water rights as men according to customary rights, but have very limited voice in decision-making over water resources management.

Appendix 4: Details from Abyan

Table A4.1 Governance Structures in Abyan – summary

Mechanisms/structure	**MAI office in Abyan, represented by the general directorate for traditional irrigation.**
Role in water management - what are they meant to do?	• Implementation of legislation, rule and regulations for regulating/organising agriculture and irrigation activities. • Implementation of irrigation infrastructures including irrigation canals, wears, diversion structures, control gates, and programmes for supporting farmers etc. • Providing support for building the capacities of farmers and WUAs to consider gender issues. • Raising awareness and improving water use efficiency and its modern technologies. • Implementation of early warning systems related to floods and flash floods • The resolution of water-related conflicts either amicably, through description and explanation of the rules and regulations to the conflict's parties, or, if not resolved, the conflicts cases referred to the courts.
Role in water management - what do they do in reality?	Currently, the irrigation department doesn't have enough resources to play its roles and fulfil its mandates. The Irrigation Department in Abyan for example lack an office building to implement their daily jobs, as it was occupied illegally during the "Arab Spring". Their equipment was lotted or was not maintained, and they lack funds for operating the irrigation system in Abyan Delta. Many staff have retired or left the offices to join donors' projects or migrate. Remaining staff often don't receive their salaries for months at a time, while many lack training and capacity building support in key subject matter. They are in dire need of capacity building including logistics, training and renewal of staff and infrastructure support.
Mechanisms/structure name 2	**NWRA**
Role in water management - what are they meant to do?	• Assessment and management of water resources. • Issuing of clearances for water use • Issuing of awareness-raising materials related to improved use of water. • Developing plans and visions for the development of water resources. • Monitoring and enforcement of laws concerning drilling and digging of wells and water exploitation. • Monitoring of water quality.
Role in water management - what do they do, if it is different	Respondents indicate that NWRA do not have a field presence in their districts. It is still possible to travel to them and gain advice is needed. Many respondents did not know about the NWRA; those that did indicated they mainly have a role on advising on the legal distance between wells.

from what they are meant to do?	Key experts informed the study that the lack of funds, as well as lack of other resources, skilled personnel and even salaries limit their work.
Mechanisms/structure name 5	**WUAs and Operation Committees**
Role in water management - what are they meant to do?	• Management and operation of irrigation/water structures, and distribution of water according to rules and regulations • Coordination with local government institutions, local authorities and relevant organisations. • Resolution of conflicts between beneficiaries, if any, in coordination with relevant institutions.
Role in water management - what do they do in reality?	WUAs are not functional due to a lack of capacities and finance. They typically operate during the implementation of international projects and suspend their activities as these projects and programmes close.

Table A4.2 Water User Associations – Abyan

District	Village	Name of WUA
Khanfar	Beer AlShaik	Beer AlShaik WUA
Khanfar	Khabt Lasloom	Khabt Lasloom WUA
Khanfar	AlGabaleen	AlGabaleen WUA
Khanfar	Wadi Johayssah	Gahayssah WUA
Khanfar	AlFaish via	Al-Faish WUA
Khanfar	Batais	Batais WUA
Khanfar	Jeser 8	Jeser 7 WUA
Khanfar	Al-Kod	AL Jraib WUA
Khanfar	Arashan	Agriculture Cooperative Association (ACA)
Khanfar	Al-Rumailah	Hertely WUA
Khanfar	Arashan- Batais	Arshan Association for irrigation and water structures
Zinjibar	Al-Rumailah Al-Gharbiah	Hartly WUA
Zinjibar	Al-Garayeb	Al-Grayeb Dam WUA
Zinjibar	Al-Tariah	AlTariah WUA
Zinjibar	Al-Dergag	Ad-Dirgag Agriculture Cooperative Association

Table A4.3 Water-related Structures in Khanfar and Zinjibar

Location: Khanfar	Structure	Description
Between Gea'ar and Zanjbar: Gawl Al-Sha'abiah	Al Dew Dam[13]	In the area between Gea'ar and Zanjbar, the wadi has expanded dramatically to the extent that it threatens the agricultural lands and villages in the Al-Gawl Areas. This is due to the damage of the Al-Dew Dam. Accordingly, wadi bank protections and the construction of distribution canals to discharge water out of the villages are urgently needed for Gawl Al-Sha'abiah - located between Gea'ar and Zanjbar.
Al-Garayeb Al-Uliaa	Batais Dam, Shaqat (Canal) Ba Omar	The main stream of the valley branches from it to the stream of Umbatana. Between these two streams, the Al-Guhaisah area is located. The whole area is named Al-Garayeb Al-Uliaa. The main Canal of Al-Garayeb Al-Uliaa which discharges water to the Umbatana canal is full of sand and clay sediments to the extent that the surface of the canal and the agricultural land are level. As a result, some farmers used this canal and cultivate their crops inside the canal's bed. These structures require cleaning using heavy equipment and the installation of control gates and small dams (locally known as frames).
Arshan-Algarayeb Al-Uliaa		In need of gabion protection works to protect the well in Al-Rae'ey village.
Ma'azoub Bait Al-Rae'ey		Currently, activities are being implemented by an FAO project, namely the enhancement of the role of women in peacebuilding, with Al-Tanweer Association and Irrigation and Water Structures Association as implementing partners. This needs completion through expanding the gabion works to protect the agricultural lands and the villages alongside the wadi.
	Tiran Canal – Wadi Hassan	There is a need for a gabion head to divide water between the east and west directions, as currently, the western sub-canal is not operational. On the easter side is the Al-Fashlah canal. This canal serves Beir Othman Village farmers and extends up to Al-Khaznah village on the eastern sides the beneficiaries are the farmers of Al-Tariah and Obar Othman areas.
	Al-Fashlah Canal	In need of gabion protection works.
	Aidarous Canal	the canal is full of sediments and distracted gates' frames. Therefore, disputes between the farmers under this point in the wadi is standing for long time.
	Ras Aidarous Canal: Obar Othman (Othman Canal) – Wadi Hassan	The wadi stream is diverted and needs gabion structures to re-direct the water back to the canal. This current diversion resulted in depriving farmers and farming areas of water, and also threatens the villages of Obar Othman Area and nearby agricultural lands with erosion and uncontrolled flooding, as well as threatening to damage the Aidrous Canal. Damage to this latter canal, which is different from the Ras Aidarous Canal, could lead to damage to the Obar Othman villages. The

[13] This water structure and the Batais Dam and Al-Sadah Bridge (also named Bizi Bridge) are not included in the list of interventions to be carried out within the KfW-funded Programme titled "Resilience Programme in the Irrigation and Agricultural Sector" while all other water structures included in this table are.

		three gates of the Ras Aidarous canal are also damaged and need replacement. Other interventions include gabion structures to redirect water flow to the main canal course and gabions to protect the Aidarous Canal and Kandam Canal.
	Kandam Canal	The Kandam canal is adjacent to the Ras Aidarous. It is clogged by sediments, which resulted in water being diverted to the Aidarous Canal and damage to the gates of the Aidarous canal. It is currently impossible to direct water to the Kandam Canal, so it flows into the sea.
	Ubar Husein Canal extended to Al-Kawbaliah Village	The canal is located in the Zahwan area of Ad-Dirgag and extends from Ras Ubar Al-Husain near Hassan Dam to the end of Al-Kawbaliah Village. It serves the following bridges: Al-Sadah Bridge, Almizan Bridge, Alfishah Bridge, and the Ubar Mike'eil.
	Wadi Alia canals	These include three canals and Um Al-Sarha Bridge.
	Al-Sadah Bridge (also named Bizi Bridge)	This is located at the head of the Ubar Husein canal. Due to the damage of upper canals, the canal in not functional and in full capacity and dispute on available water
	Girbat Farah Bridge	due to the sediments and damage of operation gates, the three canals are not functional leading to dispute between farmers on the limited water
	Aidarous Bridge	Same as above
	Kandam Bridge	Same as above
	Al-Yafe'ei Bridge in Wadi Hassan Ubar Othman	Same as above
	Ubar Husein Canal	This canal experiences soil erosion and needs rehabilitation. It is the main canal for key bridges that also need rehabilitation and maintenance. The Al-Sadah Bridge, located at the head of the Ubar Husein canal in the BizI Area – in Ad-Digag, needs rehabilitation as the floods swept the arms of canals away; the Almizan Bridge, located in Amjiblah area, needs work as floods swept the arms of the canal away and erosion deteriorated the canal sides. This bridge distributes water between the main Ubar Husein canal and Wadi Alia, which arrive at Aidarous and Kandam Bridges. The Alfishah Bridge, located in Al-Fisha area and known as Abbood Bridge, suffers erosion and needs to be lifted; the same is needed for the Ubar Mike'eil, located in the Ad-Dirgag area.
	Wadi Alia canals	All three of these canals are damaged due to soil erosion and need rehabilitation and restoration. In addition, Ubar Om Al-Sarha is damaged. This used to irrigate more than 50 feddans, which are also in need of gabion defences.
	Al-Sadah Bridge (also named Bizi Bridge)	The dam is damaged and agricultural lands are exposed to being washed away.
Location: Zinjibar	**Structure**	**Description**
	Al-Garaeyb	The Al-Garaeyb Dam is not operational. The control gates constructed by a UN agency were poorly designed and placed at a point of the dam

	(check) Dam	which meant they didn't operate effectively. There is a need for diversion protection structures to raise the water to the dam, as well as reconstruction of the damaged 6 distribution and the controlling gates. If these gates were rehabilitated, more than 5000 feddan of agricultural lands could be irrigated.
	Jasr Ubar Al-Kowd (Check) Dam	Due to the damage of control structures, gates and frames, some farmers are deprived from using the irrigation water which is directed downstream the wadi. Some farmers using groundwater for irrigation are opposing any rehabilitation works
	Jasr Abushanab (check) Dam	Same as above
	Qamshiah check dam	Has been damaged therefore, the water is not shared with the canals to avoid overwhelming the city. Previously the irrigation department of MAI managed this, but now they don't play any role due to lack of funds and the structure is unmanaged.

Table A4.4 Key drivers of water-related conflict according to Key Informants – Abyan

This table is an aggregation of the answers of all Key Informants in Abyan who answered the questions in this table.

In some cases, more than one Key Informant indicated that a driver was important. Sometimes, only one informant chose a driver to be important. The drivers that had at least one informant choosing it as important are included in this summary table.

Drivers of Water-Related Conflict - Abyan	**Manifestation**	**Impact**
Governance		
Inadequate water policies & strategies	- The absence of government and relevant policies results in conflict around the uncontrolled drilling of wells, and the use of floodwater by powerful people while depriving other farmers - No water management strategies at basin, governorate and country levels due to the current war conditions - There is no enforcement of laws and regulations	- Water-related conflicts, that negatively affect the agriculture production in the wadis and accordingly food insecurity, and poverty - Ad-hoc and inefficient use of water. Water floods uncontrolled and flows into the sea, stopping thousands of farmers from irrigating their lands and consequently the poverty, food insecurity and the like
Inadequate service provision	- Lack of budget for water resources management at wadi and basin levels, lack of funds for rehabilitation of damaged key and other irrigation structures - Relevant government institutions don't fulfil their mandatories due to the ongoing war and lack of funds, absence of the state and no enforcement of laws and regulations	- Conflict on the limited water resulted from the damaged infrastructures - Longstanding problems continue and farmers don't benefit from floods - Almost all farmers don't benefit from the flood water
Decisions on water disputes not being enforced	- Control of powerful people over water and main irrigation structures with the absence of enforcing authorities. - Problems and conflicts continue long term without resolution possible	- Water-related conflicts continue for years which negatively affect the productivity and income of farmers and have an impact on different aspects of their lives including poverty, education, health, and incomes in general - Depriving of some farmers from irrigating their land and relevant consequences as mentioned above

Inadequate traditional water management	- Not inadequate but traditional water management systems do not exist	- Almost 80 per cent of water flows into the sea and farmers depend on groundwater for irrigating their lands - Water is not managed by any institution. Farmers have moved to using wells to irrigate their land using solar energy, which has the potential for future risks in terms of overexploitation of groundwater and its salination
Leaders don't have enough knowledge and experience to manage water well	- Some decisions are unfair	- Depriving some farmers of irrigating their lands
Social		
Power dynamics (unfair access to water for some people, etc.)	- Some farmers irrigate their farms while others cannot	- Inequitable access to water
Resources		
Unfair allocation of water	- This is mostly due to the damage to the main irrigation structure upstream, which affects water distribution downstream and increased competition on limited water discharges by the lower canals which, in some cases, are also full of sediments, trees and weeds	- Unfair access to water, and conflict over limited water, means that the farmer can't cultivate their land
Lack of money to manage water	- The MAI office can't manage water due to a lack of funds - Relevant institutions lack the required finance to manage water including operational budget and the fund to rehabilitate and maintain the damaged irrigation infrastructures.	- 80 per cent of the irrigation system is damaged and does not benefit farmers - Agriculture production deteriorated, resulting in decreased incomes, lack of employment and poverty
Infrastructure		
Poor or declining quality and conditions	- Most irrigation structures are damaged and non-functional	
Water infrastructure not doing what it was meant to do (it was poorly designed or built)	- Water infrastructure is not doing what it was meant to do. This is because they are damaged and due to a lack of maintenance and rehabilitation	

Families or villages illegally building water infrastructure (eg. digging wells in riverbeds)	- Families or villages illegally building water infrastructure including uncontrolled digging of wells. In addition, some families and powerful people build some new structures to irrigate their land to bypass the damaged canals upstream - When farmers upstream build improvised structures to irrigate their farms, they stop other farmers from building similar structure as this gets more difficult with farmers then needing larger, more costly structures.	- This results in depletion and salination of groundwater resulting from uncontrolled drilling of wells - In addition, the building of new structures stops downstream farmers from irrigating their lands
Environment		
Water quality getting worse (eg. water is becoming more saline)	- Salination of groundwater is evident - Water quality is getting worse due to the over-pumping of groundwater. This is because the irrigation infrastructures are damaged and the farmer recourse to pumping water from wells which resulted in over-exploitation of groundwater and accordingly its quality decrease	- Productivity decrease
External Interventions		
Unpopular or unfair projects being implemented by government or agencies	- INGOs and donors' projects are implementing projects without considering the real and actual needs of target communities. In almost all cases, they don't consult with target communities and if they invite some targeted people to participate in the launching workshops, they don't consider their recommendations in the project design. - They don't coordinate with government institutions and implement their interventions through other institutions - INGOs and donors' projects implement projects without a knowledge of the local context. Therefore, rarely do these projects achieve their objectives nor serve farmers	- Interventions that don't respond to the actual needs of people and many of them don't serve the purpose for which they were implemented. Just wasting of money and fund provided by donors

Appendix 5: Details from Hadhramout

Figure A5.1. Al-Qatn and Shibam districts

Source: FAO and IOM, 2022. Assessment of water infrastructure and use Part 1/3: Shibam and Al-Qaten districts, Hadhramout

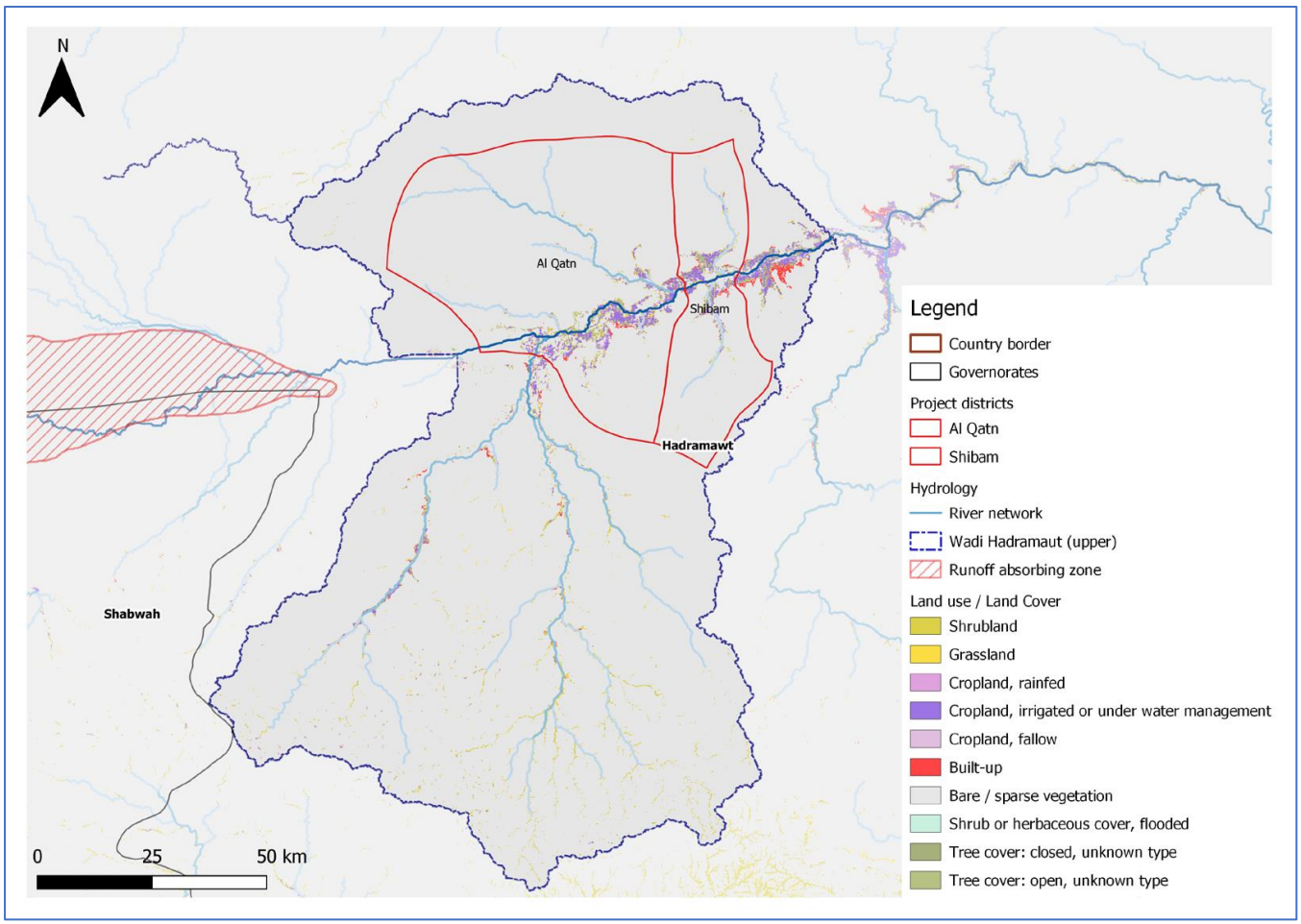


Table A5.1 Governance Structures in Hadhramout – summary

Mechanisms/structure	MAI office
Role in water management - what are they meant to do?	• Implementation of legislation, rule and regulations for regulating/organizing agriculture and irrigation activities. • Implementation of irrigation infrastructures including irrigation canals, wears, diversion structures, control gates, and programmes for supporting farmers etc. • Providing support for building the capacities of farmers and WUAs to consider gender issues. • Raising awareness and improving water use efficiency and its modern technologies. • Implementation of early warning systems related to floods and flash floods

	• The resolution of water-related conflicts either amicably, through description and explanation of the rules and regulations to the conflict's parties, or, if not resolved, the conflicts cases referred to the courts.
Role in water management - what do they do in reality?	Currently, the irrigation department doesn't have enough resources to play its roles and fulfil its mandates.
Mechanisms/structure	**NWRA**
Role in water management - what are they meant to do?	• Assessment and management of water resources. • Issuing of clearances for water use • Issuing of awareness-raising materials related to improved use of water. • Developing plans and visions for the development of water resources. • Monitoring and enforcement of laws concerning drilling and digging of wells and water exploitation. • Monitoring of water quality.
Role in water management - what do they do, if it is different from what they are meant to do?	Currently, the NWRA doesn't have enough resources to play its roles and fulfil its mandates.
Mechanisms/structure	**WUAs and Operation Committees**
Role in water management - what are they meant to do?	• Management and operation of irrigation/water structures, and distribution of water according to rules and regulations • Coordination with local government institutions, local authorities and relevant organizations. • Resolution of conflicts between beneficiaries, if any, in coordination with relevant institutions.
Role in water management - what do they do in reality?	WUAs are not fully functional due to a lack of capacities and finance. They are operated only during the implementation of international projects and suspend their activities as these projects and programmes close. However, WUA members indicate that they still take a role in water-related dispute resolution in the community when they can, even with no resources and limited capacity.

Table A5.2 Water User Associations - Hadhramout

WUA Names	Location
Sharg Al-Qafel WUA	Shibam Wadi Bin Ali
Zabied abd Garab Zabied WUA	Shibam Wadi Bin Ali
Al-Hessah and Alhaga WUA	Shibam Wadi Bin Ali
Augda Mubarak weirs WUA	Shibam Wadi Bin Ali
Al-Manwara WUAs	Shibam Wadi Bin Ali
Al-Khalieo Balkhash and Sharg Balagba WUA	Shibam Wadi Bin Ali
Jrob Shibam WUA	Shibam - Jrob
Jesr Al-Saidea WUA	Shibam - Jrob
Jefel WUA	Jefel - Shibam
Arshan and Moshah WUA	Shibam -Arshan
Wadi Jib WUA	Wadi Jib-Shibam
WUG of AL-Moatared canals and Weirs	AlQatn - Wadi Hinn
WUG of Ross Canals and Weirs	AlQatn - Wadi Hinn
Mansam Canals WUA	AlQatn - Wadi Hinn
Al-Magsam Weir WUG	AlQatn - Wadi Hinn
Saqiea Al-Tan weir WUG	AlQatn - Wadi Hinn
Wadi Manwab WUA	AlQatn - Wadi Manwab
WUA in Shibam called the Ghaith Association	Shibam

Table A5.3 Water related Conflicts in Hadhramout

	District	Village/Wadi	List of Identified Conflict Issues in Shibam District
1	Shibam	Wadi bin Ali	Conflict on Zabied Main canal
2	Shibam	Wadi bin Ali	Conflict on Al-Kulaan and Al-Matrah canals
3	Shibam	Wadi bin Ali	Al-Hessah and Alhaga canals
4	Shibam	Wadi bin Ali	Conflict on Om Al-Baier canals
5	Shibam	Wadi bin Ali	Conflict on Al-Manwara canals
6	Shibam	Wadi bin Ali	Conflicts on Om Al-Arba'a and Om Al-Mawaset canals
7	Shibam	Jrob Shibam	Conflicts on Jrob Shibam Main canal, Al-Hajez Al-Najdi and Jesr Al-Saidea canals
8	Shibam	Jefel	Conflicts on Al-Aliea and Dafien canal, Ras Al-Hawiah canal and Ras AlHaid canals
9	Shibam	Jefel	Conflict on Sharg Al-Saada canals, Sharj Al-Saif and Nakher Rubidan Canals
10	Shibam	Moshah and Arshan	Conflicts on Mousheh canal, Al-Tabikha canals, Qa'a Al Tayeb, Al-Mashraqyah, Al-Wasta and Al-Guraybat canals
11	Shibam	Moshah and Arshan	Conflicts on Al-Khudar, Al-Suhar and Ba Asem canals
	District	**Village/Wadi**	**List of Identified Conflict Issues in Al-Qatn District**
12	AL-Qatn	Wadi Hinn	Conflicts over Mansam, Rous and Mu'atared canals in Wadi Hinn - AlQatn
13	AL-Qatn	Wadi Manwb	Conflicts on WADI bajedan canals, AlKuaser, Matrah AlBatahf and Al-Kholo'o canals - Wadi Manwab Al-Qatn

WUGs for wells' water in Shibam and Al-Qatn Districts of Hadhramout

WUG Name	District	# of members	Date established	Head of WUA	General Secretary
Al-Qatn	Al-Qatn	13	2006	Rabie'e Saleh Bahyan	Ghaleb Muhsen Al-Ahmadi
Sibakh Al-Qara Al-Wast	Shibam	37	2006	Mahrous E'idhah Handom	Taye'e Khamis Qa'arour
Lamlah	Al-Qatn	22	2006	Hadi Salem Shadhy	Salamah Saleh Bin Dihbaj

Al-Rayan	Al-Qatn	22	2007	Saeid Saleh Bu Airan	Saleh Salmin Bin Huwail
Jujah Al-Sharqyah	Shibam	28	2007	Omar Saeed Al-Saadi	Saeed Awad Al-Saadi
Jujah Al-Gharbiah	Shibam	20	2007	Awad Karama Al-Saadi	Ahmed Habib Al-Saadi
Wadi Naam	Shibam	12	2007	Hakim Bin Awad	Husain Mohamed Bin Kulaib
Al-Hariah and Sahyah	Shibam	20	2007	Azzan Saeed Balhasel	Salem Rais Bin Abdul Aziz
Jua'aimah Al-Sharqyah	Shibam	16	2007	Fawzi Abdulkhaleq Al-Kathiri	Ali Salem Qarwan
Jua'aimah Al-Gharbiah	Shibam	17	2007	Abdullah Mubarak Bin Abdat	Sharif A. Aziz Saeed
Sabakh Al-Qarah Al-Sharq	Shibam	12	2007	A. Hakim Amer Bin Abdulaziz	Raji Saleh Handoom
Sabakh Al-Qarah Al-Gharb	Shibam	16	2007	Yaslem Eydha Handoom	Sulaiman Hamood Handoom
Qawz Al Duais	Shibam	13	2007	Ali Abdullah Bin Kudda	Saeed Jumaan Bin Kulaib
Saeylat Almisk /Alqarah	Shibam	12	2007	Abdulmajid bin Bishr Bin Abdulaziz	Ali Salem Ba Dhawy
Wadi Bin Ali	Shibam	16	2007	Abdulkarim Ubaid Al-Jabiri	Mre'ey Badr Al-Jabiri
Al-Khasha'ah Wal Abr	Al-Qatn	35	2007	Mabkhout Saleh Al-Dahboul	Mutee'e Salem Bin Hatrash
Al-A'aqad	Al-Qatn	17	2007	Abdullah Salem Al-Dahri	Thabet Saleh Bin Huwail
Henin	Al-Qatn	11	2008	Saelh Ahmed Bin Fadle Al-Buraiki	Salem Omar Ba Khuraisah
Al-Khdid	Al-Qatn	13	2008	Ahmed Saeed Ba Arimah	Saeed Salem Bin Qudailm
Manwab Wa Brouj	Al-Qatn	16	2008	Saleh Faraj Bin Juawih	Naser Abdullah Bin Kulaib
Khamour	Shibam	6	2008	Salem Ali Bin Hasn	Salah Embarak Bin Hasn
Al-Safoulah	Al-Qatn	16	2009	Walid Mubarak Bin Huwail	Salamah Saleh Bin Dihbaj
Dar Al-Raq	Al-Qatn	13	2009	Karamah Saeed Bin Jawfan	Abdullah Mohamed Bin Jawfan
Wadi Sar	Al-Qatn	20	2009	Amed Salamah Bin Huraiz	Ramadan Awad Muhainadan

Table A5.4 Key drivers of water-related conflict according to Key Informants – Hadhramout

This table is an aggregation of the answers of all Key Informants in Hadhramout who answered the questions in this table.

In some cases, more than one Key Informant indicated that a driver was important. Sometimes, only one informant chose a driver to be important. The drivers that had at least one informant choosing it as important are included in this summary table.

Drivers of Water-Related Conflict in Hadhramout	**Manifestation**	**Impact**
Governance		
Inadequate water policies & strategies	- Breaching of laws by different people - There is no enforcement of laws and regulations	- Disruption of irrigation system in the basin.
Inadequate service provision	- There is an absence of the government, due to war conditions, lack of funds and so on - No budget is allocated for relevant institutions - All water infrastructures in the Wadi are damaged and people compete for the remaining water	- Institutions are inactive resulting in poor management of water resources and deterioration of irrigation infrastructures due to a lack of funds for their maintenance and rehabilitation. - No adequate water for irrigation and accordingly decrease in productivity, production and decreased incomes.
Unfair decisions on water disputes being made by the government	- Delay in decisions on water disputes	- Depriving some farmers of their rights in favour of others
Decisions on water disputes not being enforced	- Even the decisions are unfair in most of them, their enforcement is the key issue	- The conflict continue and water and land resources are not used
Inadequate traditional water management	- Traditional irrigation management systems are not functional - The traditional systems are not being applied due to a lack of clear vision of their operation	- Water is managed by people themselves leading to a renewal of conflicts. The roles played by WUAs and committees are limited due to a lack of funds and poor economic conditions. - No one controls water use at the basin level
Social		
Demographic changes (PG, IDPs, urbanisation etc.)	- Selling of lands by newcomers to new people who don't know about the traditional irrigation systems - This is reflected by the newcomers and IDPs - Increasing population and accordingly, increased competition for scarce water	- Disruption of the ongoing irrigation systems resulting in conflicts over water for irrigation - Some farmers sell their lands to these people who don't know the local traditions. In turn, these violate the traditional irrigation systems

Gender		
Water and dispute decisions being made only by men	- Women are not included or limited included in water-related disputes decisions	- Depriving women from involvement in many activities and identification of women's needs accordingly
Resources		
Unfair allocation of water	- Due to a lack of distribution canals, water is diverted to the farmers close to the watercourse. - Due to damaged structures, water is not distributed fairly to the farms	- Depriving some farmers of irrigation - People neglect their lands, look for other jobs, decreased food availability and decreased income. This reflects itself in poverty, education and wellbeing
Lack of money to manage water	- All relevant institutions and associations lack the money to manage water or address water-related conflicts.	- Latent conflicts, water is not used and flows downstream, agricultural lands are not cultivated due to conflicts
Unfair access to water	- Damaged distribution and diversion canals - Not all farmers irrigate their lands as needed	- Due to a disrupted irrigation system - In the case of wells, some shares holders prevent others from irrigating their lands
Infrastructure		
Poor or declining quality and conditions	- Due to a lack of funds for the rehabilitation of irrigation facilities, more of these structures are in poor condition and most of them are not functional. - Damaged infrastructures and blocked canals due to lack of funds for operation and maintenance	- Increased conflicts due to competition on limited water and some farmers can't irrigate their lands - Farmers neglect their lands which result in decreased incomes and loss of jobs
Water infrastructure not doing what it was meant to do (it was poorly designed or built)	- While most water infrastructures were well designed and built, these structures lack periodic and continuous maintenance, which renders them useless.	- Agriculture production decreased, and conflicts increased.
Families or villages illegally building water infrastructure (eg. digging wells in river beds)	- Random construction of houses on the banks of valleys or narrowing the watercourse, and thus the torrent erodes agricultural lands - Random drilling of wells through violating and disobeying the law - The number of wells increased without considering the distance stipulated in the water law.	- Change the direction of watercourse leading to depriving farmers of irrigating their land as well as erosion of soil - Overexploitation of groundwater - Deterioration of water quality and quantities

Environment		
Water quality getting worse (eg. water is becoming more saline)	- During the big torrents came in 2008, the flood water appearance was black as a result of mixing with oils for Petromasila (petroleum company), which affected the agricultural land and water. By that time, the company cleaned the pollution. But the fear is in case this phenomenon repeats (when large torrents descended and mixed with Petromasila oil wastes. - water is becoming more saline due to overexploitation	- Pollution of agricultural lands and water resources - Productivity decreases
Water source running out (eg. water table falling)	- Water depletion	- More cost of irrigating lands and decreased incomes
External Interventions		
Unpopular or unfair projects being implemented by government or agencies	- Interventions are designed without consulting local authorities and communities	- Construction and implementation of projects and interventions that do not respond to the real needs of targeted communities with the potential to fuel conflicts
Unfair decisions on water disputes being made by courts	- Unfair decisions by courts that deprive some farmers of their water rights in favour of other powerful people	
Security		
Destruction of water infrastructure by conflict	- Lack of enforcement of laws - Security institutions lack the capacities to address water-related conflicts.	- Many water-related conflicts are unsolved and become latent conflicts while some farmers are unable to irrigate their lands or be involved in agricultural production, which has indirect impact on family income, poverty, food security, education, and nutrition.

Table A5.5 Key drivers of water-related conflict in Hadhramout Governorate

Sourced from FAO and IOM, 2020. Context Analysis Report in support of the project Water for Peace in Yemen: Strengthening the role of women in water conflict resolution and climate change mitigation. Table 6: Conflict causes & drivers around water resources in Wadi Hadhramaut

STRUCTURAL CAUSES
• The lack of early warning systems for floods, which makes it impossible to anticipate heavy rains and prepare for heavy torrents • Infrastructural damage to large parts of the flood irrigation system • Torrent pathways obstructed or deepened randomly by construction work or vegetation (e.g. Sesbania trees) • Urban sprawl near the torrent pathways • Increased volume of flood water entering the valley from downstream • Reduced presence and duty performance of government authorities responsible for the management of the torrent pathways • Absence of laws relevant to the water sector (e.g. land tenants' rights are not guaranteed legally, interventions/ new work on torrent pathways are not regulated legally) • Weakness of the rule of law related to water resource issues • Rising prices for water extraction
BEHAVIORAL DRIVERS
• Landowners' lack of awareness of the public interest to access and benefit from the flood water • Landowners lack of awareness of the damages to flood irrigation systems • Resulting lack of rehabilitation/ consolidation work of irrigation systems • Misuse of water during cultivation of land due to seeking financial gains • Abandonment of farmlands by their owners • Dispute over lands near the torrent pathways
ATTITUDINAL DRIVERS
• The indifference, and consequent lack of position taking, of the community related to community-harming interventions
HISTORICO-CULTURAL DRIVERS
• The nationalization of farmlands and issuance of the Agricultural Reform Law, that replaced traditional torrent pathways regulating mechanisms • Negligence of relevant customs and traditions related to the regulation of the use of torrent pathways

Sourced from Table 7 Conflict resolution blockers around water resources in Wadi Hadhramaut

CONFLICT RESOLUTION BLOCKERS
• Lack of funding/ financial support to address the infrastructural issues causing conflicts around water resources • Lack of engagement and management from state sector representatives a) in addressing the infrastructural issues causing conflicts around water resources, and b) in mitigating the conflicts around water resources • Lack of support from law enforcement actors in managing conflicts around water resources • Lack of easily accessible water sources • Lack of interest in resolving the water conflicts through long-term, sustainable solutions

- The persistent war that wears down the communities' capacity to engage in water conflict resolution in a constructive manner, due to the following contextual stressors:

STRESSORS

- The continuous presence of the threat of violence or violence itself
- Chronic shortage of natural resources and basic goods
- The rising prices in a country with dramatic loss of income and livelihood opportunities
- The subsequent food and water insecurity
- The absence of opportunities and public/ social services that contributes to the feeling of hopelessness
- The demographic changes experienced by certain communities due to the war

Appendix 6: Details from Dhamar

Figure A6.1. Wadi Siham and Wadi Rima upstream catchment and land use

Derived from land cover data of the ESA Land Cover Maps v2.0.7 dataset (ESA, 2017)

Source: Acacia Water, 2021

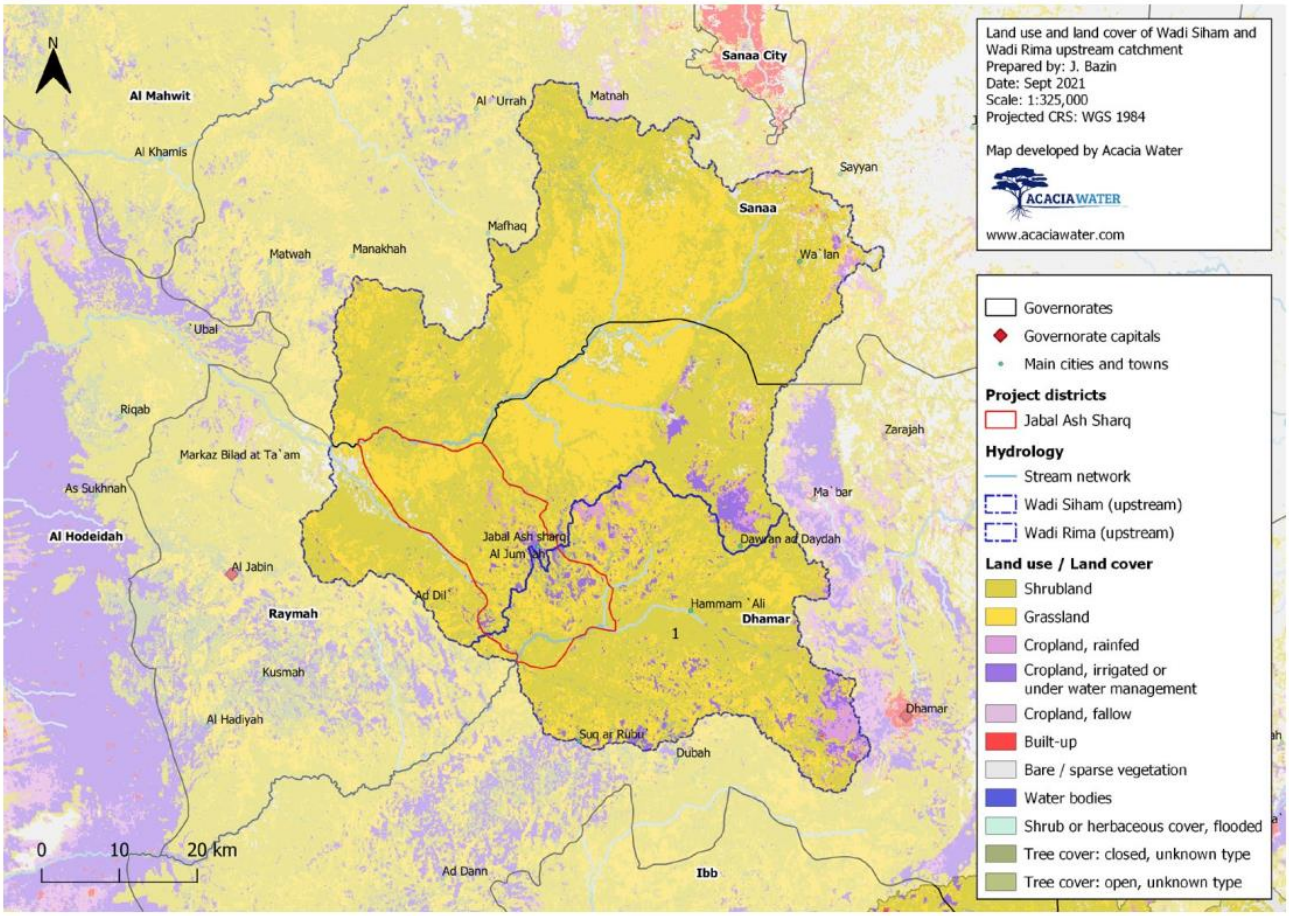


Table A6.1 Key Wadi Rima/Siham upper catchment recommendations

Source: Acacia Water, 2021

Water supply management action	**Water demand management action**	**Explanation**
	Feasibility and pilot study on less-water intensive cropping patterns with focus on rainfed agriculture	Create awareness among farmers on impact of water intensive cultivation. The priority focus in the near-future should lie on shifting towards sustainable agricultural practices relying on rainfed crops, combined with rainwater harvesting techniques. A feasibility study should assess and identify suited alternatives to current water-intensive cropping patterns (involving vegetables, fruits, qat etc.), presenting a positive business case. Subsequent piloting together with farmers helps in awareness raising as well as to showcase vital alternatives. The pilots are advised to also involve varietal research, to identify crop varieties most suited to this specific area.
Feasibility mapping and pilot study on application 3R (recharge, retention, reuse) techniques, with special focus on rehabilitation of traditional RWH structures and terrace rehabilitation		Many traditional RWH techniques are present in Yemen. Knowledge on these systems is often available with local communities and experts. Adopting a community approach may help identify most suited techniques and/or indicate where existing structures can be rehabilitated/improved. Within the hilly landscape of Wadi Rima/Siham upstream catchments, terrace cultivation is practiced. Capturing and retaining (more) water in the system, may reduce flood peaks and increase prolong baseflow for the downstream Tihama plain. In the upstream catchments it favours water availability and reduces pressure on groundwater resources.

Table A6.2 Water User Associations - Jabal Al-Sharq District of Dhamar

District	subdistrict/ village	Will the WUA be reactivated or newly established?	What form of water use is governed by the WUA? (e.g. spate water irrigation or water harvesting structures etc.?)
Jabal AlSharq	Bani salim (Bani Asead) بني سالم بني اسعد	newly established	water harvesting structures
Jabal AlSharq	Almikhlaf (Bani Asead) المخلاف بني اسعد	newly established	water harvesting structures
Jabal AlSharq	Maghribat Aleinab, Qarq and Alqarih مغربة العنب وقرق والقارة	newly established	water harvesting structures
Jabal AlSharq	Qabli and Muasata (Bani Qashib) قبلي و موسطة بني قشيب	newly established	water harvesting structures
Jabal AlSharq	Bani Ruyah بني رويه	newly established	water harvesting structures
Jabal AlSharq	Mikhlaf Aldaher مخلاف الظهر	newly established	water harvesting structures
Jabal AlSharq	Mikhlaf Alhada' and Qeran مخلاف الحداء وقران	newly established	water harvesting structures
Jabal AlSharq	Damaam دمام	newly established	water harvesting structures
Jabal AlSharq	Remaa رماع	newly established	water harvesting structures

References

[i] Homer-Dixon, T., 1999. Environment, Scarcity and Violence, Princeton University Press, Princetown.

[ii] Ohlsson, L. and Turton, A., 2000. The Turning of a Screw: Social resource scarcity as a bottle-neck in adaptation to water scarcity. Stockholm Water Front 1, 10-11.

[iii] Wolfe, S. & Brooks, D. B., 2003. Water Scarcity: An alternative view and its implications for policy and capacity building. Natural Resources Forum, 27, 99–107.

[iv] UN Sustainable Development Group (UNSDG), 2016. Conducting a Conflict and Development Analysis Tool https://unsdg.un.org/resources/conducting-conflict-and-development-analysis-tool

[v] Ministry of Agriculture and Irrigation, 2012. National Agriculture Sector Strategy and Investment Plan 2012-216, Yemen

[vi] WWAP (World Water Assessment Programme), 2012. The United Nations World Water Development Report 4: Managing Water under Uncertainty and Risk. Paris, UNESCO

[vii] The Hague Institute for Global Justice, 2014. The Political Economy of Water Management in Yemen: Conflict Analysis and Recommendations

[viii] Homer-Dixon, T., 1999. Environment, Scarcity and Violence, Princeton University Press, Princetown.

[ix] Ohlsson, L. and Turton, A., 2000. The Turning of a Screw: Social resource scarcity as a bottle-neck in adaptation to water scarcity. Stockholm Water Front 1, 10-11.

[x] Wolfe, S. & Brooks, D. B., 2003. Water Scarcity: An alternative view and its implications for policy and capacity building. Natural Resources Forum, 27, 99–107.

[xi] FAO, 2021. Aquastat. https://www.fao.org/aquastat/statistics/query/index.html?lang=en

[xii] IOB - The Policy and Operations Evaluation Department of the Netherlands Ministry of Foreign Affairs, 2008. Support to Rural Water Supply and Sanitation in Dhamar and Hodeidah Governorates, Republic of Yemen, IOB Impact Evaluation No. 315, The Hague.

[xiii] Gleick, P., 1996. Basic Water Requirements for Human Activities: Meeting Basic Needs. Water International, 21, 83-92.

[xiv] NWRA – National Water Resources Authority, 2021. Workshop on Water Resources Management – Yemen, October 10 - 11, 2021

[xv] Acacia Water, 2021. Water Availability In Yemen: Final Report

[xvi] Acacia Water, 2021. Water Availability In Yemen: Final Report

[xvii] NWRA – National Water Resources Authority, 2021. Workshop on Water Resources Management – Yemen, October 10 - 11, 2021

[xviii] NWRA – National Water Resources Authority, 2021. Workshop on Water Resources Management – Yemen, October 10 - 11, 2021

[xix] The International Food Policy Research Institute (IFPRI), 2011. Climate Change and Floods in Yemen. Impacts on Food Security and Options for Adaptation. IFPRI Discussion Paper 01139. Washington D.C. http://reliefweb.int/sites/reliefweb.int/files/resources/ifpridp01139.pdf

[xx] NWRA – National Water Resources Authority, 2021. Workshop on Water Resources Management – Yemen, October 10 - 11, 2021

[xxi] FAO 2021, Aquastat – FAO Country Profile Yemen. https://www.fao.org/aquastat/en/countries-and-basins/country-profiles/country/YEM

[xxii] NWRA – National Water Resources Authority, 2021. Workshop on Water Resources Management – Yemen, October 10 - 11, 2021

[xxiii] FAO and IOM, 2020. Context Analysis Report in support of the project Water for Peace in Yemen: Strengthening the role of women in water conflict resolution and climate change mitigation

[xxiv] FAO and IOM, 2020. Context Analysis Report in support of the project Water for Peace in Yemen: Strengthening the role of women in water conflict resolution and climate change mitigation

[xxv] WHO, 2021. Country files for SDG 6.3.1: "Proportion of wastewater safely treated" https://www.who.int/teams/environment-climate-change-and-health/water-sanitation-and-health/monitoring-and-evidence/water-supply-sanitation-and-hygiene-monitoring/2021-country-files-for-sdg-6.3.1-proportion-of-water-safely-treated

[xxvi] UN-Water, 2020. SDG 6.2.1a: https://www.sdg6data.org/country-or-area/Yemen

[xxvii] ACAPS Analysis Hub, 2021. Yemen: Effects of the fuel embargo at Al Hodeidah port on fuel supply dynamics and fuel prices, Thematic Report, 17 August 2021. https://www.acaps.org/special-report/yemen-impacts-fuel-dynamics-and-fuel-price-structures

[xxviii] ibid

[xxix] Embassy of the Kingdom of the Netherlands, 2005. Institutional and sectoral analysis of the water and environment sector in Yemen. Sana'a, EKN.

[xxx] Aklan, S. and Lackner, H. 2021. Solar Powered Irrigation in Yemen: Opportunities, Challenges and Policies. Policy Brief No 22, Sana'a Center for Strategic Studies

[xxxi] FAO, 2021. Global Information and Early Warning System (GIEWS) Country Brief Yemen https://www.fao.org/giews/countrybrief/country.jsp?code=YEM

[xxxii] ibid

[xxxiii] Unicef, 2021. Humanitarian Situation Report Mid-year; Reporting Period: 1 January 2021 - 30 June 2021 https://reliefweb.int/report/yemen/unicef-yemen-humanitarian-situation-report-1-january-30-june-2021

[xxxiv] - The Policy and Operations Evaluation Department of the Netherlands Ministry of Foreign Affairs, 2008. Support to Rural Water Supply and Sanitation in Dhamar and Hodeidah Governorates, Republic of Yemen, IOB Impact Evaluation No. 315, The Hague.

[xxxv] FAO and UN-Water 2021, Progress on Water-Use Efficiency – 2021 Update. December 2021. https://doi.org/10.4060/cb6413en

[xxxvi] ibid

[xxxvii] WWAP - World Water Assessment Programme, 2012. The United Nations World Water Development Report 4: Managing Water under Uncertainty and Risk. Paris, UNESCO

[xxxviii] World Bank, 2021. World Bank Data – Yemen https://data.worldbank.org/indicator/SP.POP.GROW?locations=YE

[xxxix] FAO, 2021. Aquastat. https://www.fao.org/aquastat/statistics/query/index.html?lang=en

[xl] World Bank Data, 2022. https://databank.worldbank.org/source/population-estimates-and-projections

[xli] The Hague Institute for Global Justice, 2014. The Political Economy of Water Management in Yemen: Conflict Analysis and Recommendations

[xlii] Hellegers, P. et al. 2008. Incentives to reduce groundwater extraction in Yemen. LEI Wageningen UR, The Hague

[xliii] ibid

[xliv] World Bank, 1997. Towards a Water Strategy: An Agenda for Action. Report No. 15718-YEM

[xlv] IOB - The Policy and Operations Evaluation Department of the Netherlands Ministry of Foreign Affairs, 2008, 2008. Support to Rural Water Supply and Sanitation in Dhamar and Hodeidah Governorates, Republic of Yemen, IOB Impact Evaluation No. 315, The Hague.

[xlvi] Ward, C. et al., 2007. Yemen's Water Sector Reform Program – A Poverty and Social Impact Analysis (PSIA). Republic of Yemen and The World Bank.

[xlvii] The Hague Institute for Global Justice, 2014. The Political Economy of Water Management in Yemen: Conflict Analysis and Recommendations

[xlviii] Ward, C. et al., 2007. Yemen's Water Sector Reform Program – A Poverty and Social Impact Analysis (PSIA). Republic of Yemen and The World Bank.

[xlix] NWRA – National Water Resources Authority, 2021. Workshop on Water Resources Management – Yemen, October 10 - 11, 2021

[l] Acacia Water, 2021. Water Availability In Yemen: Final Report https://en.acaciawater.com/nw-29143-7-3937413/nieuws/review_of_yemens_water_resources.html?page=0

[li] Taher, T., Bruns,, B., Bamaga, O., Al-Weshali, A. and van Steenbergeni , F., 2011. Informing and Enabling Local Ground Water Governance for Yemen. Prepared for The National Conference on Management and Development of Water Resources in Yemen, January 15-17, 2011

[lii] Ward, C. et al., 2007. Yemen's Water Sector Reform Program – A Poverty and Social Impact Analysis (PSIA). Republic of Yemen and The World Bank.

[liii] NWRA - National Water Resources Authority, 2008. National Communication and Awareness Strategic Programme for Integrated Water Resources Management. Ministry of Water & Environment, Republic of Yemen.

[liv] Hellegers, P. et al. 2008. Incentives to reduce groundwater extraction in Yemen. LEI Wageningen UR, The Hague

[lv] For example, see: Zabara, B., 2018. Enhancing Women's Role in Water Management in Yemen. Brief 9, CARPO – Center for Applied Research in Partnership with the Orient.

[lvi] FAO and IOM, 2020. Context Analysis Report in support of the project Water for Peace in Yemen: Strengthening the role of women in water conflict resolution and climate change mitigation..

[lvii] ibid

[lviii] FAO and IOM, 2020. Context Analysis Report in support of the project Water for Peace in Yemen: Strengthening the role of women in water conflict resolution and climate change mitigation.

[lix] ibid

[lx] ibid

[lxi] ibid

[lxii] Al-Mashreki, M. 2018. Impact of Climate Change on Groundwater in Dhamar Basin, Yemen.

[lxiii] ibid

[lxiv] Hassan, M., 2018. Assessment of water resources in Dhamar Governorate, Yemen Republic

[lxv] Taher, T., Bruns,, B., Bamaga, O., Al-Weshali, A. and van Steenbergeni , F., 2011. Informing and Enabling Local Ground Water Governance for Yemen. Prepared for The National Conference on Management and Development of Water Resources in Yemen, January 15-17, 2011

[lxvi] IOB - The Policy and Operations Evaluation Department of the Netherlands Ministry of Foreign Affairs, 2008. Support to Rural Water Supply and Sanitation in Dhamar and Hodeidah Governorates, Republic of Yemen, IOB Impact Evaluation No. 315, The Hague.