WATER MANAGEMENT AREA PROFILE: TAL BRAK, AL-HASAKEH JANUARY 2023

INTRODUCTION

More than a decade of conflict, resulting destruction of infrastructure, and unavailability of maintenance, rehabilitation, and management services has had a devastating impact on the general population's access to water in Syria. More frequent droughts across the region due to climate change have exacerbated the water crisis.[1] In 2021, 70% of the population in northern Syria was without regular access to safe drinking water because of water cuts and the destruction of basic infrastructure.[2] Water shortages and inaccessibility have also increased household reliance on unregulated water sources such as boreholes, wells, and expensive private water trucking services to fulfil their drinking and non-drinking needs.[3] According to the Northeast Syria Joint Market Monitoring Initiative (JIMMI), the price of trucked water increased by 18% between May and October 2022.[4] As such, high cost of water from trucking services is an added burden for households, contributing to their overall economic insecurity.

Effects of the water crisis are also multi-faceted, with direct impact on food security, health, and livelihood outcomes across the region.[5] This necessitates a more coordinated response to the water crisis that not only addresses the water sufficiency needs of communities in the short and mid-term, but also strengthens their resilience to adapt to water scarcity, fosters self-sufficiency and decreases dependence on external aid actors, and builds their ability to respond to changes related to climate, infrastructure operations, and local capacities through sustainable management practices.

As such, **REACH conducted water management area-based assessments (water ABAs) across northeast Syria (NES) to understand the underlying drivers of water insecurity and their impact on local communities. Additionally, the water ABAs aimed to identify the capacities of local actors and management structures in their response to drought-related shocks and assess how sustainable water management and usage practices can be improved to strengthen resilience of communities, thereby enabling local stakeholders to adapt and recover from drought and climate-related drivers of water scarcity in the long-run.**

Multi-sectoral ABAs conducted by REACH in 2021[6] highlighted that each assessed area in northern Syria had a unique combination of resources, infrastructure, and stakeholders involved in water management. Reflecting that, the water ABAs are a follow-up to the 2021 ABAs and aim to establish a clear, consolidated picture of the local water resources, management structures, and usage practices. Further, they identify specific areas for support to inform sustainable drought response programming that would improve the overall resilience and recovery outcomes of communities through interventions that build on local structures and capacities.

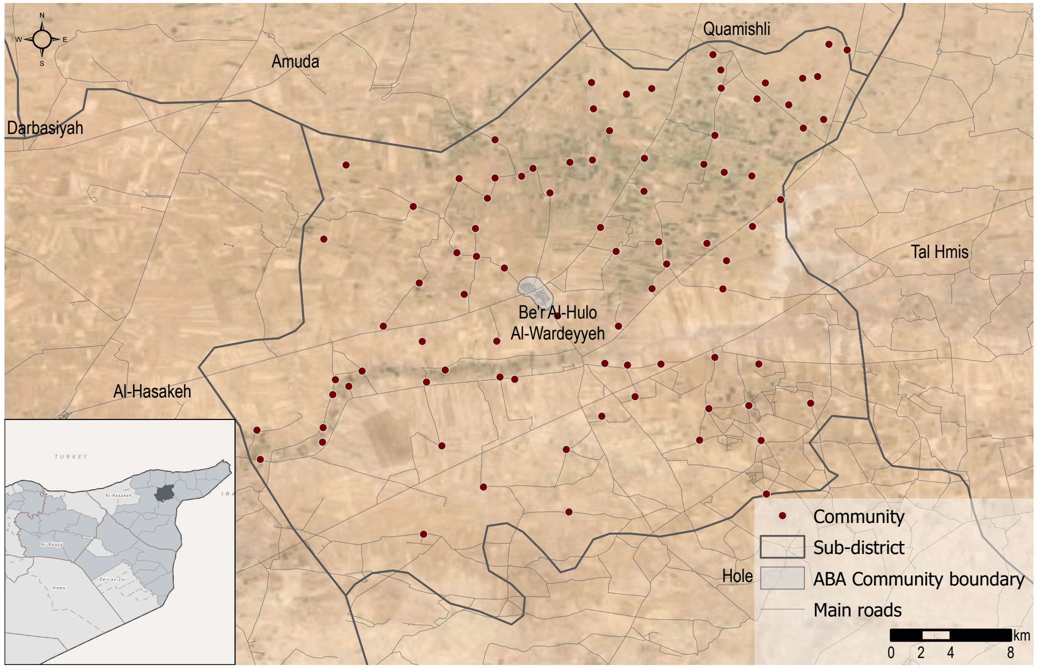
AREA CONTEXT AND DEMOGRAPHICS

Tal Brak is located in central Al-Hasakeh Governorate's Be'r Al-Hulo Al-Wardeyyeh sub-district. The closest urban center is Al-Hasakeh city, approximately 34 kilometers (km) away. Tal Brak area acts as a central point for access to services and administration for its surrounding villages.[a] The closest water bodies are the Khabur River, located approximately 30 km at its closest point, and the Jaghjagh river, a tributary of the Khabur river, approximately at 5 km. Participants from the 2021 Multi-sectoral ABA estimated that approximately 2,727 households (HHs) resided within the assessed Tal Brak area, as of May 2021.[a]

Estimated proportion of HHs by displacement status[a, 7]

99%	Host/residents
1%	Internally displaced persons (IDPs)

Map 1: Tal Brak "Community Area" Boundary[a]



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METHODOLOGY AND ASSESSMENT OVERVIEW

REACH pursued a mixed-methods approach, using a combination of semi-structured and structured tools to understand the conditions of the overall water systems in the "area of focus". The area of focus was based on the locally-defined community boundaries from the 2021 multi-sectoral ABA. However, relevant water infrastructure and services are not necessarily limited to those specific geographical boundaries. As such, infrastructures that were located outside of the ABA boundaries but were clearly important for fulfilling the water needs of the population residing within the ABA area were included in the assessment. Additionally, the assessment aimed to account for the ways in which surrounding communities were dependent on infrastructures located within the ABA boundaries.

A secondary data analysis, particularly of the 2021 multi-sectoral ABAs, in combination with consultations with WASH and Food Security and Livelihoods technical experts, was conducted to inform the development of the assessment and its key informant (KI) tools.

Each data collection tool consisted of two sessions – **1) a mapping focus group discussion (MFGD) to map and locate all water resources, infrastructures, and service areas, and 2) a key informant panel discussion (KI PD) to collect information on these assets across various themes like the functionality of these water assets, their maintenance and management structures, availability and maintenance of water sources, their intersection with livelihoods, etc.** The two sessions were conducted in succession with the same group of KIs. Each activity was divided into separate sessions owing to the nature of information being collected in them. While the MFGDs were predominantly conducted to map and locate all water infrastructures, their characteristics, and relevant management stakeholders and their interactions, the KI PD presented a more nuanced picture of the overall conditions and circumstances of the water system and of management practices around the operations and handling of these resources and infrastructures.

Based on the review of the 2021 multi-sectoral ABAs and external consultations, the assessment was **conducted with five different types of KI groups** in the area of focus, participants for which were identified using existing REACH field networks. Selection of participants for each KI group was based on the KIs' knowledge of the area, water system management, maintenance, available water services, and the agro-based livelihoods sector. Findings are based on the perceptions of the KIs, and hence, should be considered indicative only (see pg. 19 for the challenges and limitations associated with the assessment).

All data collection and analysis activities for the assessment were conducted in accordance with IMPACT's minimum standards requirements and checklist for structured and semi-structured data processing and analysis.[8, 9] All steps were taken to protect the anonymity of participants involved in this study by removing all personally identifiable information from the data.

In total, **31 KIs participated in the in-person data collection activities in Tal Brak between 27 and 30 June 2022**. The breakdown of these KIs according to the different KI groups is as follows:

8	**Water Station Managers**	Water and municipality department representatives, water station managers, engineers, support staff
6	**Sector Experts**	Local or international NGOs working in water management and/or agricultural livelihoods, community leaders, local council representatives, agriculture/ irrigation department representatives
5	**Farmers and livestock owners**	Local farmers, livestock owners, breeders, herders
6	**Water Trucking Providers**	Public and private water trucking providers, operators, vendors
6	**Piped Network Operators**	Network operators, including those associated with the local authorities/ municipalities, private and/or local/INGOs providing ad hoc support

REACH field teams used printed base maps to mark and locate all water sources present in and around each area, and the specific neighbourhoods which received services from those sources. These base maps were digitalised using geo-spatial software to produce infrastructure and service maps. Further, thematic and content analysis was conducted on the collected information, and data was triangulated with additional remote sensing analysis on cropland extent, vegetation health, rainfall-based drought indicators, and ground water trends over time to understand the environmental impact of water scarcity on agro-based livelihoods.

KEY HIGHLIGHTS

According to most KIs, the overall functionality and services related to water stations, tanks, and the piped network improved in comparison to one year ago. This increase in functionality was attributed to infrastructural rehabilitation and expansion of the piped network system in the last one year. Conversely, some KIs noted that water trucking service provision, in terms of frequency and coverage, decreased over the same time period, as the demand for trucked water and HH reliance on water trucking services decreased due to improved network functionality and access.

According to most KIs, local infrastructure and service management actors were unable to conduct regular infrastructural maintenance work and unable to cope with service disruptions and/or faults independently due to a lack of funding and resources.

Local authorities were reportedly not involved in management or maintenance of water sources like wells and boreholes used specifically for livelihood activities. As a result, individual owners were responsible for their maintenance and upkeep. Findings suggest that absence of systemic oversight and monitoring of private wells may result in unsustainable usage practices such as unregulated drilling of wells, especially in the absence of viable irrigation infrastructure. These unsustainable practices could further deteriorate water resource levels and water quality in the area.

Findings suggest that environmental factors related to climate change, such as the lack of rainfall and shift in the seasonality of rainfall, adversely impacted water availability for HHs. Since most HHs in Tal Brak are dependent on water stations which extract water from underground aquifers replenished by rainfall, the variability in rainfall affected the overall availability of water in the area. Farmers were also reported to be negatively affected as they rely on rainfall to replenish groundwater, which they source through private wells to irrigate croplands. According to most KIs, this shift in the rainy season also adversely impacted farmers' ability to effectively plan their crop cycle around predictable rainfall patterns.

Groundwater levels declined in the area as a result of recurring drought in 2021 and 2022 (see pg. 10). As a result, most KIs noted that existing wells and boreholes were unable to source adequate quantities of water. Reportedly, pumped water was also of degraded quality, with increased sediments and mineral content affecting the overall quality of crops. Overall expansion and rehabilitation of wells, boreholes, and underground aquifers was noted by all KI groups as a requirement. However, in the absence of overarching management of wells in the area, findings suggest that rehabilitation and expansion done by individual farmers could have significant implications for sustainable resource management, where unregulated drilling may further deplete groundwater resources and worsen the impact of drought if not done sustainably.

Decline in agricultural productivity and agricultural yield were reported by farmer and livestock KIs due to insufficient water for irrigation and change in salinity and alkalinity of soil. As a result, poor quality and health of crops were observed. Most KIs noted that farmers resorted to cropland abandonment due to inability to cope with the rising cost of water and other inputs such as seeds, fertilisers, farming equipment, etc., and noted their shift towards other livelihood activities.

Findings suggest that the adoption of sustainable water management practices varied according to the different capacities of local authorities and individual farmers. While local authorities reported lacking resources to implement sustainable management practices themselves, absence of coordinated support from the local authorities for livelihood activities left adoption of sustainable irrigation and livestock tending practices to individuals. Therefore, implementation of sustainable practices depended highly on the capacities, resources, knowledge, and attitudes of individual farmers and livestock owners, as showcased by the overall findings. Usage of shared water resources, especially groundwater, impacts availability of water for all. As such, findings indicate that the uptake of sustainable practices at the systems, institutional, and individual levels, to strengthen the water resilience in Tal Brak requires a more regulated and coordinated response.

OVERVIEW OF KEY WATER INFRASTRUCTURES

According to the information shared by the KIs across all KI groups, HHs in Tal Brak area primarily receive water from Tal Adhan water station, which is located outside of Tal Brak area (see pg. 6). Tal Adhan station extracts groundwater from nine underground aquifers through pumping. Water from eight of these aquifers is directed to the Tal Brak water tank through a main pipeline, whereas water from the remaining aquifer is allocated to nearby Smeihan village. Another water station and a water tank were also identified near Tal Brak - Tal Mishiya station, which sources water from underground aquifers as well, and is connected to the Tall Temmi tank, approximately 1 km southeast of Tal Brak. Because of the proximity of Tal Mishiya station and Tall Temmi tank to Tal Brak, these infrastructures are used as backup sources of water for Tal Brak in case of any service disruptions. Stressing this, all sector expert KIs highlighted that in case of any issues in operations with either Tal Adhan station or Tal Brak water tank, local authorities source water from the Tall Temmi tank through public water trucking to HHs in Tal Brak to ensure uninterrupted water services to all HHs. All water stations, water tanks, and water trucking services were noted to be owned and managed by local authorities and their dedicated departments and agencies (see pg. 9).

4 **water infrastructures providing water to Tal Brak and its surrounding areas**

2 Water Stations

2 Water Tanks

Publicly owned and managed by local authorities

Source of water for HH usage (both drinking and non-drinking purposes) (as reported by sector expert KIs)

Piped water network receiving water from Tal Adhan water station

Functionality of Tal Adhan and Tal Mishiya water stations[b] (as reported by water station and sector expert KIs)

Partially functional

- Frequent breakdown of electrical transformers and generators
- Shortage of electricity
- Limited water pumping capacity
- Increased sedimentation in groundwater
- Lack of maintenance of boreholes/aquifers/wells
- Unregulated pipeline connections

Change in functionality of Tal Adhan and Tal Mishiya water stations in comparison to one year ago[b] (as reported by water station KIs)

More functional

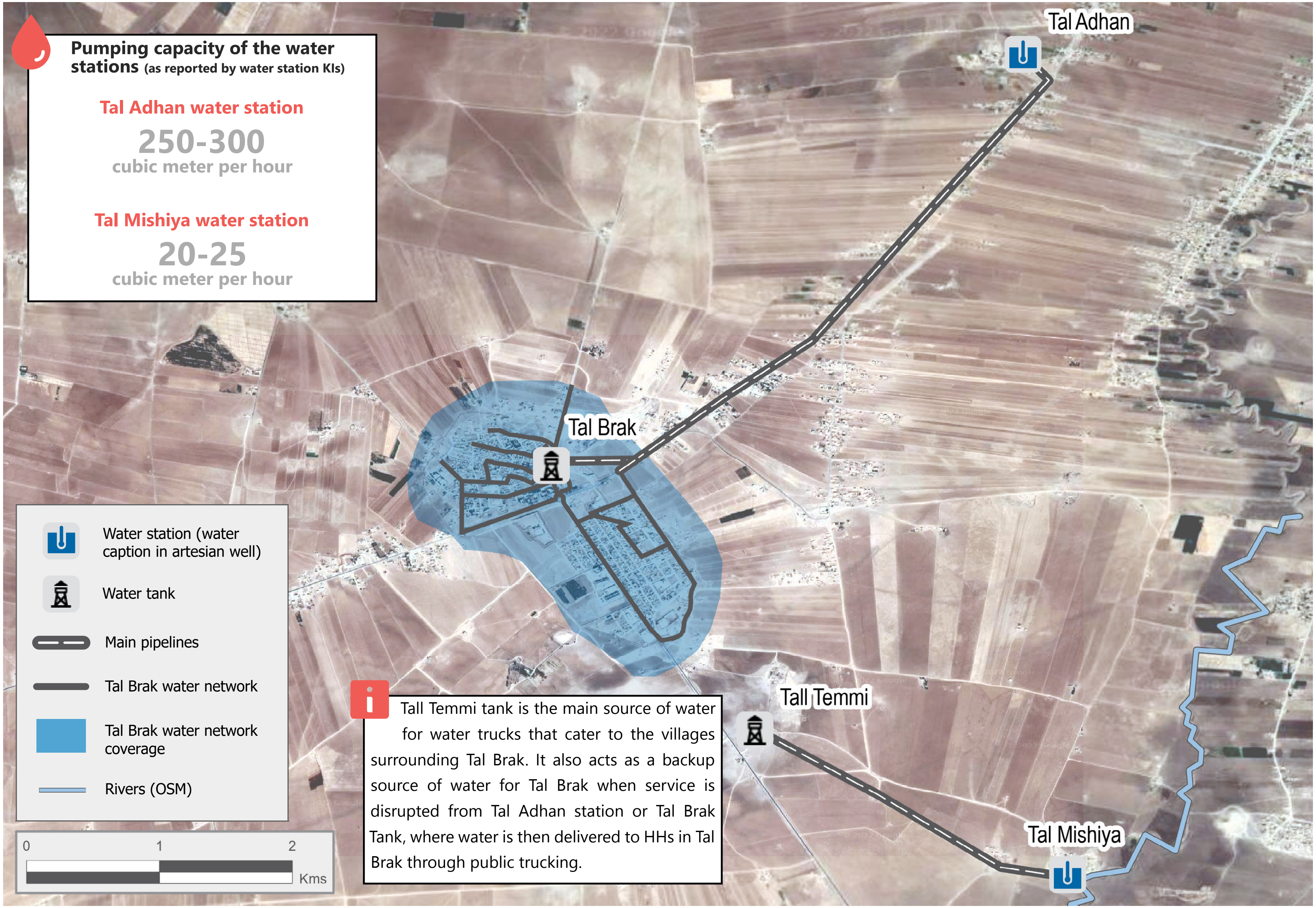
- Rehabilitation/repair/maintenance activities of existing infrastructure carried out within the last year
- Source of power/electricity for water pumping upgraded
- Received support from external organisations/stakeholders

Change in service delivery of Tal Adhan and Tal Mishiya water stations in comparison to one year ago[b] (as reported by water station KIs)

Increased

- Tal Adhan station connected to more pipelines which cater to other communities
- Water stations have increased their pumping capacity to source more water from the aquifers
- Received support from external organisations/stakeholders

Map 2: Water Stations and Tanks Located Within and Near Tal Brak



OVERVIEW OF KEY WATER SERVICES AND DELIVERY MECHANISMS

An extensive network of pipelines connect all neighbourhoods and HHs to piped water system, according to participants from across all KI groups. Piped network KIs further noted that a main pipeline connects Tal Brak tank to Tal Adhan station (see pg. 8). All sub-pipelines were reported to be connected directly to individual HH tanks which are filled on the day of service. Public water trucking provisions, managed by local authorities and sources from Tal Brak tank, were also noted to be present, either to cater to additional needs of HHs or as a backup in case of service disruption due to issues in the pipelines. In case of infrastructural issues at either Tal Adhan station or Tal Brak tank, public water trucks source water for Tal Brak HHs from Tall Temmi tank as a filling point and deliver water to neighbourhoods in Tal Brak. In the villages surrounding Tal Brak, water was noted to be distributed through water trucking services only, filled at Tall Temmi tank and managed by the Tal Brak Municipality (see pg. 9), since there was no proper water network system in place at the time of data collection. Some water trucking KIs noted that livestock herders and bedouins, who own small/private water tankers, register themselves with the local authorities to fill water directly from the Tal Brak tank to transport and use water as per their needs.

Piped Network System | **Water Trucking Services**

Publicly owned and managed by local authorities

Number of water trucks owned by local authorities = 10

- 5 trucks under fixed contracts, 5 under service contracts; of these, 3 trucks not operational[b] and need repair

Number of days water trucking services being provided, in comparison to one year ago, decreased (as reported by water trucking KIs)

- Demand for trucked water decreased

Coverage of water trucking services (in terms of number of neighbourhoods/HHs being catered) , in comparison to one year ago, decreased (as reported by water trucking KIs)

- HH reliance on water trucking decreased as a result of increase in functionality and sufficiency of the piped network

Functionality of the piped network system[b] (as reported by piped network and farmer KIs)

Partially functional

- Electrical malfunctions
- Very high/unregulated pressure from water stations
- Submersible pump/pipe failure
- Frequent breaks in the network pipes causing leakage
- Illegal connections from the main pipeline feeding into the Tal Brak tank causing insufficiency at the Tal Brak tank end

Change in functionality of the piped network system in comparison to one year ago[b] (as reported by piped network KIs)

More functional

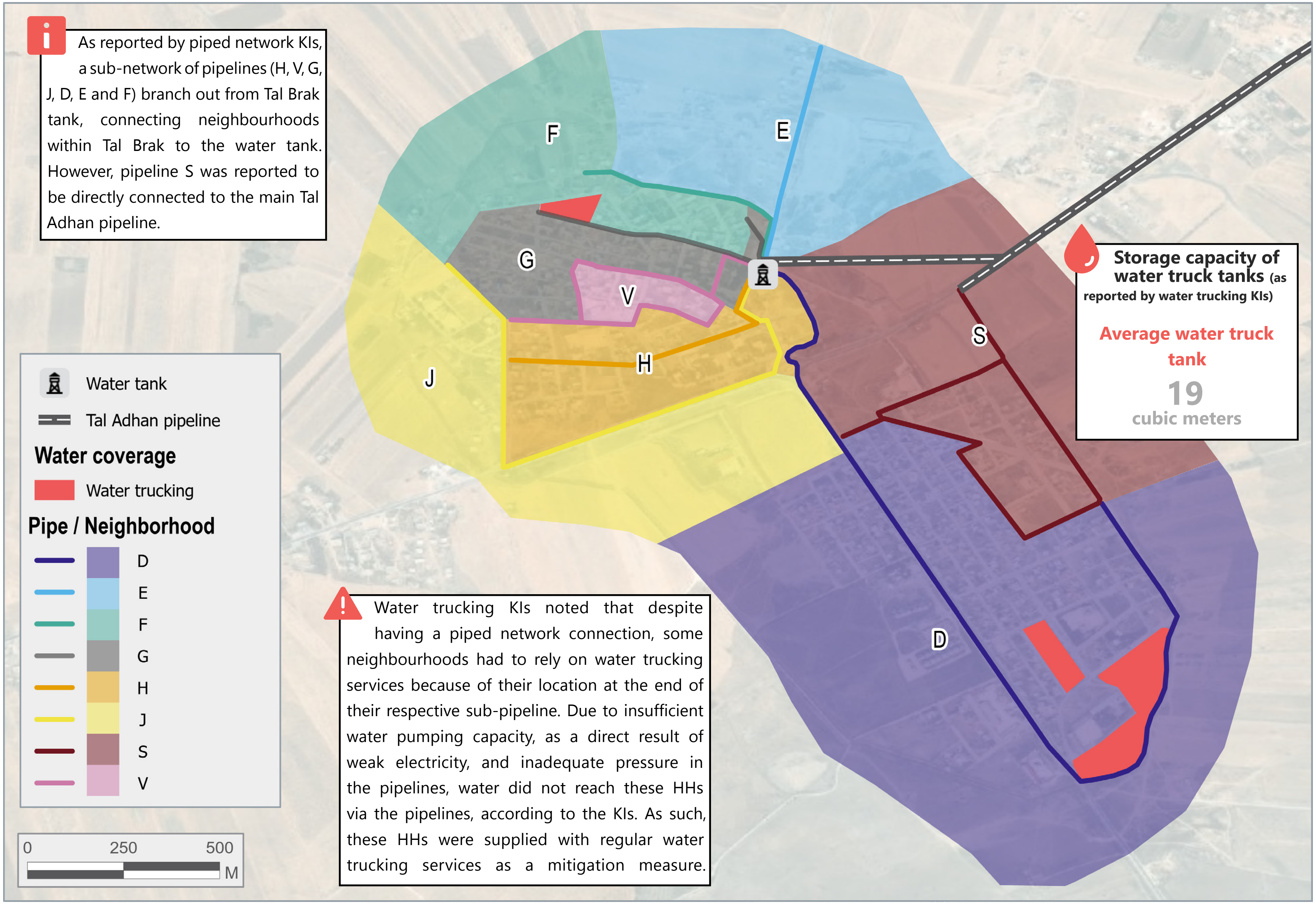
- Source of power/electricity for water pumping upgraded

Change in service delivery of the piped network in comparison to one year ago[b] (as reported by piped network KIs)

Increased

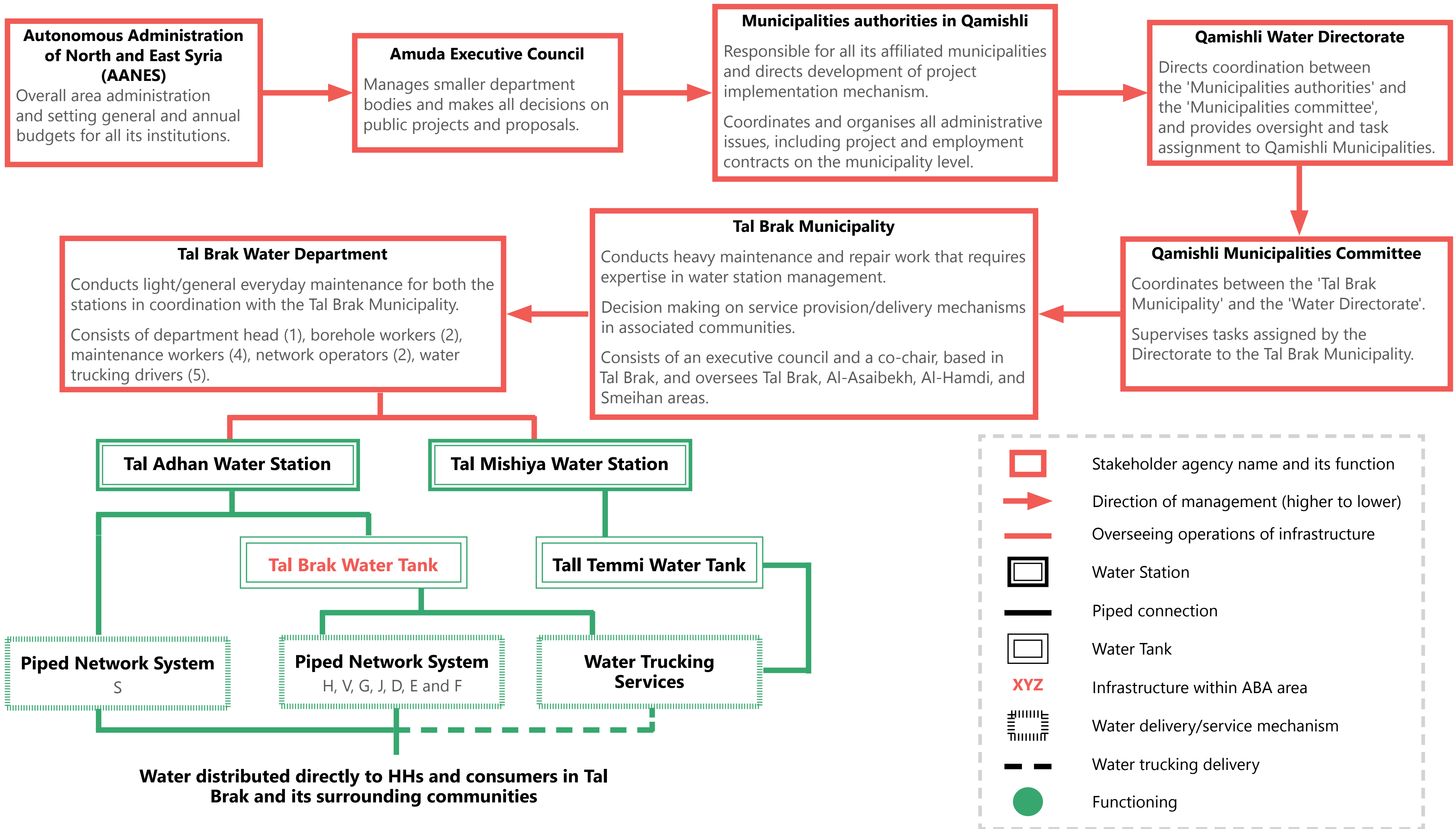
- Additional pipelines constructed to expand coverage/more neighbourhoods connected with a piped network
- Frequency of operation of Tal Adhan station and Tal Brak tank increased (number of days that source is operational has increased)
- Hired more staff to operate/maintain the network
- Received support from external organisations/stakeholders

Map 3: Areas of Service



LOCAL WATER MANAGEMENT AND MAINTENANCE STRUCTURES

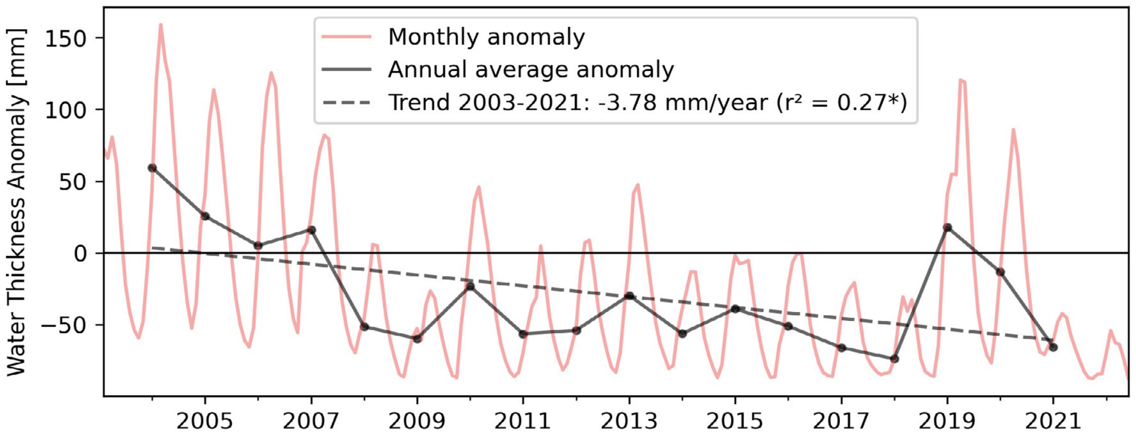
Key Actors and the Hierarchy of Decision-Making in the Management and Maintenance of Water Infrastructure and Services



CLIMATE-CHANGE AND ITS IMPACT ON THE AVAILABILITY OF WATER

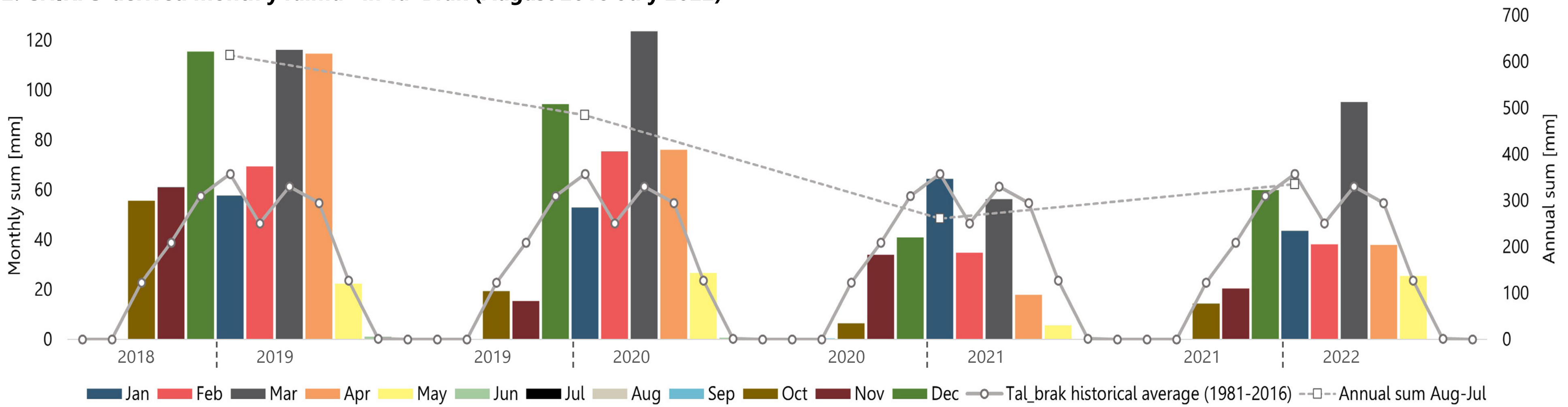
Analysis of groundwater storage in Tal Brak area highlights a downward trend in the available groundwater levels in the last two decades (see Figure 1). The average annual decrease in groundwater levels was calculated to be -3.78 mm per year, since 2003. High rainfall events in 2019 and 2020 stabilized this trend and replenished/recharged groundwater in Tal Brak. However, the onset of severe drought in 2021[10] and perhaps over-extraction of groundwater to meet the demand of the general population during the drought, likely contributed to the depletion of groundwater in the region, again, bringing groundwater levels to lower points than before 2019; groundwater storage for 2022 was calculated to be even lower than 2021 levels.

Figure 1: Average Annual Groundwater Storage Anomaly for Tal Brak (2003-2022)[12]



Climate Hazards Group InfraRed Precipitation With Station (CHIRPS) data[11], which calculates the rainfall sum in mm per month in an area, further shows that Tal Brak experienced limited rainfall in 2022 as compared to previous years (see Figure 2). However, rainfall in 2022, observed at approximately 300 mm as an annual sum, was still higher than 2021, when the annual rainfall sum was less than 300mm. A typical rainy season in Al-Hasakeh governorate spans from October of that particular year to May of next year. When compared to the past 35 years, rainfall was significantly low not only at the beginning of the rainy season in 2021 (October and November) but also in January 2022, which is historically the month with the highest expected amount of rainfall. Instead, for the 2021/2022 season, the highest amount of rainfall was recorded in March 2022, highlighting a delay in the rainy season. Resonating the findings from these remote sensing analyses, sector expert KIs as well as farmer and livestock KIs reported that the most recent rainy season (2021/2022) was delayed and that the area had experienced less rainfall compared to the previous two years' rainy seasons (2020/2021 and 2019/2020). All KIs from both groups acknowledged that these environmental factors/weather-related changes relating to the lack of precipitation and the shift in the seasonality of rainfall have had an adverse impact on the water sources in and around Tal Brak area.

Figure 2: CHIRPS-derived monthly rainfall in Tal Brak (August 2018-July 2022)



OVERVIEW OF AGRO-BASED LIVELIHOODS

Sources of water used for agriculture and livestock-based livelihood activities (as reported by sector expert, and farmer and livestock KIs)

- Private wells
- Rainfall

→ **Agriculture and irrigation**

- Private wells
- Water Trucking Services
- Piped Network System

→ **Livestock tending and feeding**

Public/local authorities not involved in management or maintenance of boreholes and wells used for agricultural purposes

While farmers and livestock owners/breeders in Tal Brak were reportedly able to access water for their livelihood activities, either directly through pumping groundwater or through piped network and water trucking services, all KIs noted that there was not sufficient water to cover their needs.

With consistent decrease in groundwater levels and average rainfall levels as a result of climate-change (See pg. 9), farmers have been particularly affected by the water shortages across the region. Recurring droughts have prevented the natural replenishing of groundwater levels. Compounding this, unregulated drilling of wells, in the absence of viable irrigation infrastructure, has exacerbated the situation and has contributed to lowering the groundwater table even further, causing existing wells to no longer be able to pump water adequately. In cases where water can still be pumped from private wells, increased sediments and mineral content in the water affected the quality of crops. Unregulated and unmaintained wells also amplified the risk of water quality degradation and contamination[13], thereby increasing the risk of water-borne diseases and other health risks.

Functionality of the private wells and boreholes[b] (as reported by farmer and livestock KIs)

Partially functional

- Increased sedimentation in groundwater
- Lack of maintenance of boreholes/aquifers/wells

Change in availability of water from sources used specifically for livelihood purposes, in comparison to one year ago (as reported by farmer and livestock KIs)

Remained same

Decline in agricultural productivity due to water quality issues in the area in the year prior to data collection commonly reported (as reported by farmer and livestock KIs)

Issues reported

- Poor quality of crops
- Slow and stunted growth
- Change in salinity of soil
- Change in alkalinity of soil

According to most KIs, farmers were largely unable to cope with the water quality issues and unable to treat water before usage, due to:

- Unavailability of resources/equipment required for treatment
- High cost of available treatment inputs (fuel, chemicals, etc.)
- Lack of knowledge on the processes/methods to treat water

Illnesses/health decline among livestock in the area in the year prior to data collection commonly reported (as reported by farmer and livestock KIs)

No issues reported

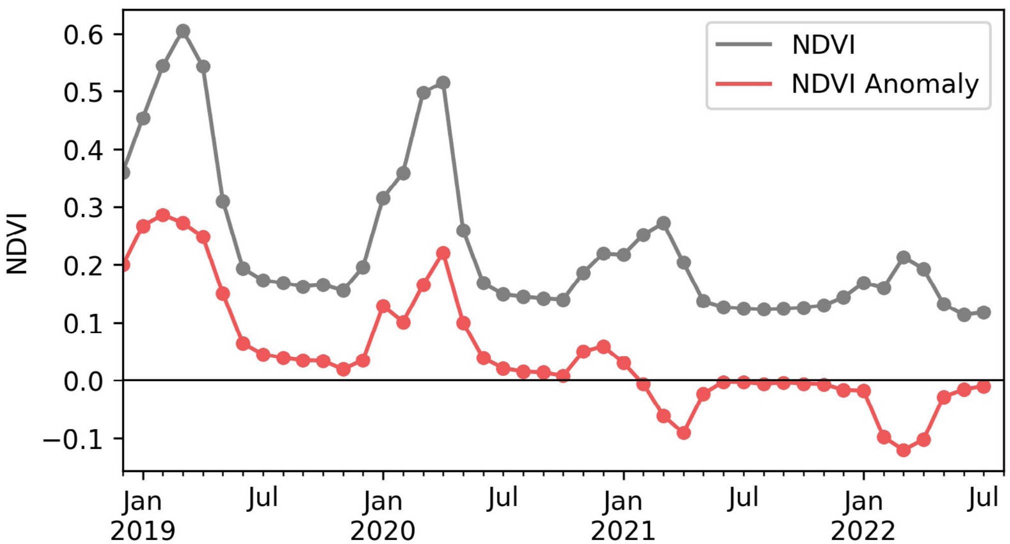
According to the information collected in the 2021 multi-sectoral ABA[a] the main crops that were cultivated by farmers for income in the surrounding areas of Tal Brak were wheat, barley, and legumes. According to Food and Agriculture Organization (FAO), wheat production in 2021 in Syria was slightly more than half the amount of wheat produced in 2020.[14] Similarly, in 2021, barley was harvested in only one-fourth of the total area harvested in 2020, thereby indicating a 75% decrease in the areas for barley harvest.

Reflecting these findings, most sector expert and farmer KIs reported that the overall agricultural yield in and around Tal Brak area had decreased in comparison to two years ago. All farmer KIs also noted that as a result of rising cost of inputs like water, seed, fertilisers, and fuel, farmers in the area had resorted to abandoning their cropland and shifted to other sources of income.

Strengthening this evidence, remote sensing analysis using the Normalized Difference Vegetation Index (NDVI), an indicator for vegetation health and density, for areas around Tal Brak showed a significant decrease from 2019 to 2022 (see Figure 3). The NDVI values in March and April 2022, which are usually the months with the highest NDVI (maximum NDVI just before harvest), were very low, shown by the almost non-existent NDVI peak.

NDVI anomaly is the difference between the average NDVI for a particular month of a given year, and the average NDVI for the same month over a specified number of years (2000-2019).[15] The drought in 2021 severely affected crop yield and productivity to levels unseen before. Furthermore, remote sensing data showed a negative NDVI anomaly for 2022, even lower than that of 2021, indicating that crop productivity in 2022 has been at its lowest levels compared to previous years. While a negative NDVI anomaly could be reflective of crop type changes in an area, most farmer KIs in Tal Brak confirmed that there had not been any significant crop type changes in 2022, strengthening the evidence for deteriorating crop productivity in Tal Brak and its surrounding areas.

Figure 3: Normalized Difference Vegetation Index for Tal Brak (NDVI)[16, 17]



Changes in overall agricultural yield in comparison to two years ago (as reported by sector expert and farmer and livestock KIs)

Yield decreased

Occurrence of cropland abandonment in the last two years (as reported by farmer and livestock KIs)

Cropland abandonment reported

Reasons for cropland abandonment (as reported by farmer and livestock KIs)

- **Unavailability of water**
- **Rising cost of farming equipment**
- **Rising cost of fertilisers/insecticides**
- **Rising cost of seeds**
- **High cost of fuel**

Rate of cropland abandonment at the time of data collection compared to the same month two years prior to data collection (as reported by farmer and livestock KIs)

Less frequent

Figure 4: NDVI Anomaly Maps, Crop Growing Seasons (Nov-May) in the years 2019-2022[18]

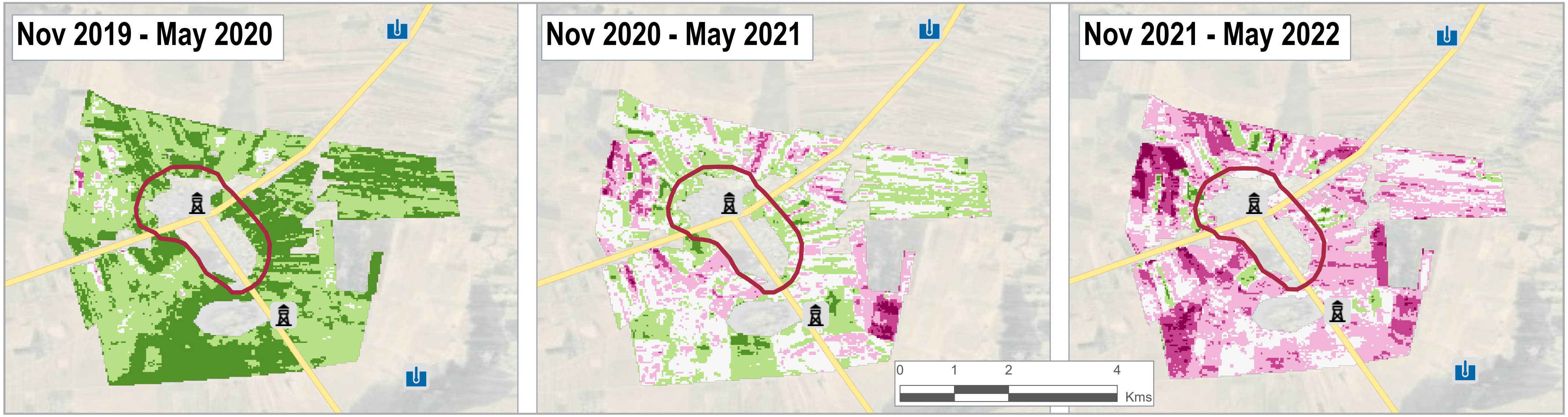
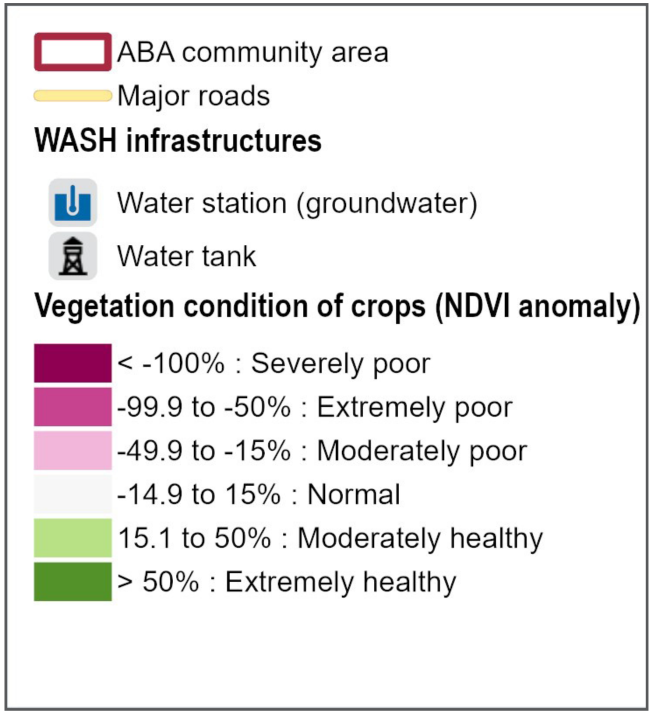


Figure 4 shows the extent of changes/deviation in the vegetation health and density, between 2019 and 2022, in the agricultural areas in and around Tal Brak, when compared to the 20-year NDVI mean (2000-2019).[19] The use of NDVI anomaly has important implications in analysing the drought intensity and for spatial identification of areas most impacted by it. However, other factors such as costs of agricultural inputs and equipment (see pg. 11) also contribute to the productivity and health of crops. As such, the NDVI anomaly maps can be a proxy indicator of how crop productivity has changed over seasons in an area, understanding that the cause of these changes could be multi-faceted. The typical crop growing season in NES is from November of a particular year to May of the next year and it is during this period that vegetation health is at its highest.

Crop productivity between November 2019 and May 2020 indicated moderate to extremely healthy crops (signified by the depth of the 'greenness'). However, between November 2020 and May 2021, also the period when the region experienced severe drought (see pg. 10), vegetation health significantly decreased. The agricultural deterioration in Tal Brak's surrounding areas continued in the next season (November 2021 to May 2022) and highlighted extremely to severely poor crop health, signalling significant impact on crop productivity, possibly a reduction in crop yield, and abandonment of agricultural land (especially those areas with NDVI anomaly being 'severely poor').

A decrease in crop productivity has implications on communities beyond just the economic impact on farmers. While low crop productivity reduces the overall income of farmers as a result of decreased yield that they could sell in markets, low harvests often result in higher cost of food, forcing HHs to dedicate a larger share of their income towards purchasing food items.[20] The average surveyed HH in Tal Brak's reported monthly expenditure amount was calculated to be 1.5 times their reported monthly income, with food expenditure taking the highest share of the average monthly income (69%).[a] Lower food production, in terms of quantity and quality, combined with low purchasing power of HHs, also contributes to food insecurity and negative health outcomes.[21]



SUSTAINABLE WATER MANAGEMENT AND AGRO-BASED PRACTICES

Sustainable management and use of water resources is a critical element of drought response in Syria. Similarly, sustainable agriculture (including irrigation and livestock activities) could enable a more efficient use of available resources, mitigating the impact of agriculture on the environment, and strengthening the capacity of farmers and livestock rearers to adapt to climate change and climate variability.[22]

While piped network and sector experts KIs indicated that sustainable water management practices had already been implemented in the area, water station KIs noted that that they had tried to adopt some practices but were unable to implement them due to a lack of funds. On the other hand, water trucking KIs reported that they had neither adopted nor were planning to adopt sustainable practices due to a lack of funds, as well as the need to address more pressing issues at hand.

Farmers and livestock owners in Tal Brak primarily rely on private wells located on their property for their livelihood activities, where local authorities do not manage or provide any support for the management and maintenance of these private wells. As a result, uptake of sustainable management practices was reportedly largely left to the individual to implement or not according to their knowledge, resources, attitudes, etc.

Sustainable water management practices adopted by local actors and service providers for management of water sources (as reported by water station, sector expert, water trucking and piped network KIs)

Already adopted	Piped network and sector expert KIs	• Water consumption monitoring • Water rationing and conservative distribution
Tried to adopt but could not implement	Water Station KIs	• Regulating expansion and digging of public and private wells • Connection with solar energy to operate equipment
Neither adopted nor thinking of adopting	Water trucking KIs	

Farmer and livestock KIs in Tal Brak noted that no sustainable practices for management of agro-livelihood water resources were being used at the time of data collection due to a lack of funds. However, support to farmers and livestock owners for sustainable water irrigation and tending practices was noted by most KIs as areas of improvement that could increase the availability of water for livelihood purposes in this area and improve agro-based activities.

Sustainable water practices that could be implemented by farmers and livestock owners for irrigation (†) and tending livestock (‡) (by the type of practice for each, as reported by farmer and livestock KIs)

- **Efficient water delivery systems like irrigation canals, watershed reserves, etc.** †
- **Drip irrigation[23]** †
- **Alternative energy source for farming machinery (solar power)** †
- **Reclaimed water usage to tend to livestock** ‡

Type of assistance needed to incorporate sustainable practices (as reported by farmer and livestock KIs)

- **Training on implementation** †
- **Equipment** †
- **Inputs**
  - **Seeds, organic fertilisers, etc.** †
  - **Organic fodder, water treatment material, etc.** ‡

Findings suggest that, while local water management and maintenance actors were generally interested in adopting sustainable water management practices to improve the availability of water for the population, they often lacked the resources necessary to implement such practices. Furthermore, in the absence of coordinated support from the local authorities for livelihood activities, adoption of sustainable practices for agro-based livelihoods seems to have remained dependent on the capacities and perceptions of individual farmers and livestock owners, resulting in inconsistent uptake, despite interest.

OVERALL AREAS OF IMPROVEMENT

The absence of sufficient electricity to operate infrastructure was a recurring theme in the assessment. Across the region, the lack of electricity affected not only HH private consumption but posed a serious barrier to the functioning of necessary infrastructure and services. Fluctuations in electricity also led to frequent breakdown of electrical transformers and generators at the water stations (see pg. 5), and electrical malfunctions in the piped network operations (see pg. 7). Communities without access to piped network systems also reportedly resorted to drawing illegal connections from the main pipelines as the expansion of piped network coverage had not kept pace with the urban expansion in and around Tal Brak area, according to sector expert KIs. These illegal connections added more burden on the existing network, and led to water insufficiency in the neighbourhoods legally connected to the piped network (see pg. 7).

Overall areas of improvement to increase the functionality and serviceability of the water stations, tanks, and piped network (as reported by water station and piped network KIs)

- **Plan for regular inspection and maintenance**
- **Infrastructural improvements like additional water storage capacity, stronger pipelines, etc.**
- **Better access to parts and equipment needed to increase functionality like electrical cables, submersible pumps, etc.**
- **Have sustainable alternatives for source of power**
- **Increased funding for regular maintenance**

According to all KIs, there were no provisions for regular maintenance or inspections for any type of water infrastructure or service provisions. Repair work was done only on ad hoc basis, or when needed, or when operations were entirely disrupted in an emergency. While KIs for all KI groups noted that regular maintenance of the water stations and tanks, piped network, and water trucks was important to improve the functionality of the infrastructure and services, all KIs noted that they were unable to conduct regular maintenance work or cope with any service disruptions independently. The water station KIs further noted that the funding allocation for their maintenance activities had been cut in the last year by higher authorities. As a result, maintenance work had to be conducted from the overall budget of Tal Brak Municipality which covered other responsibilities in the area as well. This reduction in their budget posed the biggest challenge in their capacity to conduct regular maintenance and find longer term solutions for persistent issues. A lack of sufficient machinery and equipment was also a major challenge in conducting these repairs. This lack of adequate tools was further highlighted by some sector expert KIs who noted that repair equipment and tools were often shared and rotated between various municipalities and departments, causing delay in fixing issues and prolonging the period of service disruption.

Facilities that the water stations need but management actors are not able to access
(as reported by water station KIs)

- **New storage tank with increased capacity**
- **Alternative electricity sources**
- **Stronger pumping equipment to improve water pressure**
- **Pipe replacement**
- **Water tank and pipe cleaning materials**

Facilities that the piped network need but management actors are not able to access
(as reported by piped network KIs)

- **Stronger pumping equipment to improve water pressure**
- **Alternative electricity sources**
- **Pipe cleaning materials**
- **Robust connection between main pipeline connecting the water station and tank to sub-pipelines in a network**

SPECIFIC REQUIREMENTS TO IMPROVE OPERATIONS OF KEY INFRASTRUCTURE AND SERVICES (triangulated for all KIs)

- Upgrading the electrical supply cables at the water stations that can withstand power fluctuations; Changing and replacing the electrical supply cables in both the stations from 90 mm to 150 mm.
- Replacement of old circuit breakers at the water stations to avoid regular electrical faults.
- Extensive repair/maintenance of the two transformers at Tal Adhan station, or installation of a third transformer to support the operations.
- Installation of electricity generators at Tal Mishiya station in order to pump appropriate quantities of water into the Tall Temmi tank.
- Construction of additional main pipeline connecting Tal Adhan station and Tal Brak tank to relieve pressure on the existing pipeline.
- Setting a comprehensive plan for equitable water distribution mechanism and expansion of the piped water network in the surrounding communities experiencing rapid urban expansion.
- Construction of additional ground storage tank in Tal Brak with a capacity of 1,500 barrels to support the existing water tank.
- Replacement of old submersible pumps and pipes at Tal Adhan station.
- Provision of regular electricity supply by adding solar panels to operate the stations and piped network; Solarisation of pumps used by farmers to extract water through private wells.
- Support to farmers and livestock owners for adoption of sustainable water irrigation and tending practices; provision of equipment and inputs required for adopting sustainable agro-livelihood techniques.
- Expansion and rehabilitation of all private wells, boreholes, and underground aquifers used by water stations to source water.
- Provision of disinfectants (chlorine) to farmers and livestock owners for maintenance of clogged wells, and borehole covers to protect groundwater from debris and garbage.
- Provision of additional water trucks and/or repairing existing trucks to increase service coverage in the villages surrounding Tal Brak that are dependent on water trucking services.
- Provision of equipment, devices and tools for repair and maintenance of stations and piped network, or funding to procure equipment needed for maintenance - welding machines, generators, water pumps with higher pumping capacity, replacement pipes that can withstand high pressure, etc.

WATER RESILIENCE IN TAL BRAK

Shifts in the hydrological cycle, declining economic conditions in the region, and stretched capacities of local stakeholders affect the resilience of water systems and the populations that rely on them.[24] Assessing where a potential lack of resilience stems from is crucial for resilience programming, especially given the context of drought and water shortages in northeast Syria, and its implications on the long-term sustainability of existing water resources.

Secondary data review of various resilience frameworks[25, 26, 27, 28] indicated that measuring water resilience can take multiple approaches, focusing on one, all, or a combination of levels like HH/individual-, institutional/stakeholder- and/or service/system-level information. The water ABAs and 2021 multi-sectoral ABA explore components of resilience on all three levels. Triangulating the data from both assessments result in a resilience-focused indicator pool that collates information across the three main levels. Specifically, the attributes that could identify resilience of critical infrastructure, stakeholders, and HHs in an area include, but are not limited to; the presence of water assets/infrastructure, functionality and operationality of available assets and services, management and maintenance capacities of local actors, capacity of all local stakeholders to respond to shocks and stresses, water sufficiency, accessibility to water for all purposes, the ability of the general population to cope with or recover from water-related shocks and stresses, etc.

Understanding the key elements of these three levels of resilience could provide insights into recovery improvements and interventions that could foster and strengthen water-related resilience of communities, and increase self-sufficiency. To this end, findings from the resilience-focused indicator pool from the water ABA and the 2021 multi-sectoral ABA have been summarized in this section to explore overall resilience of the water system and community members in Tal Brak area.[c]

Water resilience

Systems level + Institutional level + Individual level

Indicator response value key:[c]		
Yes	Somewhat	No
✓	!	✗

Response positivity key:[d]	
Positive indication	Negative indication
Green	Red

Systems-related water resilience-focused indicators and their extent of presence in Tal Brak (triangulated for all KIs and the 2021 Multi-sectoral ABA)

Presence of water stations in or in close proximity to the area	✓ (Yes, positive)
All water stations are fully functional	! (Somewhat, negative)
Presence of piped water network in the area	✓ (Yes, positive)
Connectivity of piped network to all neighbourhoods	✓ (Yes, positive)
Presence of alternative/backup water services in the area	✓ (Yes, positive)
Piped network fully functional	! (Somewhat, negative)
HHs using piped network as the primary source of water[a]	✓ (Yes, positive)
HHs satisfied with the quantity of water available[a]	! (Somewhat, negative)
HHs satisfied with the quality of water available[a]	✓ (Yes, positive)
HH source of water does not vary according to season[a]	✓ (Yes, positive)
HHs reporting water is sufficient to meet basic needs[a]	✓ (Yes, positive)

Institutional water resilience-focused indicators and their extent of presence in Tal Brak (triangulated for all KIs and the 2021 Multi-sectoral ABA)

Presence of local water management structures	✓
Local management actors support/maintain water sources used for livelihood purposes	✗
Local water management coordination structures being followed in practice	✓
Local water management actors have the capacity to conduct regular maintenance of infrastructure and services	✗
Management actors able to cope with faults/repairs independently	✗
Management actors adapting sustainable water management practices	✓

Individual water resilience-focused indicators and their extent of presence in Tal Brak (triangulated for all KIs and the 2021 Multi-sectoral ABA)

Farmers and livestock owners able to cope with decrease in agricultural yield and productivity due to water scarcity	✗
HHs incorporating negative coping strategies to fulfill water needs[a]	!
Farmers and livestock owners abandoning agricultural land	✓
HHs practicing water collection or conservation techniques[a]	✓
Farmers and livestock owners adapted sustainable practices for agro-based activities	✗

The presence of key water infrastructure and services (piped, and backup such as water trucking), and defined local management structures to maintain them highlight that the water resilience of systems and institutions is better than the individual/HH-level resilience in Tal Brak. Farmers and livestock owner KIs noted that farmers in the area were unable to cope with water shortage and its effect on agricultural productivity and, as a result, were resorting to extreme coping strategies such as cropland abandonment to pursue other income-generating activities. Out of those HHs that reported water insufficiency (20%)[a], several HHs reported using negative coping strategies to cope with the lack of water, signalling weaker resilience of some HHs and overall, somewhat weak resilience at the HH-level in the area. Sustainable management and usage of water resources is a key factor in understanding the resilience of communities and stakeholders, since it showcases the capacities of these entities to be able to use and maintain the available resources in the long term. Reflecting the responses of management actors, and farmers and HHs,[a] institutional and individual-level resilience could be advanced and further improved in terms of adapting sustainable water management, usage, and conservation practices.

CHALLENGES AND LIMITATIONS

1. All information and findings noted by the KIs should be considered indicative only.
2. While it was originally anticipated that through the sector experts and farmers and livestock owners KIs REACH would be able to map out all water sources used for livelihood activities, it was found that the FGD setting was not the sufficient means to mark livelihood-specific water sources. It was noted by all KIs that private wells were the most common sources of water for agriculture and livestock tending and almost every plot of farmland had its own private well, managed and owned by individuals. This meant that it was not possible to locate all the private wells on the map through FGDs due to the inability of the KIs to determine the points of the wells with any accuracy across large areas, and such a mapping would require more resources with on-ground level mapping through field visits and site inspections.
3. Due to regional traditions and contextual circumstances, it was found that there are limited female stakeholders and actors who were in decision-making positions within the local authorities' departments and institutional bodies. While REACH field teams did their best to find and invite female stakeholders that hold such positions, the representation of women in this assessment is limited.
4. All the findings presented are based on self-reporting and the perceptions of the KIs. Due to inherent biases in self-reporting, there may be under-or over-reporting of certain aspects. This could be particularly likely for themes such as those relating to the management capacities of with local stakeholders.

KEY DEFINITIONS

Area: An area refers to a geographically defined area with administrative boundaries. Areas can be both service and community based.[29]

Area-based approach: An area-based approach is a geographically targeted, multi-sectoral, multi-stakeholder, and participatory programmatic approach which may be applied in both urban and rural settings.[30]

Functionality of water infrastructures:

- **Fully functional** – An infrastructure is fully functional when it can work and function as expected, in its full capacity, and with little or no issues.
- **Partially functional** – An infrastructure is partly or partially functional when it works but not at its full capacity, and with significant issues that ultimately affect the quality/availability of its services. Partially functional infrastructures can be made fully functional with repair and maintenance of certain parts and machinery of the full system.
- **Non-functional** – An infrastructure is considered non-functional when it exists in the area but doesn't function or operate at all. These infrastructures are unable to provide any service unless they are completely fixed/rehabilitated/overhauled to restore their functionality.

Integrated water resource management strategy: Integrated water resources management strategy refers to a process which promotes the coordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.[31]

Resilience: Resilience is the ability of an individual, a household, a community, a system and/or a country to cope with, adapt and recover from shocks and stresses. Resilience covers all stages of a shock or stress, from prevention (when possible) to adaptation (when necessary), and includes positive transformation that strengthens the ability of current and future generations to meet their needs and withstand crises.[32, 33]

Resilience indicators: Qualitative and/or quantitative metrics to track the impacts of the actions on resilience of the system and/or stakeholder(s).[34]

Service area: A service area is a catchment area for services and/or markets. These are often, but not necessarily, linked to administrative and/or geographical boundaries and denote which and what services are being catered to particular neighbourhoods/communities/sub-areas within a larger area.[35]

Stakeholder: A stakeholder can be a person, group of people, sector, company, agency, community or organisation that influences or is influenced by the use and governance of a common set of resources.[36]

System: A set of interconnected socio-economic, institutional, governance, infrastructure, management and biophysical components that function as a whole.[37]

Water governance and management: Water governance refers to the political, social, economic and administrative systems in place that can influence water use and management. It determines the equity and efficiency in water resource and services allocation and distribution, and balanced water use between socio-economic activities and ecosystems.[38]

Water infrastructure: Water infrastructure refers to a broad term for systems of water supply, treatment, storage, water resource management, flood prevention and hydro-power. The term also includes water transportation systems such as canals, pipelines, etc.[39]

Piped water network: Water networks are a system of pipes and trenches providing the appropriate quality and quantity of water to a community.[40]

Water resilience: Water resilience is commonly understood as the ability of water systems to withstand a variety of water-related shocks (floods, droughts, changes in water quality) without losing their ability to support key functions, as well as the ability of water systems to transform and adapt to new hydrological systems.[41]

Water resources: Water resources means all waters of the area occurring on the surface, in natural or artificial channels, lakes, reservoirs, or impoundments, and in subsurface aquifers, which are available, or which may be made available to agricultural, industrial, commercial, recreational, public, and domestic users.[42]

Water resource/infrastructure management: The process of planning, developing, and managing water resources, in terms of both water quantity and quality, across all water uses. It includes the institutions, infrastructure, incentives, and information systems that support and guide water management.[43]

Water station: Water station refers to a facility for supplying potable water to the water storage tanks of trailers or other potable water containers.[44]

ENDNOTES

a. REACH (May 2022). Northeast Syria: Tal Brak, Al-Hasakeh - Area Profile.

b. At the time of data collection.

c. For the full list of the questions and option choices on which the resilience indicators are based on please refer to Annex 1 on pg. 22.

d. Positive indication means that presence/"extent" of that indicator is a positive factor contributing to the resilience of the system/institution/HH. Presence of a negative "indicator" denoted weaker resilience.

1 REACH (April 2022). Briefing Note: Humanitarian Impact of Water Shortages in Northeast Syria.
2 UN Office for the Coordination of Humanitarian Affairs (OCHA) (September 2021). Water Crisis in Northern and Northeast Syria - Immediate Response and Funding Requirements.
3 REACH (April 2022). Briefing Note: Humanitarian Impact of Water Shortages in Northeast Syria.
4 Northeast Syria Cash Working Group (October 2022). Northeast Syria Joint Market Monitoring Initiative (JIMMI).
5 REACH (April 2022). Briefing Note: Humanitarian Impact of Water Shortages in Northeast Syria.
6 REACH (2021-2022). Northern Syria Area-Based Assessment.
7 MFGD participants and KIs, in the 2021 multi-sectoral ABA[a], estimated that of the total HHs residing in Tal Brak, 75% of HHs were returnees, 24% were non-displaced residents, and 1% were IDPs. For reporting purposes, the proportion of non-displaced residents and returnees have been combined into one category i.e. the host/resident population (99%).
8 IMPACT Initiatives (January 2020). Establishing minimum standards for data cleaning & processing at IMPACT.
9 IMPACT Initiatives (October 2020). IMPACT Minimum Standards Checklist for Semi-Structured (Qualitative) Data Processing and Analysis.
10 International Rescue Committee (March 2022). Syria 11 years on: Hunger, drought and a collapsing economy threatens even more misery for millions, the IRC warns.
11 Climate Hazards Group InfraRed Precipitation With Station Data, Version 2.0 Final (CHIRPS) were used to calculate the rainfall sum in mm per month per pixel. For the charts, the spatial mean of the monthly sum was calculated using all pixels that fall within the area of the community. The historical mean for each month of the year was calculated based on the time period 1981-2016 (35 years). CHIRPS data have a spatial resolution of 0.05 degrees (≈ 5.5km).
Climate Hazards Center, University of California, Santa Barbara. CHIRPS: Rainfall Estimates from Rain Gauge and Satellite Observations.
12 Surface Model Copernicus Land Monitoring Service (CLMS) L4 data was used to calculate groundwater storage (GWS) anomalies. Global Land Data Assimilation System (GLDAS) CLMS is produced with Gravity Recovery and Climate Experiment (GRACE) data assimilation. GRACE satellites observe changes in the Earth's gravity field (i.e., movements of mass such as water bodies or aquifers) from which changes in the amount of stored water can be derived. The GLDAS CLSM product has a spatial resolution of 0.25 degrees (approx. 27-28 km). The charts include three graphs:

i) Monthly GWS anomalies represent the deviation from the baseline 2004-2009 average.

ii) The annual GWS graph represents the average anomaly for each annual cycle (November-October).

iii) The trend graph describes the change in the annual average anomaly from 2003-2021 over time. The slope indicates the change in mm per year and the r-squared value indicates the strength of the relationship between the annual average anomaly and time, i.e., the statistical significance of linear trend. National Aeronautics and Space Administration (NASA) Goddard Earth Sciences Data and Information Services Center (GES DISC). NASA Earth Data: GES DISC.

13 R. Chesnaux (January 2012). Uncontrolled Drilling: Exposing a Global Threat to Groundwater Sustainability
14 Food and Agriculture Organization (FAO) (December 2021). 2021 FAO Crop and Food Supply Assessment Mission to the Syrian Arab Republic.
15 NDVI is used to quantify vegetation greenness and useful to understand vegetation health or vegetation condition. High NDVI values correspond to healthy vegetation while low NDVI corresponds to unhealthy or little vegetation. As for annual crops, high NDVI values correspond to crops at their peak growth stage. Lower NDVI values reflect crops in their growing period before they have reached their peak growth stage or bare soil after harvest or during land preparation process before plant growth starts. REACH used NASA Landsat surface reflectance products with a spatial resolution of 30m to compute NDVI. For each season an anomaly map was computed by subtracting the historical average (2000-2019) from the seasonal NDVI using the images from November to May (e.g., November 2021-May 2022). The anomalies are presented in percentage deviation from the historical average. For the time series charts, monthly NDVI and NDVI anomalies were computed using all pixels within the agricultural boundaries of the respective community. A monthly anomaly is computed by subtracting the historical average of the respective month of the year from the monthly NDVI value, e.g., Aug 2022 anomaly = Aug 2022 – historical average for August. Annual cropland maps produced by UNOSAT. For the cropland mask for Rweished, a

combination of the 2018-2021 maps was used.NDVI values should not be interpreted directly as crop yield, as there is not necessarily a linear relationship between NDVI and crop yield. NASA. Landsat Science.
16 Ibid.
17 Ibid.
18 Ibid.
19 Ibid.
20 REACH (April 2022). Briefing Note: Humanitarian Impact of Water Shortages in Northeast Syria.
21 Ibid.
22 Consortium of International Agricultural Research Centers (CGIAR) (February 2021). Achieving Sustainable Agricultural practices: From Incentives to Adoption and Outcomes.
23 Drip irrigation is the practice of applying small amounts of water and fertilizer uniformly across a specific area. The water and fertilizer are delivered directly to the crop root zone, eliminating runoff, evaporation, and drift. Eco-Drip (2022). What is Drip Irrigation?
24 A. Chapagain et al. (2021). Water Resilience Assessment Framework.
25 Mercy Corps (July 2017). Stress: Strategic Resilience Assessment.
26 Manish Sharma, et al. (May 2022). Measuring urban water resilience at household level: A comparative study through a framework for developing countries.
27 A. Chapagain, et al. (2021). Water Resilience Assessment Framework.
28 Arup (April 2019). The City Water Resilience Approach.
29 IMPACT Initiatives (March 2019). Area-Based Assessment with Key Informants - A Practical Guide.
30 Ibid.
31 UN Environment Programme. What is Integrated Water Resources Management?
32 European Commission (March 2021). Resilience & Humanitarian-Development-Peace Nexus.
33 CARE (2020). Understanding Resilience: Perspectives from Syrians.
34 A. Chapagain, et al. (2021). Water Resilience Assessment Framework.
35 IMPACT Initiatives (March 2019). Area-Based Assessment with Key Informants - A Practical Guide.
36 A. Chapagain, et al. (2021). Water Resilience Assessment Framework.
37 Ibid.
38 Ibid.
39 Ibid.
40 Sustainable Sanitation and Water Management University. Network Design and Dimensioning.
41 Lucy Rodina (July 2019). Water resilience lessons from Cape Town's water crisis.
42 Manish Sharma, et al. (May 2022). Measuring urban water resilience at household level: A comparative study through a framework for developing countries.
43 Arup (April 2019). The City Water Resilience Approach.
44 A. Chapagain, et al. (2021). Water Resilience Assessment Framework.

ANNEX 1: RESILIENCE INDICATOR QUESTIONS AND RESPONSES

Resilience-focused indicator	Assessment sources - Data collection type	Source question as asked in the surveys	Answer options	Assumptions and choices to allocate response value for the indicator
Systems-related water resilience-focused indicators				
Presence of water stations in or in close proximity to the area	Water ABA - Water station manager MFGD	How many water stations are present in and around this area that provides their service to populations within this area?	{Open-ended response}	Water stations present = Yes; Water station not present = No
All water stations are fully functional	Water ABA - Water station manager MFGD	Please tell us about the functionality of the water stations marked on this map (Fully functional, partially functional, non-functional?)	{Open-ended response}	Fully functional = Yes; Partially functional = Somewhat; Non functional = No
Presence of piped water network in the area	Water ABA - Piped network operator MFGD	What are the types of water sources in this area that the piped networks are connected to?	{Open-ended response}	Piped network present = Yes; Piped network not present = No
Connectivity of piped network to all neighbourhoods	Water ABA - Piped network operator KI PD	Are there neighbourhoods in this area that need to be connected with the piped network system but are not connected yet?	Yes; No; Do not know	No (Piped network connected to all neighbourhoods) = Yes; Yes (There are neighbourhoods that need to be connected) = No
Presence of alternative/backup water services in the area	Water ABA - All KI groups	{Through content analysis}	{Relevant information to check: Presence of public or private water trucking services? Water sourced from another water station?, etc.}	Alternative services present = Yes; Alternative services not present = No
Piped network fully functional	Water ABA - Piped network operator MFGD	Please tell us about the functionality of the piped water networks marked on this map (Fully functional, partially functional, non-functional?)	{Open-ended response}	Fully functional = Yes; Partially functional = Somewhat; Non functional = No
HHs using piped water as the primary source of water	2021 ABAs - HH-level interviews	What is the main source of drinking water used by your household?	Piped water network; Public tap/standpipe; Free community borehole or well; Paid community borehole or well; Private borehole or well; Surface water (lake, pond, dam, river); Springs; Rainwater collection; Water trucking conducted by authorities or an NGO; Private water trucking conducted by private citizens; Bottled water; Other (specify)	Largest proportion of HHs selecting "Piped water network" as the primary source of water = Yes; Largest proportion of HHs selecting another option choice = No

Resilience-focused indicator	Assessment sources - Data collection type	Source question as asked in the surveys	Answer options	Assumptions and choices to allocate response value for the indicator
HHs satisfied with the quantity of water available	2021 ABAs - HH-level interviews	How satisfied are you with the quantity/ amount of water available from this source?	Very satisfied; Satisfied; Neutral; Dissatisfied; Very Dissatisfied	Proportion of HHs selecting "Very satisfied" + Proportion of HHs selecting "Satisfied" is greater than 50% = Yes; Proportion of HHs selecting "Very dissatisfied" + Proportion of HHs selecting "Dissatisfied" is greater than 50% = No; If neither of the above = Somewhat
HHs satisfied with the quality of water available	2021 ABAs - HH-level interviews	How satisfied are you with the quality of water available from this source (taste/smell/ cleanliness/etc.)?	Very satisfied; Satisfied; Neutral; Dissatisfied; Very Dissatisfied	Proportion of HHs selecting "Very satisfied" + Proportion of HHs selecting "Satisfied" is greater than 50% = Yes; Proportion of HHs selecting "Very dissatisfied" + Proportion of HHs selecting "Dissatisfied" is greater than 50% = No; If neither of the above = Somewhat
HH source of water does not vary according to season	2021 ABAs - HH-level interviews	Do your household's water sources vary depending on the season?	Yes; No	Highest proportion of HHs selecting "No" = Yes; Highest proportion of HHs selecting "Yes" = No
HH reporting water sufficiency to meet basic needs	2021 ABAs - HH-level interviews	Has your household had enough water to meet its basic needs in the last 3 months?	Yes; No	Highest proportion of HHs selecting "Yes" = Yes; Highest proportion of HHs selecting "No" = No
Institutional water resilience-focused indicators				
Presence of local water management structures	Water ABA - All KI groups	Please identify and map the main actors and decision makers involved in the management and maintenance of each water stations in this area.	{Open-ended response}	Local management structure present = Yes; Local management structure not present = No

Resilience-focused indicator	Assessment sources - Data collection type	Source question as asked in the surveys	Answer options	Assumptions and choices to allocate response value for the indicator
Local water management coordination structures being followed in practice	Water ABA - All KI groups	Is this structure actually followed in practice? If not, why?	{Open-ended response}	Followed in practice = Yes; Variation in coordination structure and how activities conducted on-ground = No
Local water management actors have the capacity to conduct regular maintenance of infrastructure and services	Water ABA - All KI groups	How regularly maintenance work is done? If some repair or maintenance work was required but not done or partially done, why so?	{Open-ended response}	Regular maintenance work is done = Yes; Not done regularly/done on ad-hoc basis/ only done in emergency or when an issue disrupts services/lack financial capacity = No
Management actors able to cope with faults/repairs independently	Water ABA - All KI groups	If you needed to make improvements, would you need external support in doing so? If yes, what type of support would you need?	{Open-ended response}	No, do not need external support = Yes; Yes, need external support = No
Management actors adapting sustainable water management practices	Water ABA - Water station manager KI PD - Sector expert KI PD - Water trucking KI PD - Piped network KI PD	Have you adopted or thinking of adopting any sustainable practices for management of the water sources/resources in the area?	Not involved in the management of water sources at all; Yes - already adopted; Yes - thinking of adopting; No - neither adopted nor thinking of adopting; Tried to adopt but could not implement	At least two out of four of these KI groups reporting adoption of sustainable water management practices in the area = Yes; Only one KI group reporting adoption of sustainable water management practices in the area = Somewhat; No KI group reported adoption of sustainable water management practices in the area = No
Individual water resilience-focused indicators				
Farmers and livestock owners able to cope with decrease in agricultural yield and productivity due to water scarcity	Water ABA - Farmer and livestock owner KI PD	How are farmers in the area coping with/ managing these issues?	Not doing anything/unable to manage or cope; Treating water at own cost before use; Abandoning cropland; Using stronger fertilisers and chemicals; Sourcing water from other locations/ outside area where water quality is better	KIs selected any other option besides " Not doing anything/unable to manage or cope" or " Abandoning cropland" = Yes; KIs selected " Not doing anything/unable to manage or cope" or " Abandoning cropland" = No

Resilience-focused indicator	Assessment sources - Data collection type	Source question as asked in the surveys	Answer options	Assumptions and choices to allocate response value for the indicator
HHs incorporating negative coping strategies to fulfill water needs	2021 ABAs - HH-level interviews	What measures have you or household members taken to cope with the lack of water in the last 3 months?	Reduce consumption of drinking water; Reduce consumption of non-drinking water; Spend money usually spent on other things to buy water; Receive water on credit; Borrow water from friends/family; Exchanging goods or other favours in order to receive water; Rely on drinking water stored previously; Drink water from a source known to be of bad or unsafe quality; Collect water from a dangerous place; Collect water from a source that is further away than the usual one; Other (specify)	If at least 50% of the HHs that reported that they did not have enough water to meet their basic needs in the last 3 months select "Reduce consumption of drinking water" or "Reduce consumption of non-drinking water" or "Drink water from a source known to be of bad or unsafe quality" or " Collect water from a dangerous place" = Yes; If 20% to 49% of the HHs that reported that they did not have enough water to meet their basic needs in the last 3 months select "Reduce consumption of drinking water" or "Reduce consumption of non-drinking water" or "Drink water from a source known to be of bad or unsafe quality" or " Collect water from a dangerous place" = Somewhat; If less than 20% of the HHs that reported that they did not have enough water to meet their basic needs in the last 3 months select "Reduce consumption of drinking water" or "Reduce consumption of non-drinking water" or "Drink water from a source known to be of bad or unsafe quality" or " Collect water from a dangerous place" = No
Farmers and livestock owners abandoning agricultural land	Water ABA - Farmer and livestock owner KI PD	Has there been any cropland abandonment in and around this area in the last two years?	Yes; No; Do not know	KIs selected "Yes" = Yes; KIs selected "No" = No
HHs practicing water collection or conservation techniques[a, f]	2021 ABAs - HH-level interviews	Does your household currently practice any water collection or conservation techniques?	None; Rainwater collection; Re-use of water; Water conservation	HHs selecting any other option choice(s) except "None" and the combination thereof was greater than 50% = Yes; Proportion of HHs selecting "None" greater than 50% = No
Farmers and livestock owners adapted sustainable practices for agro-based activities	Water ABA - Farmer and livestock owner KI PD	Are there any sustainable practices for management of the water sources/resources in the area that are already being utilised by farmers and livestock owners?	Yes; No; Do not know	KIs selected "Yes" = Yes; KIs selected "No" = No