ASSESSMENT ON ACCESSIBILITY TO SUFFICIENT AND QUALITY WATER IN WATER-STRESSED AREAS IN LIBYA

Executive summary:

Water Scarcity in Libya, its drivers, and impacts.

According to the National Water Stress Rankings of the World Resources Institute, Libya is among the top 10 countries with extreme high-water stress.[1] Both natural and human factors affect the ability of the Libyan population to access water resources and address its basic needs. In particular, climate factors determining water's availability, such as low precipitation rates and high temperature, combine with social and political factors, which play a key role in influencing the sustainability of Libya's infrastructures and the regular provision of good-quality water to all the country's regions.
In addition, Libya's almost exclusive reliance on groundwater as its main water source is a challenge that contributes to the depletion of water resources as well as the degradation of the quality of water as shown by several scientific studies.[2] This is driven by the over-exploitation of groundwater resources to meet increasing water needs, stemming from intensive irrigation activities, growing demand for water for domestic use in the Northern region, and the overall improvement of living standards in the region. In this sense, the transition to alternative water sources and the reliance on techniques such as water desalination or sewage water treatment appears as a necessity to mitigate the risk of water stress in Libya and prevent the exacerbation of water needs in the most water-stressed regions.

Besides climate factors, maintenance of water infrastructures remains a problem in a fragile political context hindering the development of sustainable public policies and the implementation of structural reforms to ensure the functionality and the upgrading of infrastructures that have been exposed to armed conflicts since 2011. In areas where households struggle to secure consistent access to good-quality water resources, common coping strategies such as connecting informally to the public network have contributed to a weakening of the functionality and management of the public water supply system.

Summary of key findings:

a. Overall, **most households reported having enough water to meet their needs**, although 27% do not fully meet their water households needs. Drinking and hygiene needs were most frequently reported as the most important household needs that are not fully met, by 50% and 40% of respondents respectively. Households in Derna, Sirt, and Sebha mainly **rely on bottled water and water from the public network for drinking and cooking purposes**. Almost half (44%) of households use bottled water for drinking purposes because of the poor water quality from the public network. The factors affecting the quality of water mentioned by the key informants are groundwater over-exploitation (causing seawater intrusion), the lack of regular and effective maintenance of WASH infrastructures as well as wastewater overflow. For other purposes such as hygiene, washing clothes, and cleaning the house, the most reported source of water was the public network. Other sources such as water trucking, protected wells, and boreholes are also reportedly used for these purposes and often help fill the gap by providing

[1] Water stress occurs when the demand for water exceeds the available amount during a certain period or when poor quality restricts its use. Water stress causes deterioration of freshwater resources in terms of quantity (aquifer over-exploitation, dry rivers, etc.) and quality (eutrophication, organic matter pollution, saline intrusion, etc.), European Environmental Agency
[2] MEWINA, Libya Water Sector M&E Rapid Assessment Report, 2014

access to water (especially in Derna where key informants (KIs) reported maintenance works caused an interruption of the supply from the public network). 28% of households reported that **their livelihood activities had been affected by lack of sufficient water resources** during the previous six months. The most common water sources used for livelihood activities are reportedly water from the public network (50%) and water trucking (25%).

b. Various **factors hindering households' access to sufficient and clean water sources** have been reported by interviewed households and key informants. For example, in Derna, a large percentage (57%) of households reported rarely having access to water from the public network. Electricity is one of the factors causing issues with the regular supply of water. Frequent power cuts, especially in summers, cause regular water outages. According to all KIs in Derna, electricity was constantly cut off for two months until the end of the month of March and consequently water supply was also interrupted. In Sebha, 5 KIs mentioned that power cuts occur very often (more than 10 times a year) (4/6) or everyday (1/6). In addition, water expenditures can be an economic burden with 38% of HHs reporting that their current expenditures on water is negatively affecting their savings. According to the 30% of households that noticed a change in prices of one of their water sources in the last 12 months, 87% reported that water trucking prices have increased in the last year. Besides electricity cuts and long-lasting and ineffective maintenance works leading households to resort to alternative, expensive water sources, security incidents affecting water infrastructure can also have an important impact on the water supply. The most frequent incidents highlighted by key informants consist in the theft of equipment including but not limited to pumps, electrical cables, and vehicles, from WASH infrastructure. Finally, armed conflicts also reportedly had long-lasting and sometimes irreversible consequences on water infrastructure.

c. In order to **cope with the poor quality of water**, 40% of households treat water before drinking it. They mainly filter it or use chlorine or other disinfection products. Treatment strategies are frequently use by households before cooking, 35% treat the water before using it for preparing food by boiling it, filtering it, or using chlorine or other disinfection products. The use of bottled water is very frequent in the assessed locations for drinking as well as for cooking purposes. Besides being the primary source used for drinking purposes in Sirt and Derna, it is also the main source for preparing food in Derna. Water trucking is also an important source generally used to cope with the regular water outages, although households and key informants reported that it is expensive.

d. **Most of the surveyed households are connected to the public network without an official subscription to the General Company for Water and Wastewater (GCWW)**. In Derna, the percentage of households connected to the public network with an official subscription is higher than in Sebha and Sirt. Although 89% of households in Sirt and all respondents in Sebha never pay water fees to access water from the public network, 37% of households in Derna pay fees every time or most of the time they are due. Even if the management of the public network seems more regulated in Derna, the interviewed KIs mentioned that frequent water outages dissuade households from paying their fees regularly. KIs mentioned that the fees do not match the current water consumption of households. This was echoed by the 50% of households with an official subscription to the GCWW (15% of all households) who reported that water fees are lower than the value of the service. Relating to this, although most households know what a water meter is, almost all respondents reported that they do not have one and 46% are not willing to get one. Finally, KIs report that informal connections created without notifying the GCWW are also widespread in the country, have negative impacts on the functionality of water infrastructure, and regularly cause leaks.

e. Most (56%) **households that encountered a problem with their main water source approached the GCWW** to fix the problem (even if they don't necessarily have an official subscription to the public network) and 31% contacted a neighbourhood or a community representative across all assessed municipalities. In contrast to other municipalities, most of the surveyed households in Sebha prefer to rely on community leaders to fix their problem (57%). In addition, 38% of households rate the **overall level of service from the public water supply system** as poor or very poor and 43% rated the **GCWW receptiveness to complaints** as poor

or very poor. The main suggestions formulated by households to improve the water supply services are to "increase the number of hours per day that water is supplied" and to "improve existing infrastructure of the water supply system".

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List of Acronyms

MMRP: Man-Made River Project
WASH: Water, Sanitation and Hygiene
KII: Key Informant Interview
GCWW: General Company for Water and Wastewater
GIS: Geographic Information System Mapping
ACLED: Armed Conflict Location & Event Data Project
MSNA: Multi-sectoral needs assessment
NWAS: North-Western Sahara Aquifer System
NSAS: Nubian Sandstone Aquifer System
GEF: Global Environment Facility
UNDP: The United Nations Development Programme
UNESCO: The United Nations Educational, Scientific and Cultural Organization
IAEA: The International Atomic Energy Agency
GRACE: The Gravity Recovery and Climate Experiment
GDC: General Desalination Company
LYD: Libyan Dinars
ABA: Area-Based Assessment
MMRA: Man-Made River Authority
BMZ: Federal Ministry for Economic Cooperation and Development

Geographical Classifications

Region: Administrative level 1
Mantika: Administrative level 2
Baladiya: Administrative level 3
Muhalla: Administrative level 4

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Introduction:

Rationale of the assessment:

Groundwater, the main source of water in Libya:

Libya is located in a dry region with an average yearly rainfall of less than 100mm[2] and has limited access to surface water resources. Within the country, regional variations can be observed, with the southern area (Fezzan) being particularly dry and having an average yearly rainfall of around 10mm.

Libya mainly relies on groundwater. There are two types of groundwater resources in Libya: renewable and non-renewable. Renewable resources originate from shallow aquifers (mainly located in the northern region of the country) that obtain water from rainfall and surface runoff[3]. Non-renewable resources are represented by deep aquifers (fossil water), found in the Southern region of Libya, beneath the Sahara Desert, mainly belonging to the Nubian Sandstone Aquifer System.[3] Fossil water resources were first discovered in the Al Kufra area in 1953 during exploration drilling for oil.[4]

Seawater desalination and treated wastewater represent 2.7% of Libya's water resources while groundwater represents 97% of the total volume of water used for agricultural, industrial and domestic purposes[5]. Although the establishment of desalination plants started in the sixties and there are currently about 21 operating desalination plants, all efforts in the last decades have been directed to complete the Man-Made River Project, which is considered one of the biggest engineering projects in the world, to the detriment of desalination technology.

Depletion and alteration of water quality:

Excessive groundwater extraction due to the increasing water demand for domestic purposes and for agricultural and economic activities has resulted in the decline of water levels from fossil aquifers and the contamination of coastal aquifers in the form of seawater intrusion. Oil drilling is another factor affecting the quality of water in Libya, exposing fossil aquifers to contaminants and chemicals.[6]

The lack of wastewater treatment is also a threat to public health in Libya as it has a direct impact on the quality of groundwater. Overflowing sewage can lead to soil pollution and contamination of aquifers, thus contributing to the degradation of groundwater.[7] In addition, only 45.5% of households are connected to the public sewage network[5], indicting that the remainder are connected to cesspits which cause the contamination of groundwater with by wastewater (see section on barriers to accessing water – water quality issues). Finally, wastewater treatment infrastructures have been damaged and need structural maintenance and upgrading.

Since 2011, armed conflict has had a direct impact on public services, as water infrastructure became a weapon of war and has been a target for attacks in the context of the ongoing political division between the Western and the Eastern factions.[7] In July 2021, UNICEF reported that attacks on water infrastructure put the water supply of four million people at risk,[8] while two weeks later, an attack on the MMRP (Man-Made River Project) pipeline suspended the water supply in four cities, namely Bani Walid, Misrata, Al Khums, and Zliten.

While attacks on water infrastructure have long-lasting consequences on the water supply system, a lack of or inadequate maintenance of public infrastructure and illegal connections to the water network have

[3] Surface runoff (also known as overland flow) is the flow of water occurring on the ground surface when excess rainwater, stormwater, meltwater, or other sources, can no longer sufficiently rapidly infiltrate in the soil.
[4] Encyclopedia Britannica, Great Man-Made River.
[5] UNICEF, Assessment of National Water Systems in Libya, 2021
[6] Borgen Project, Water quality in Libya, 2017
[7] Sewer overflow (SO) is the release of raw or poorly treated wastewater and fecal-derived pathogens into the environment, which could be land, water bodies (e.g. sea, river, swimming pool, etc.), groundwater or air (Elsevier, environmental research).
[8] OCHA, Attacks on water infrastructure put in jeopardy safe water supply for 4 million people, 2021

also been found to weaken the regular provision of quality water. As reported by some KIs, illegal connections created without any technical supervision from the GCWW can damage the MMRP pipes and create leaks. Finally, the functionality of the electricity network is also an important factor influencing water supply in Libya, as water outages are often caused by electricity cuts. This particularly affects households relying on the public network and those using boreholes as their main water source, as these require the use of electrical pumps.

Explaining the information gap and how the assessment objectives address it -

Although there is previous research on water scarcity issues in Libya, these assessments focused on a geological approach analysing the availability of groundwater and the climate consequences of its over-exploitation. REACH has now collaborated with the WASH sector to cover remaining gaps in understanding household capacity to access sufficient and quality water resources and in highlighting the area-specific challenges.

In addition to the overall lack of localised information on the topic, it needs to be considered that attacks on water infrastructures have been relatively recent. According to data from the Armed Conflict Location & Event Data Project (ACLED)[9], assaults occurred recently, and the highest number of security incidents was recorded in 2018 and 2019. This indicates that information gaps exist in terms of the impact of the conflict on water infrastructure and consequently on the Libyan populations' ability to access water resources for drinking or domestic uses. ACLED is a disaggregated data collection, analysis, and crisis mapping project. It collects real-time data on the locations, dates, actors, fatalities, and types of all reported political violence and protest events around the world.

In light of the above, this assessment aimed to support a better understanding of households' needs and access to sufficient quality water. It is also intended to support the WASH sector's response in Libya and its assessment strategy, including by triggering reflection on the potential alternatives that could mitigate the risk of water distress in the country. To this end, the implementation of alternative techniques to groundwater exploitation such as desalination or sewage water treatment were explored.

Key partners and stakeholders -

The assessment was conducted in collaboration with the Libya WASH cluster and intended to support the WASH sector response in Libya. The key findings of the assessment will be publicly shared in hopes that they will be used by different entities involved in the development, management, and monitoring of water resources in Libya.

To strengthen results and their uptake, key stakeholders involved in the development, management, and monitoring of water resources in Libya took part in the assessment and shared their expertise on water usage, access modalities, and challenges hindering regular access to good-quality water resources through by participating in KI interviews.
More specifically, local authorities in the assessed municipalities (Derna, Sirt and Sebha) provided information on local water supply issues and challenges. Representatives of the GCWW local offices contributed to give a clear picture on topics such as the functioning of the public water supply and the challenges municipalities face to maintain water infrastructure in a post-conflict context and to provide sufficient and quality water resources to households. Further interviews were conducted with private sector entities, particularly those in the construction sector.

In addition to the WASH sector partners, synergies have also been sought with the Ministry of Water Resources to inform it about the scope and objectives of the assessment and to request its feedback and inputs to the research. The key findings of the study will be shared with the Ministry through a dedicated presentation, with the objective to raise awareness on the main water needs and to foster the development of evidence-based policies and programs.

[9] The Armed Conflict Location & Event Data Project, official website

Overview of the report structure:

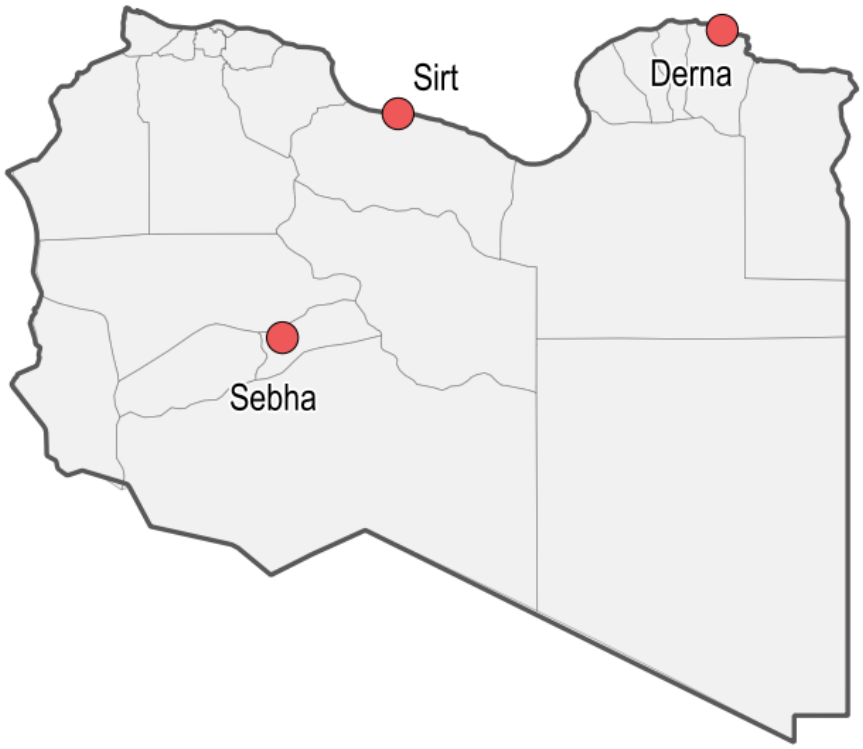
This report is structured in two main components. The first part examines the water situation on a national scale and revisits the main water sources found in Libya. An extensive analysis of the groundwater presence has been carried out since it is the main source of water in Libya. This introduction to Libya's climatic profile also reviews the factors that directly impact the availability of water resources such as rainfall and temperature trends.
The report then explores the modalities of access to the different sources of water for households in three municipalities: Derna, Sirt, and Sebha. This component also discusses the uses that households make of the different water sources, including drinking, domestic uses, and livelihood activities. An overview of the barriers that households face in accessing sufficient quality water is then provided, and coping strategies used to address these barriers are discussed. Finally, an analysis of the management of the water supply through the public network is carried out by exploring the modalities of access to this public source, the fees related to it, and the regularity of households' access to it. Finally, a focus on maintenance services clarifies which structures contribute to the development and maintenance of key water infrastructure as well as the challenges they face.

Methodology:

Geographical scope

The geographical area of interest for the assessment varies across the different components. On one hand, all secondary data analysis based on the review of key scientific papers as well as GIS and remote sensing research methods adopted a nationwide scale. This analysis gives an overview of the general water situation in Libya and particularly provides information on water availability in Libya through the review of climatic factors as well as human factors, such as attacks on water infrastructure.
On the other hand, primary data collection took place in three Baladiyas (administrative level 2), Sebha, Derna, Sirt, which were identified through the analysis of the 2021 Libyan Multisectoral Needs Assessment (MSNA) findings and in consultation with the WASH sector. This preliminary selection aimed at identifying the municipalities that are most exposed to water scarcity issues and that had the lowest levels of access to WASH assistance services in 2021.

Figure 1: Locations covered by the primary data collection during the assessment (Derna, Sirt, Sebha)



Sampling strategy, data collection methods, and analysis:

The methodology of the assessment encompassed four main phases, namely the review of secondary data through GIS and remote sensing techniques, the mapping of water infrastructure and security incidents targeting this infrastructure, household interviews, and key informant interviews. The development of the methodology was conducted in coordination with the WASH sector, including the definition of the scope of the study and the design of the data collection methods and tools.

Review of secondary data:

The secondary data review focused on climatic factors that have an impact on water availability. The analysis particularly examined precipitation and temperature trends from 1990 to 2020, as well as the groundwater evolution from 2011 to 2021 according to the available data from GRACE technology[10].

Mapping of water infrastructure and security incidents targeting this infrastructure:
The mapping of infrastructure was conducted through a review and consolidation of existing information on water infrastructure. Based on this information, the GIS and assessment teams produced a map on the main MMR pipelines, desalination plants, dams, and wastewater treatment plants and analysed their level of use compared to their design capacity.

The mapping of security incidents affecting water infrastructure was conducted through the review of ACLED data. ACLED data was used to identify attacks on water infrastructure since the outbreak of the conflicts in Libya in 2011 and until 2021. The analysis of ACLED data also helped to identify the locations mostly affected by these attacks as well as the type of attacks.

[10] GRACE Follow-On (GRACE-FO) tracks Earth's water movement across the planet. It specifically monitors changes in ice sheets and glaciers, underground water storage, the amount of water in large lakes and rivers, and changes in sea level.

Primary data collection

a. Household surveys:

Household surveys were conducted to provide a deepened understanding of the households' modalities to access water resources, their water usage, and the coping mechanisms they adopt in water stressed contexts. These interviews also explored water supply issues in each assessed location and the factors hindering households' ability to access sufficient and quality water.

Respondents were selected through a randomised representative sample at the Baladiya-level, providing findings with a 95% confidence level and 10% margin of error. A 5% buffer was also added. It has to be noted that findings are not representative of the population at Muhalla-level with a known level of precision and should therefore be considered indicative only. Data collection under this component was carried out in person between March and April 2022 in Derna, Sirt, and Sebha.

The sampling per Muhallas is as follows:

Muhallas in Sebha	Number of surveys
Al Minshiyah	11
El Jadida	11
El Kahira	10
Gardah	17
Mahdia	10
Sakra	7
Thanawiya	11
Hajara	13
Abdelkafi	10
Total	100

Muhallas in Sirt	Number of surveys
Al Jazeera	30
Alkarzabiya	7
El Gharbiyat	8
El Manara	16
El Zaafaran	14
Nasser	15
Tilal	9
Total	99

Muhallas in Derna	Number of surveys
El Bilad	20
Abu Mansour	11
Alajabilh	21
Maghar	20
Essahel Asharqi	30
Total	102

b. Key Informant Interviews:

KIIs were conducted to provide in-depth contextual and technical information to complement the data collected via the secondary data analysis. They also explored the existing gaps in terms of water resources management and provided accurate findings that could trigger the reflection on potential alternatives to cope with water stress issues.

KIIs specifically focused on the most used water sources in Libya overall and particularly in the assessed locations (Derna, Sirt, and Sebha). It also provided an analysis of the management and sustainability of water infrastructure in Libya. In addition, KIIs examined the impact of conflicts and social instability as well as the instrumentalization of water supply to fuel the political division between the Eastern and Western factions. In addition to political factors, socio-economic factors, that could lead to difficulties in protecting and maintaining water infrastructure, were taken into consideration.

The sampling of the KIs was done purposively. Respondents were identified in coordination with the WASH sector's partners, REACH field staff, and REACH local partners. A first round of KIIs was conducted with an engineer working for the GCWW office in Sebha and a WASH expert and consultant for the GCWW. A second phase was conducted at municipal level and targeted municipal actors, community leaders, employees from the GCWW local offices, or/and construction companies in the three assessed Baladiyas. These interviews provided an in-depth understanding of the management of water resources at a local level and provided an understanding of the issues faced by the population to access sufficient and quality water. Six KIIs were conducted in each assessed municipality (Derna, Sirt, and Sebha).

c. Challenges and limitations

Although some information on the climate factors affecting the availability of water resources in Libya exist, the main challenge faced by the assessment team was to find in-depth and localised secondary data on households' water usage, challenges, and coping strategies to meet their basic needs. Exhaustive information on WASH infrastructure and their functionality was also lacking. The assessment team used

the 2021 MSNA[11] data to have access to local (Baladiya) scale information to be able to identify Baladiyas with the highest water needs and conduct quantitative and qualitative primary data collection to fill this information gap. However, it is important to note that the 2021 MSNA only covered 45 Baladiyas, which means that some Baladiyas were not taken into consideration during the selection process solely on the grounds of lack of household data on WASH needs. For this reason, together with the fact that the scope of primary data collection in this assessment was limited, additional area-level research that can provide information on locations not assessed yet is needed. Finally, during the assessment it was not always possible to have a gender balance among respondents (households as well as KIs, due to the very specific profiles sought), resulting in a bias towards male respondents in the findings of household surveys in Derna, Sirt, and Sebha. This represents an important lesson learned to be integrated in future data collection cycles.

[11] REACH, Libya: Multi-Sector Needs Assessment (MSNA), Libyan Population, March 2021

SECONDARY DATA REVIEW

CONTEXT

According to the National Water Stress Rankings of the World Resources Institute, Libya is among the top 10 countries with extreme high-water stress.[12] Groundwater is the main source of water in Libya, particularly since the MRRP and its water pipeline network, covering a total of 4000 kilometres, became the main source of water since its design that started in the sixties. The MRRP provides over 60% of Libya's water.[13] However, the overexploitation of groundwater, mostly to meet irrigation demands, has negative impacts on access to sufficient and good-quality water resources[14] such as seawater intrusion. With low precipitation, higher annual temperatures and dysfunctional water infrastructure, this has put growing stress on water availability throughout the country. Moreover, the armed conflict affecting the country since 2011 has added another element to this water-stressed environment making the situation more fragile, as water infrastructure has become a target for attacks in the context of the ongoing political division. Conflicts and the volatile political situation have also weakened the country's administrative capacities and hindered the development of sustainable public policies. The creation of an institutional framework and a clear strategy related to the local water sector, as well as the protection and maintenance of water infrastructure remain the major challenges for municipalities and the GCWW to be able to ensure regular water supply to households.

GROUNDWATER AND THE MMRP

Aquifers in Libya

Groundwater is the main water source in Libya, supplying up to 98% of all water consumed. The total volume of groundwater in Libya is estimated around 100,000km³. Much of the groundwater consists of two types of aquifers namely shallow aquifers that obtain water from rainfall and surface runoff (renewable) and deeper larger aquifers filled with fossil water, which are non renewable.[15]
Groundwater resources in Libya are located in various territories: renewable aquifers are situated in the northern Jfara plain, Jabal al-Akhdar, and parts of the Hamada and central zone area, while fossil ones are in the basins of al-Kufra, Murzuk, Sarir, and the Hamada. As shown in Figure 2 below, four major aquifers can be identified: the Jfara Plain aquifer, the Murzuq-Djado Basin Aquifer, the North-Western Sahara Aquifer System, and the Nubian Sandstone Aquifer System. Most aquifers are transboundary and are jointly managed by neighbouring countries.

The **Jfara plain**, that spans from southeastern Tunisia to Tripoli, is home to a shallow, renewable and coastal aquifer that covers an area of about 45,000 km and that has been historically exploited through shallow wells and naturally-occurring springs.[16] Extraction has dramatically accelerated over the last 70 years due to increased water demand and further exploration, especially around the capital city of Tripoli. This aquifer experiences sea water intrusion, which can contaminate groundwater resources,

[12] World Resources Institute, 17 Countries, Home to One-Quarter of the World's Population, Face Extremely High Water Stress, 2019
[13] REACH, WASH Severity Classification (WSC): Overview - WSC Light Libya, 2022
[14] MDPI, Groundwater Overexploitation and Seawater Intrusion in Coastal Areas of Arid and Semi-Arid Regions, 2018
[15] Deswater, The water crisis in Libya: causes, consequences and potential solutions, 2019
[16] CAREGE, Coastal aquifer recharge and groundwater–seawater exchanges using downscaled GRACE data: case study of the Djeffara plain (Libya–Tunisia), 2021

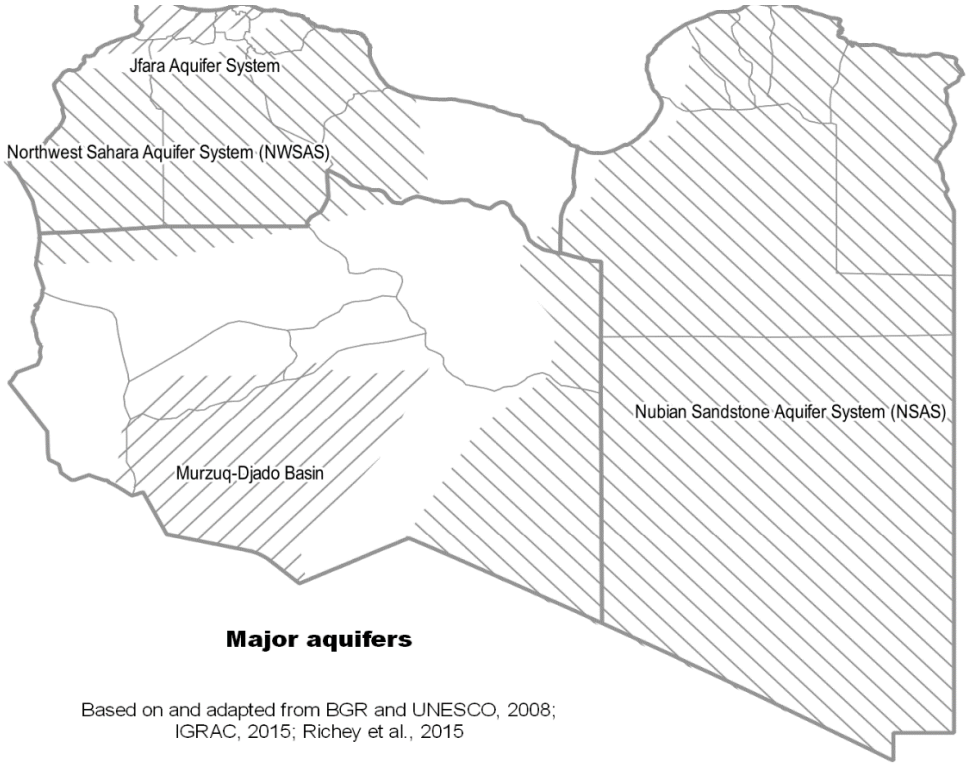
making it unsafe to drink. However, this is not a recent problem, as during the Ottoman period there were already plans to investigate alternative sources of water due to salinisation of this aquifer.[17]

The **Murzuq-Djado Basin Aquifer**[18] is a fossil aquifer found across southwestern Libya, and adjacent areas (Niger and Algeria). The overall area of the aquifer is approximately 450,000 km.

The **North-Western Sahara Aquifer System** (NWSAS) covers more than a million square kilometers and spans across three countries, Algeria, Tunisia, and Libya. It is governed by the Sahara and Sahel Observatory, an international body based in Tunis.

The most important aquifer, geopolitically and by extension, is the **Nubian Sandstone Aquifer System** (NSAS). Found across Chad, Sudan, Egypt, and Libya, it covers more than 2 million square kilometers. There is a Joint Authority for the Study and Development of the Nubian Sandstone Aquifer, established in 1992, which is an ongoing project aiming "to initiate the implementation of the endorsed Strategic Action Programme" for the NSAS. The Strategic Action Programme establishes a framework on agreed management actions to address the key transboundary concerns, and concerns that are shared between countries related to the Nubian aquifer shared by Chad, Egypt, Libya, and Sudan. The Strategic Action Programme was prepared by a team of experts drawn from the four countries with financial support of the Global Environment Facility (GEF), the United Nations Development Programme (UNDP), the United Nations Education, Scientific, and Cultural Organisation (UNESCO), and the International Atomic Energy Agency (IAEA).[19]
All the above-mentioned aquifers provide about 95% of the total water resources in Libya and are principally exploited through the MMRP, one of the biggest civil infrastructures in the world.

Figure 2: Major aquifers in Libya



[17] Klaus Braun & Jacqueline Passon, Libya at a Glance—Facts and Figures About a White Spot in Northern Africa, 2020
[18] Research Gate, Physicochemical quality of Murzuq groundwater Sabha, Libya, 2013
[19] IAEA, Regional Strategic Action Programme for the Nubian Aquifer System, 2013

MMRP and other water sources

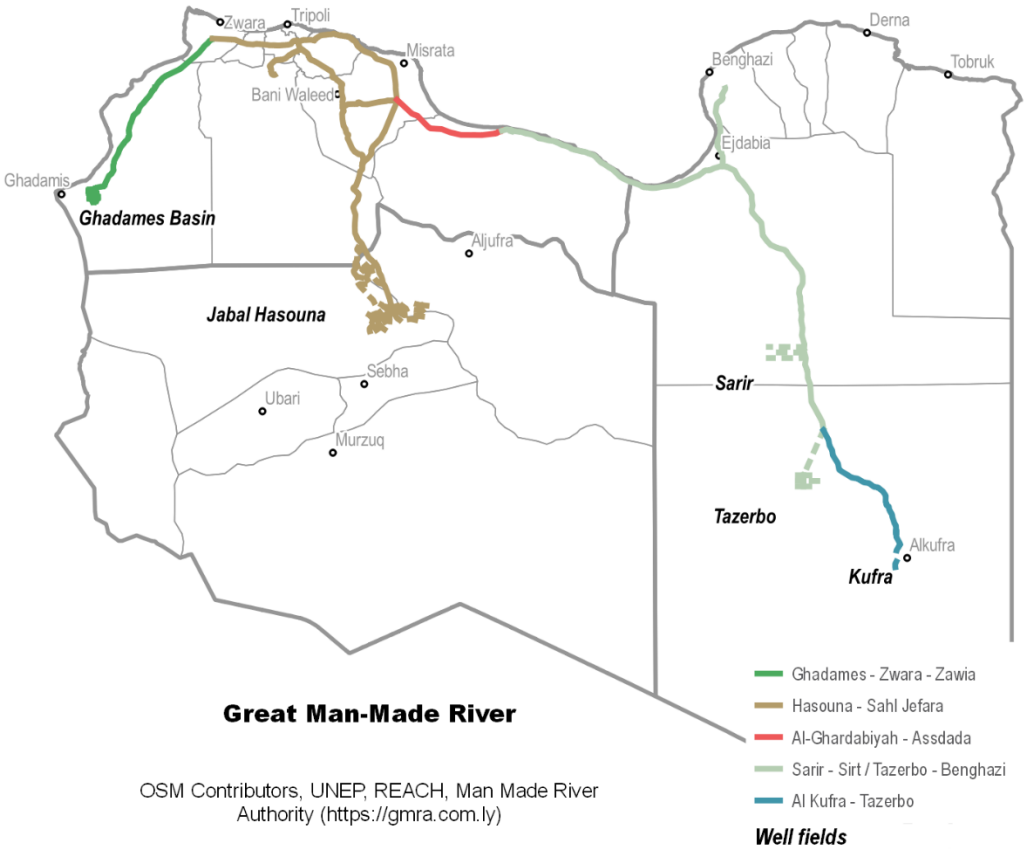
The MMR is an underground water network that was planned by the Libyan government in the 1970s in order to foster the then newly found (1953) abundance of groundwater. The construction of the MMR happened in five phases; the first phase (1983 - 1991) initially provided up to two million cubic metres of water along a 1,200km pipeline from the Ajdabiya reservoir (located in the NSAS) to the main cities of Sirte and Benghazi in the north. The second phase, in 1994, upgraded the system to pump water from the Murzuq-Djado Basin to the capital city of Tripoli. Phase three completed in 2009 saw the expansion of the existing network, increasing the water supply by a further 1.68 million cubic metres a day with eight new pumping stations and a new total of 1,900km of pipeline. In 2004, the total costs until that point in time were estimated at $27 billion USD.[20] Phases 4 and 5 of the project were on hold due to the security context in Libya. These two phases involved the extension of the distribution network and the integration of the Eastern and Western networks into a single system.[21]

The MMR project today includes over 4000km of pipeline (see Figure 3), 16 pumping stations, balancing reservoirs[22] and water treatment plants[23] and represents the major supplier of water, meeting around 75% of Libya's annual water demand, including household use. Although the original plans were for the MMR to be primarily a source for irrigating agriculture, particularly because of food insecurity, more than 30% of the municipal water demand was supplied by the MMRP in 2000.[24]

During the conflict in 2011, the MMR suffered from a lack of funding and reduced maintenance. It has been estimated that this resulted in around 30% of the current network not being used to its full capacity.[25] According to the most recent data on service provision from the Man Made River Authority (MMRA) (2017), the MMR reaches over 4 million people in Libya providing 608 million cubic metres of water. General leakage is thought to be around 30-50% of all output, further increasing the risk of water scarcity. Political disruption has also caused complexities in water policy and management.[26] In the context of the ongoing political division and fragmentation between the Western and Eastern factions, water became a target for attacks. Conflicts and the fragile political situation have weakened the country's administration and hindered the development of sustainable public policies. The development of an institutional framework and a clear strategy related to the local water sector as well as the protection and maintenance of water infrastructure thus remain major challenges.
Multiple authorities, namely the General Water Authority, the GCWW and the MMRA, are involved in the management of the MMRP. This has resulted in an inefficient approach and has impacted water supply.[27]

[20] Water Technology, GMR (Great Man-Made River) Water Supply Project, 2022
[21] Global Atlas of Environmental Justice, Great Man-Made River, 2019
[22] Law Insider: Balancing reservoirs means the reservoir constructed downstream for holding water as storage and hydraulic control.
[23] UNICEF, Assessment of water supply systems and Institutions in Libya, 2019
[24] FAO, Aquastat Report – Libya country profile, 2016
[25] Jauda R. Jouda Hamad; Marlia M. Hanafiah; Wan Zuhairi W. Yaakob, Water resources and management in Libya: Challenges and future prospects, 2017
[26] African Journal of Economic and Sustainable Development, Water infrastructure in Libya and the water situation in agriculture in the Jefara region of Libya, 2014
[27] Procedia Technology, Sustainable Integrated Water Resources Management for Energy Production and Food Security in Libya, 2013

Figure 3: Man-Made River Project's pipelines and wells fields



Besides the MMR, other water infrastructure has been engineered over the last 60 years, see Figure 4 for an overview on identified water infrastructures.

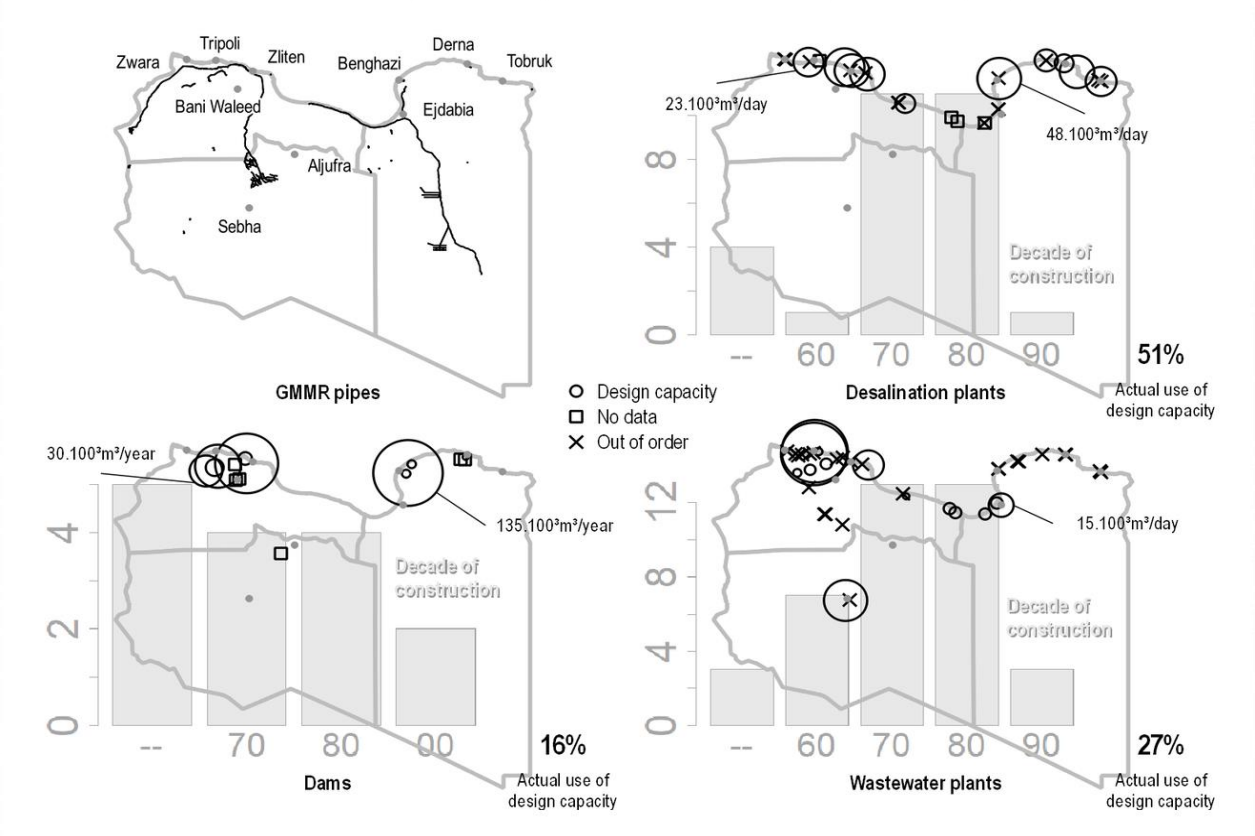
Since the 1960s, **desalinated water** in the North of Libya has been used to bridge the gap between water availability and demand. It is thought that over 400 desalination plants have been constructed over this period, however all with varying capacity and performance.[28] However, due to high costs, only eight plants are currently operational and in total are estimated to provide up to 33 million cubic metres of water per year.[29] The main issue with desalination technologies is the cost and supply of power, which has been inconsistent over time, and which is generally considered to be the main constraint to the operation of desalinisation plants. However, desalination offers a better supply option than water transfer at least in terms of cost and environmental impact: as importing water to the northern areas of Libya from the southern aquifers requires a great amount of energy, decreasing the total amount of water imported to the region by substituting it with desalination could reduce the amount of energy used for water supply, thereby reducing corresponding greenhouse gas emissions.[30]

Similarly, **treatement of wastewater** has also been introduced in recent years in Libya; nevertheless, wastewater treatment plants struggle with the same issues as desalinisation plants, namely high maintenance costs and low output. Out of 75 wastewater treatment facilities recorded, only ten are partially operative and they are only functioning at 50% of their capacity (40M m³/year out of 74M m³ installed capacity in 2012).[31]

[28] IJESC, The Current Situation of Desalination Plants in Libya, 2022
[29] The Tahrir Institute For Middle East Policy, From the River to the Sea: Water Management in Libya, 2022
[30] Konrad Adenauer Stiftung, Desalination as an alternative to alleviate water scarcity and a climate change adaptation option in the MENA region, 2020
[31] Bashir Brika, Water Resources and Desalination in Libya: A Review, 2018

Other infrastructure has also been constructed in the past decades. For example 16 major **dams** with a total capacity of 385M m³ were built to harvest rainwater, which is then supplied to irrigation channels for agricultural purposes.[32] It is believed that with the introduction of planned dams in the future, the capacity of the water supply system will increase by 120M m³.

Figure 4: Overview of the main water infrastructure (MMR pipelines, desalination plants, dams, wastewater plants) in Libya and their functionality



REMOTE SENSING ANALYSIS

Groundwater Storage Analysis

Given that groundwater resources are essential to meet agricultural and municipal water needs in Libya, it was deemed essential to provide an analysis of the availability and sustainability of this resource. The presence of groundwater was made possible through the NASA satellite labelled GRACE that monitors, amongst others, changes in underground water storage, the amount of water in large lakes and rivers, and changes in sea level. The United Nations Satellite Centre (UNOSAT) conducted the analysis using GRACE-derived groundwater storage through summer month averages, compared annually from 2011-2021, which enabled the production of trend analysis. This led to the creation of several categories depending on the behaviour of groundwater storage at a given point. A hot/cold spot trend map of Libya was thus created (Figure 5) to highlight areas where underground water levels appear to cumulate (hotspot) or, on the contrary, to decrease (cold spot).

Areas recorded as an intensifying cold spot refer to clusters of groundwater experiencing a growing trend of depletion. Concerningly, these areas are located in the deep non-renewable aquifers of the NSAS in the South East and the Murzuq in the West. These aquifers represent the main sources of water

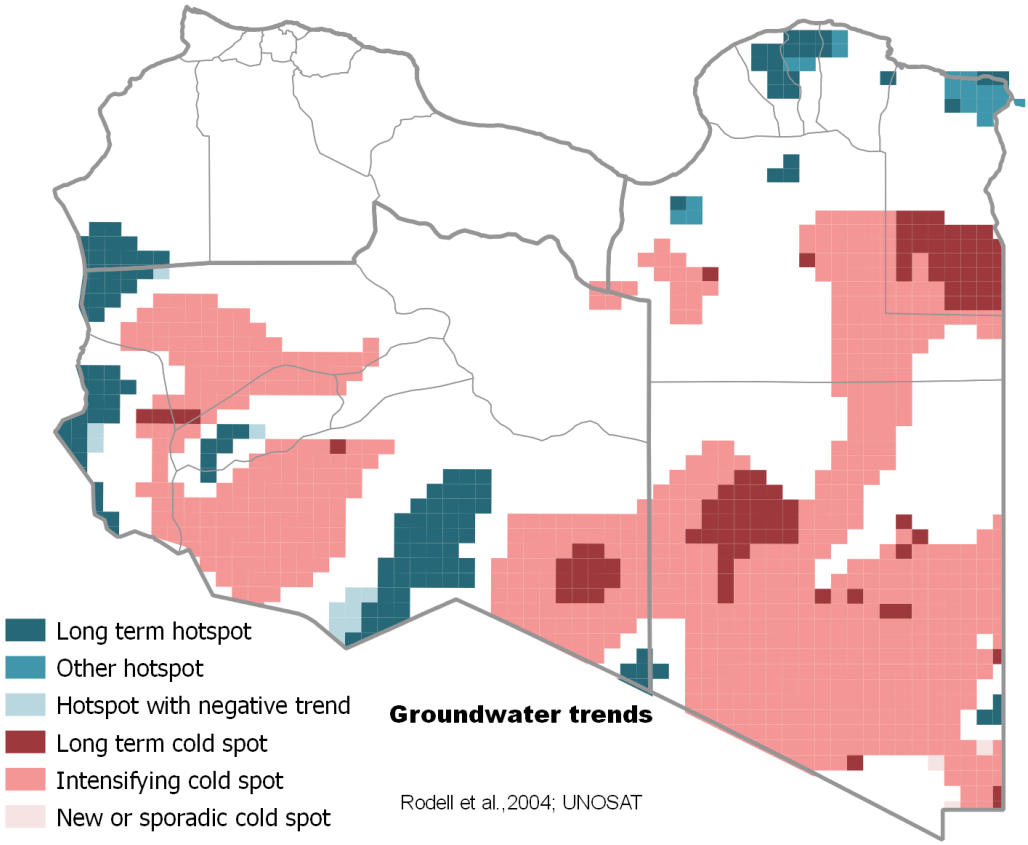
[32] Deswater, The water crisis in Libya: causes, consequences and potential solutions, 2019

for the MMR, which plays a central role in providing water to the urban centres in the North and to the irrigation channels for agriculture. These aquifers not only address the large agricultural water demand but also domestic and industrial needs. However, the reliance and over-exploitation of this resource has negative effects and contributes to decreasing groundwater levels. One KI even specified:

> *"Digging wells has become more expensive and time-consuming (as groundwater levels decreased). This means that it is necessary to drill deeper and deeper than it used to be years ago to reach water (300 meters deep instead of 80 meters at present)."*
>
> KI reporting on the national water situation (representative of the GCWW in Sebha)

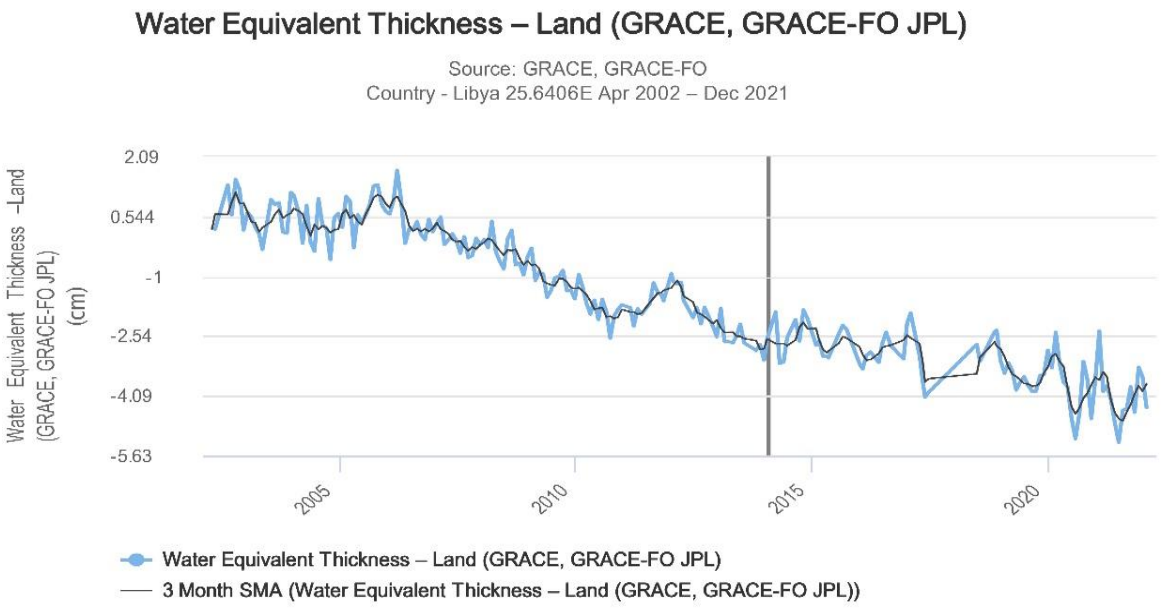
The improvement of the standard of living especially in the coastal areas of the country has also contributed to cause pressure on water resources. Areas in the North of the country where more shallow aquifers are present have experienced steady groundwater storage levels over the previous 10 years, especially in the case of the NWSAS and Jfara aquifers. These shallow aquifers located in coastal areas (where rainfall is more abundant as shown in Figure 10) are renewable aquifers annually replenished through rain. In addition, most of the groundwater used in Libya comes from deep and non-renewable (fossil) aquifers located in the South of the country as mentioned by the FAO.33 Fossil water is also transferred to the coast, where the highest water demand is.

Figure 5: Analysis of the evolution of groundwater's level



[33] FAO, Groundwater management in Libya, 2009

Figure 6: Evolution of water Equivalent Thickness' values per month



A time series of water equivalent thickness (the proportion of gravitational change due to water) analysis was also produced using GRACE and GRACE-FO JPL data from April 2002 to December 2021 (Figure 6) which records changes in Earth's gravitational field to estimate changes to its water supplies. This type of analysis is in coherence with Libya suffering groundwater storage decline which is a major driver behind water scarcity and its impact on the population. Water equivalent thickness in Libya has declined by approximately 5cm. This demonstrates that aquifers are over-exploited as their water levels are continuously decreasing and reflects the limits of the sustainability of non renewable groundwater resources as a primary water source for both irrigation and domestic uses.

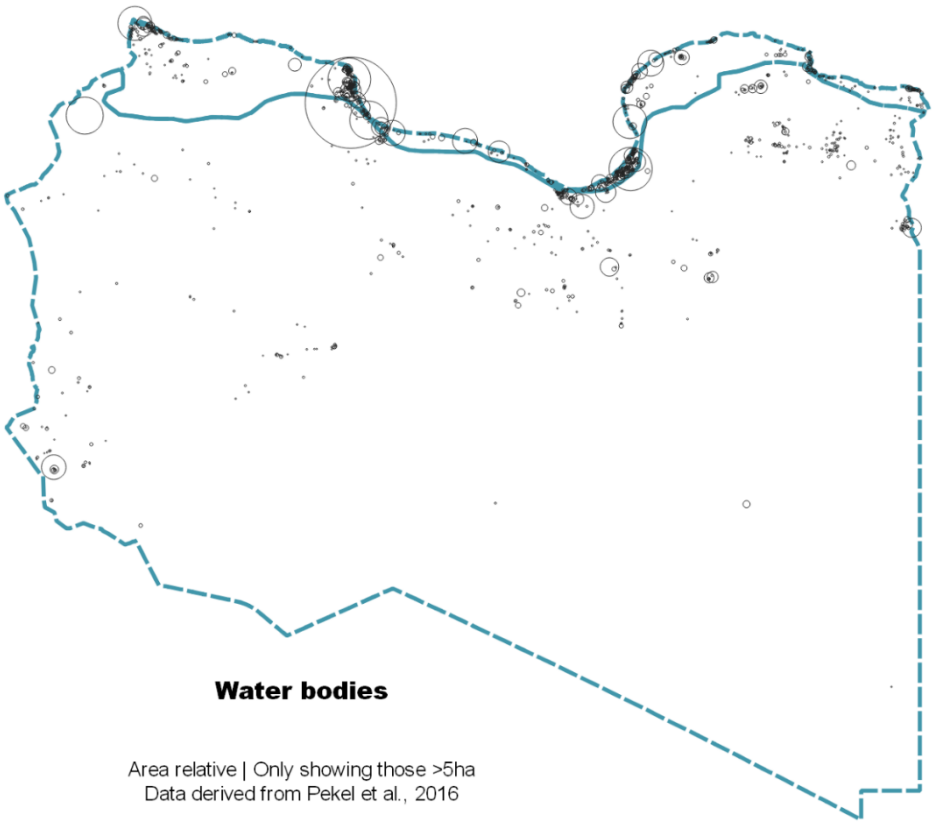
Surface Water, Precipitation, and Temperature Analysis

Because surface water is a scare source of water in Libya, as this section will show, it contributes to the country's reliance on groundwater resources. To demonstrate this, this section will draw on precipitation and temperature trend data, which has a direct impact on water availability and supply.

Surface water

Dominated by an extremely arid climate, Libya does not have major water bodies, whether artificial or natural as shown in the map below.

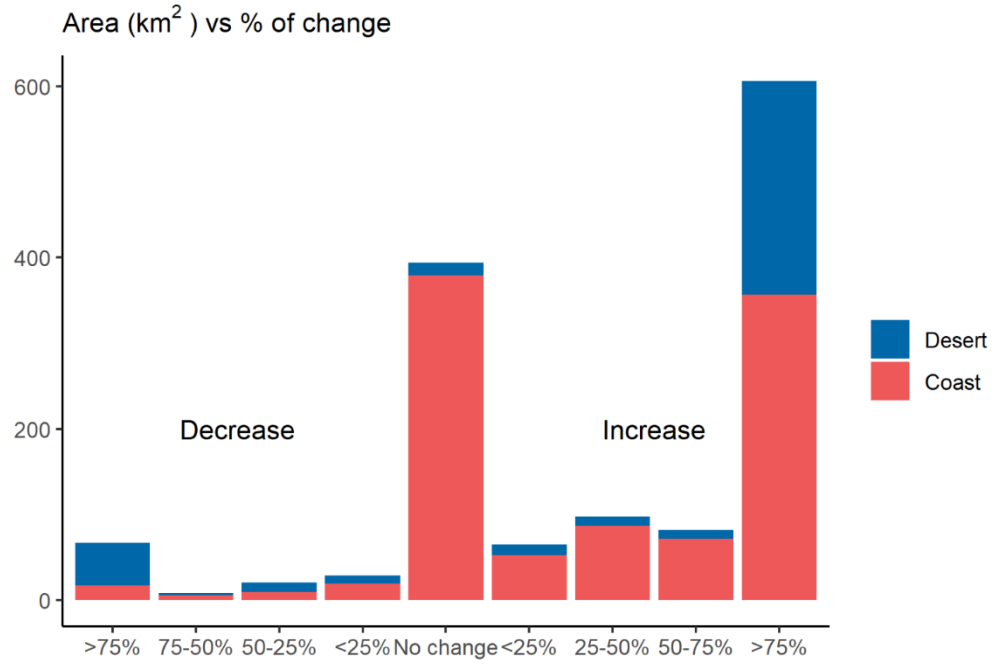
Figure 7: Presence of surface water across the Libyan territory



Among the latter, the *sebkha*[34] and other evaporitic and/or salty lakes are the most common typologies. Data covering the period between 1984 and 2020 shows that surface water has consistently occupied considerably less than 0,1% of the Libyan territory (over 1.5 million square kilometers of the overall Libyan territory).[35]

[34] Sebkha: a smooth flat often saline plain in northern Africa sometimes occupied after a rain by a shallow lake
[35] Pekel, J., Cottam, A., Gorelick, N. and Belward, A., Global Surface Water - Data Access, Nature, 2016

Figure 8: Change in surface water

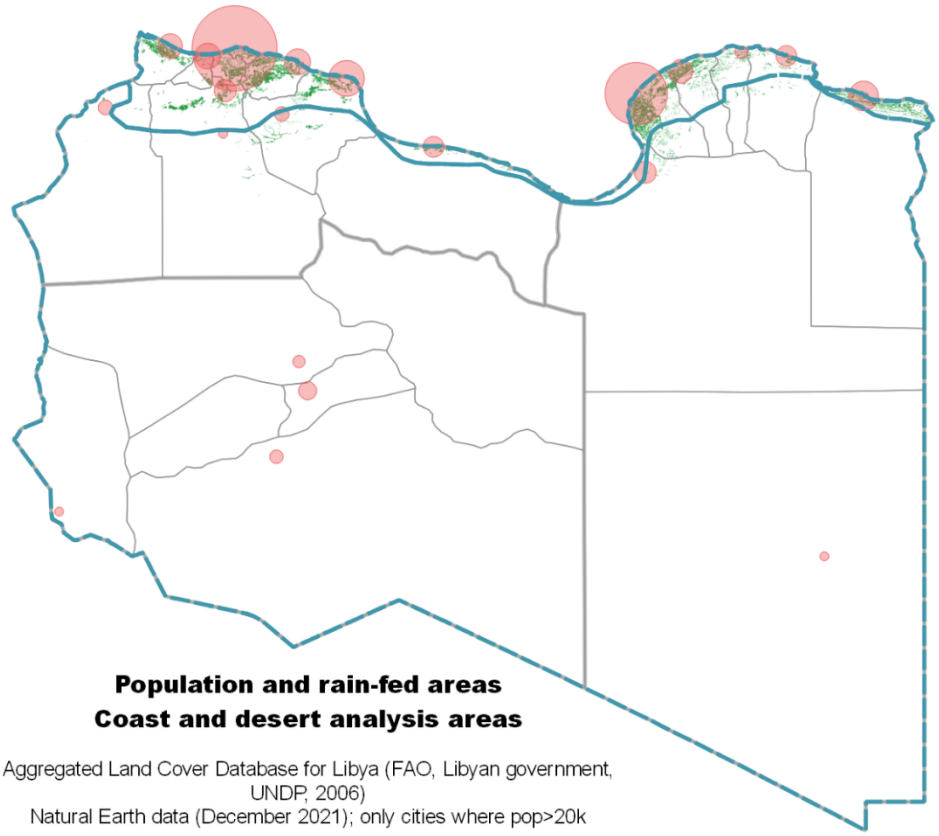


Despite its limited extension, surface water has shown an overall positive trend between 1984-2020, with a 75% increase in both desert and coastal areas.[36] However, it must be noted that a driver of this trend could be an increase in the irrigated areas or a rise in the sea level, which would increase seawater intrusion into areas liable to flooding or in surface water basins. The biggest water bodies are concentrated in the coastal band (see Figure 7). This is due to coastal and *wadi*[37]-fed lagoons, *playas*[38], and *sebkhas*[39].

In terms of the hydrological landscape, Libya can be divided into two distinct zones (see Figure 7): the coastal band, with a mild, mediterranean climate, presenting rain-fed agriculture and hosting most of the Libyan population, and a second considerably wider zone, presenting a much drier, hotter, and emptier desertscape. The terms "coast" and "desert" will be used in this report to refer to these two different geographical units, which served as the basis for the precipitation and temperature analysis.

[36] Pekel, J., Cottam, A., Gorelick, N. and Belward, A., Global Surface Water - Data Access, Nature, 2016
[37] A valley that has a river that is usually dry except when it has rained, common in desert areas of North Africa and Western Asia, Cambridge
[38] The flat-floored bottom of an undrained desert basin that becomes at times a shallow lake, Merriam Webster
[39] An area of low, level ground covered in salt, especially one found along the coast of North Africa and Saudi Arabia, Cambridge

Figure 9: Rain-fed areas in Libya



The division of Libya into two hydrological zones is in line with other studies[40] and is further supported by the differences in groundwater between the two: indeed, the desert area is home to fossil aquifers, whereas in the coastal band shallow, smaller, and seasonally recharged aquifers can be found.

Precipitation

Another component of water supply is precipitation. Annual rains are essential to maintain the dwindling rain-fed agriculture and grazing lands. They also supply the annual wadis that feed other standing water bodies. As can be expected, rainfall levels are not high in Libya. Notably, the average annual rainfall is 56mm and 93% of the land receives less than 100 mm/year[41], which is well below the 200mm considered necessary to sustain rain-fed agriculture. Figure 10 illustrates the spatial distribution of precipitation.

[40] FAO, Aqustat Report (Libya, country profile), 2016 ; Climate Knowledge Portal, Libya country profile
[41] FAO, Aqustat Report (Libya, country profile), 2016

Figure 10: Rainfall distribution

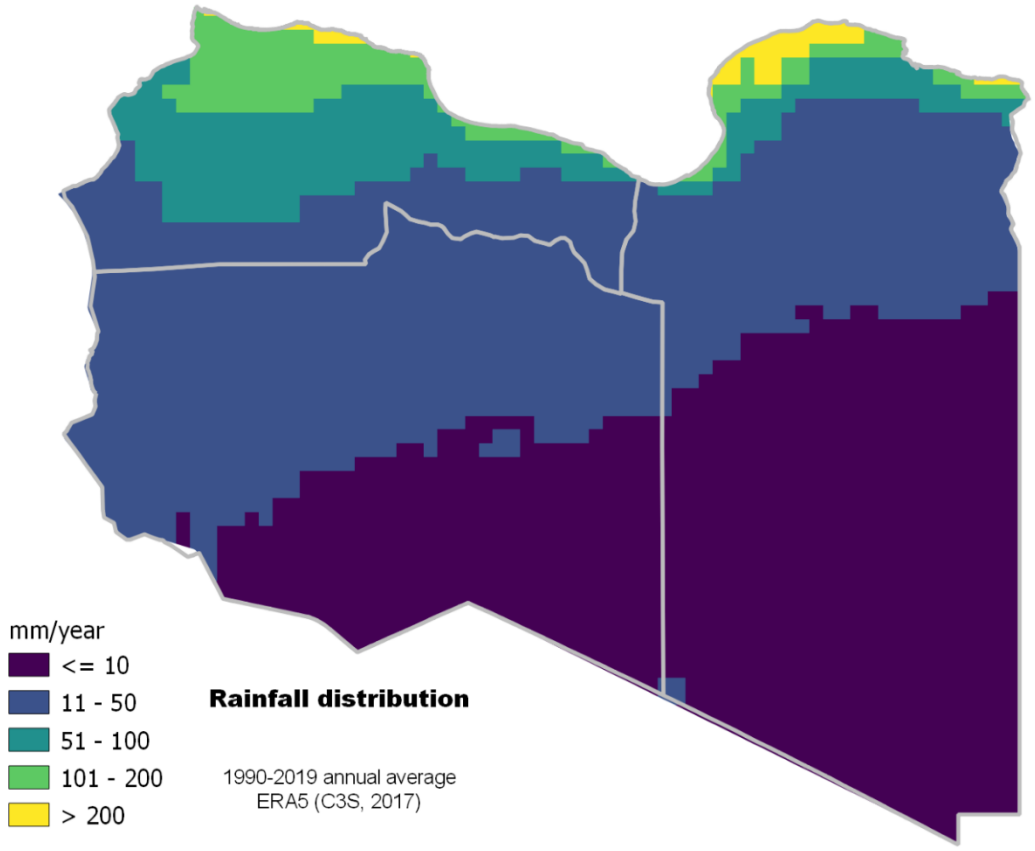
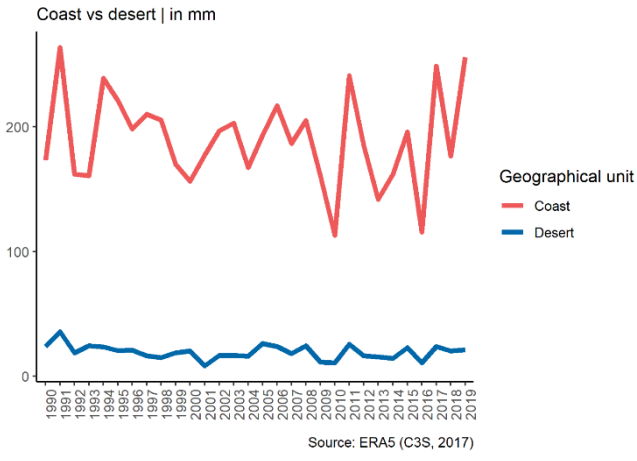


Figure (9) Annual precipitation values were analysed for trends. Values were averaged for the coast and desert zones and extracted using Google Earth Engine. Two different data sources were compared but later only the Fifth generation of ECMWF atmospheric reanalyses of the global climate (ERA5; C3S, 2017) was retained (see Annex 1).

Figure 11: Annual precipitation values per area (coastal and desert areas)



The difference between the two zones is clear, and beyond the total amount it is worth noting the volatility of the coastal area precipitation annual values (see variance in Figure 11).
The stability of the average value over the years is in line with academic and non-academic literature[42], although other studies reveal slight decreases.[43] It is assumed, however, that a decrease in total precipitation will occur in coming decades, with more certainty for the end of the century.[44]

If precipitation has remained stable (Figure 11) over the last three decades in terms of total amount, a deeper look must be taken at its pattern, especially when talking about arid environments.

Figures 12 and 13 below show an average year of precipitation (the mean of all monthly values) for each zone. Besides the difference in total rainfall across both coastal and desert areas, the precipitation

[42] Climate Change Knowledge Portal, Climatology Libya
[43] El-Tantawi, Attia Mahmoud Mohamed, Climate change in Libya and desertification of Jifara Plain, 2005
[44] Zittis, Bruggeman, Jos Lelieveld, Revisiting future extreme precipitation trends in the Mediterranean, 2021

patterns are similar, with the highest values occurring in January and December. In the case of the coast, the month of October records the highest volatility rates with regular changes and variations in precipitation trends which can be linked to sudden storms in the northern areas, causing damages to properties and crops. The desert shows a peak in variability in March, but the values (a max of 15mm) are much less disparate. Populations in Libya therefore face two paradoxical environmental issues including water scarcity and risks of flooding. The recurrent problem of floods already had devastating impacts in some cities such as Tripoli in 2013, Benghazi in 2016 where floods forced the closure of the international airport or in Bayda (Northeast of Libya) in 2020 where several thousand people were displaced after a downpour and consequent flooding.[45]

Figure 13: Average precipitation rate in coastal areas

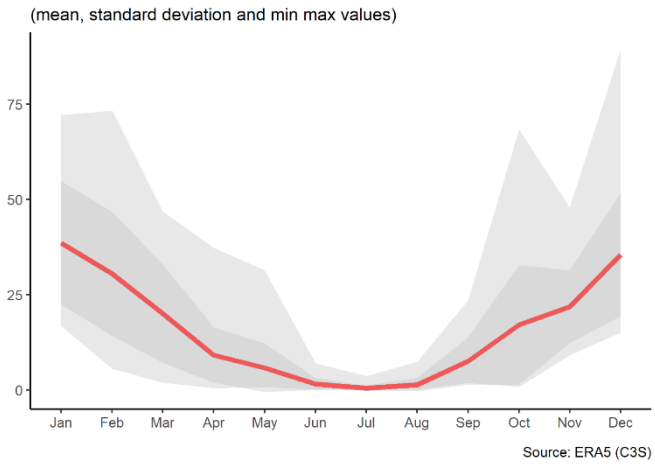
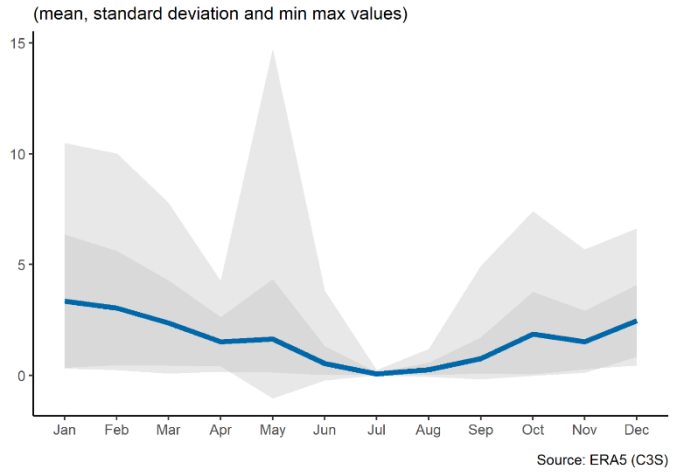


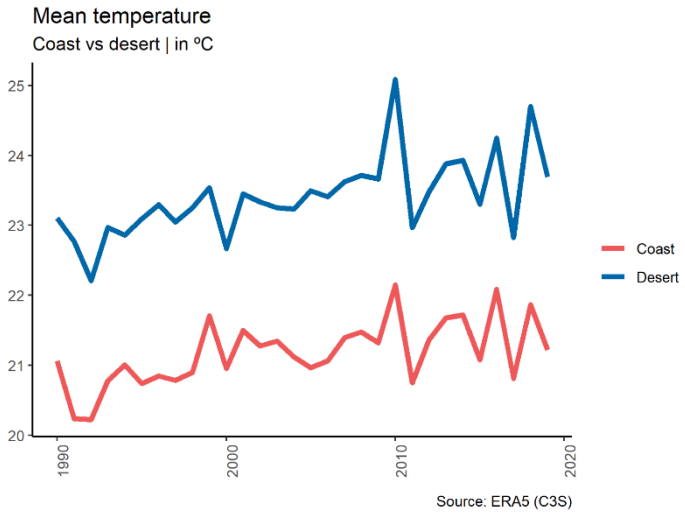
Figure 12: Average precipitation rate in the desert



Temperature

When looking at temperature trends in the period between 1990-2020, it is apparent that temperature levels have been steadily and considerably increasing (Figure 14).
In addition, and in contrast to precipitation, temperature trends and their significance are not contested amongst academics.[46]

Figure 14: Mean temperature evolution in coastal and desert regions



Regarding climate extreme indices[47] (a standard list of indicators that reflect the occurrence of extreme phenomena), both the coastal and the desert zones present similar trends with regards to mean temperature, although with important differences. Firstly, while the mean temperature is on the rise in both zones, the pattern does not appear to be the same. In the coastal areas, the maximum temperature has been increasing more quickly than the minimum temperature. Thus, the diurnal range (i.e. the difference between daily max and daily min) is clearly and steadily rising. In addition to precipitation, temperature is also a key factor influencing

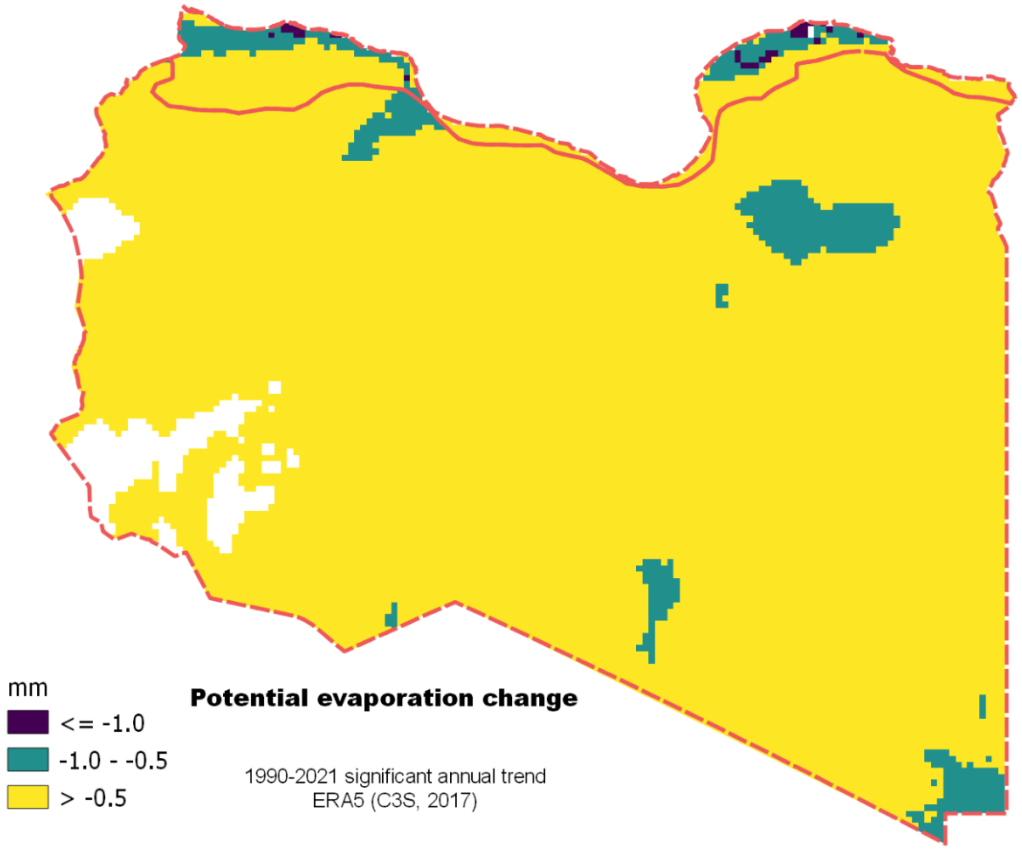
[45] The New Arab, Millions of Libyans could 'face imminent water problems' if environmental issues remain overlooked, 2021
[46] J. Lelieveld, Y. Proestos, P. Hadjinicolaou, M. Tanarhte, E. Tyrlis & G. Zittis, Strongly increasing heat extremes in the Middle East and North Africa (MENA) in the 21st century, 2016
[47] Climdex, Climate extreme indices

water availability as explained in the following section on impacts of climate change on water scarcity. Higher temperature causes the greater loss of water resources from the Earth's surface that return to the atmosphere through evaporation and transpiration. This phenomenon is known as evapotranspiration.[48] In warming climate, evapotranspiration not only affects the availability of surface water (with consequences on rain-fed agriculture in coastal areas) but also groundwater recharge level and availability. On the other hand, the temperature increase is likely to increase the water demand for agricultural, industrial and municipal uses.

Impacts on water scarcity

Precipitation and temperature have an impact on water scarcity in Libya through potential evapotranspiration: warmer air holds more moisture, and if temperatures continue to rise, more evaporation will take place off the already minimal surface water in Libya (with consequences for irrigated and rain-fed agriculture). Figure 15 shows that the biggest increases in potential evaporation are happening in the coastal band, where rain-fed agriculture takes place, with a few scattered areas in the desert zone. Though further studies should take place to make precise conclusions, a presumption can be made on negative consequences for traditional crops. Evaporation is considered to be currently around 4 million cubic meters per year and is naturally expected to increase in the future as temperatures rise.[49]

Figure 15: Potential evaporation change



Coinciding with warmer temperatures, and therefore an increase in an already rising potential evaporation, precipitation has the potential to become unpredictable in Libya.[50] As explained in a

[48] University of Illinois, Potential Impacts of Climate Change on Water Availability
[49] Brubacher, Climate fragility risk brief, Libya, 2021
[50] University of Liverpool, Trends and patterns in the climate of Libya (1945-2010), 2013

research paper published by the Department of Geography and Planning, School of Environmental Sciences of the University of Liverpool, "precipitation is a highly unpredictable weather variable across North Africa and is rapidly changing (temporally and spatially) affecting populations and societies across North Africa". Changing air temperatures will eventually start to impact where and when precipitation falls, and this could affect the coastal areas in Libya which rely on annual precipitation for irrigation of agricultural lands.

Rising temperatures are also expected to have a direct impact upon energy usage, due to the increased demand for agricultural irrigation and for cooling systems in industrial and residential areas. Agricultural and industrial areas demand for energy can therefore be predicted to rise, which will come at the cost of further driving food insecurity and putting stress on the available resources in Libya. This increased demand for energy might also exacerbate negative environmental effects since most of Libya's energy needs are satisfied by oil and natural gas. Concerning the impact of water scarcity on food security, a report published by ICRC[51] reported that "the limited renewable water resources, coupled with drought and poor soil, severely limit production, forcing the country to import about 75% of the food required to meet local needs, according to the World Bank".

The drying trend described in the previous sections is expected to affect all forms of surface water, such as wadis, dams, runoff water, percolation. While, in the case of Libya, surface water is not a significant source for either agricultural, industrial nor drinking water, this trend, together with the expected reduction of underground resources (although the timeline is uncertain), provides a gloomy picture of water availability in the country in the coming decades.

To summarize, this section reviews the different water sources present in Libya and analyses the climatic factors influencing the availability of major water resources. It also shows that Libya can be divided into two parts that have their own climatic characteristics. In one sense, the coastal area has more diversified water sources such as renewable groundwater, surface water, and desalinated water. This region is also where the demand for water is the most important and contributes to depleting the existing groundwater resources. This demand is particularly important for agriculture but also for domestic needs due to urbanization and the improvement of living standards over the last decades. The climatic profile of this area is also different from the rest of Libya since precipitation trends are higher. On the other hand, the southern region has scarce rainfall and higher temperatures. These two factors are the most important ones since they determine the presence of surface water but also the rate of recharge of the renewable aquifers. This is also where fossil water is located which serves the entire Libyan territory through the MMRP.

In sum, the ever-increasing demand and the climate profile of Libya are major threats to the availability of water and the sustainability of the primary water source. The data shows that the primary water source is groundwater, representing more than 90% of the water in Libya, and further illustrates that this water source is rapidly being depleted.

[51] ICRC, Libya: Conflict weakens farmers' abilities to mitigate climate risks, 2022

FINDINGS FROM THE PRIMARY DATA COLLECTION:

HOUSEHOLD WATER USAGE: SOURCES, BARRIERS, AND COPING STRATEGIES

Household needs and vulnerabilities:

2021 MSNA preliminary analysis:

Prior to the assessment, a preliminary analysis was conducted looking at accessibility to sufficient and quality water in water-stressed areas in Libya. This analysis was based on data from the 2021 MSNA and aimed to support the selection of the locations with the highest water needs. The following indicators were considered:

a. % of households with access to sufficient water for drinking uses
b. % of households relying on public network as the main source of water
c. Consistency of access to water from the public network by the respondent within the 30 days prior to data collection[52]

The results show that among the cities with the highest needs, Derna, Sirt, and Sebha have high needs for drinking water and lowest levels of access to water from the public network (proportionally with the percentage of households relying on this public source) as shown in figure 16.

Figure 16: Baladiyas found with high needs for drinking water and lowest levels of access to water from the public network according to the 2021 MSNA household data

Baladiya	% of households lacking sufficient water for drinking uses in the 30 days prior to data collection	% of households relying on the public network as their main source of water for drinking purposes	% of households that have no access or rarely have access to water from the public network within the30 days prior to data collection
Derna	33%	45%	51%
Sirt	48%	26%	39%
Sebha	24%	36%	21%
Libya	14%	29%	38%

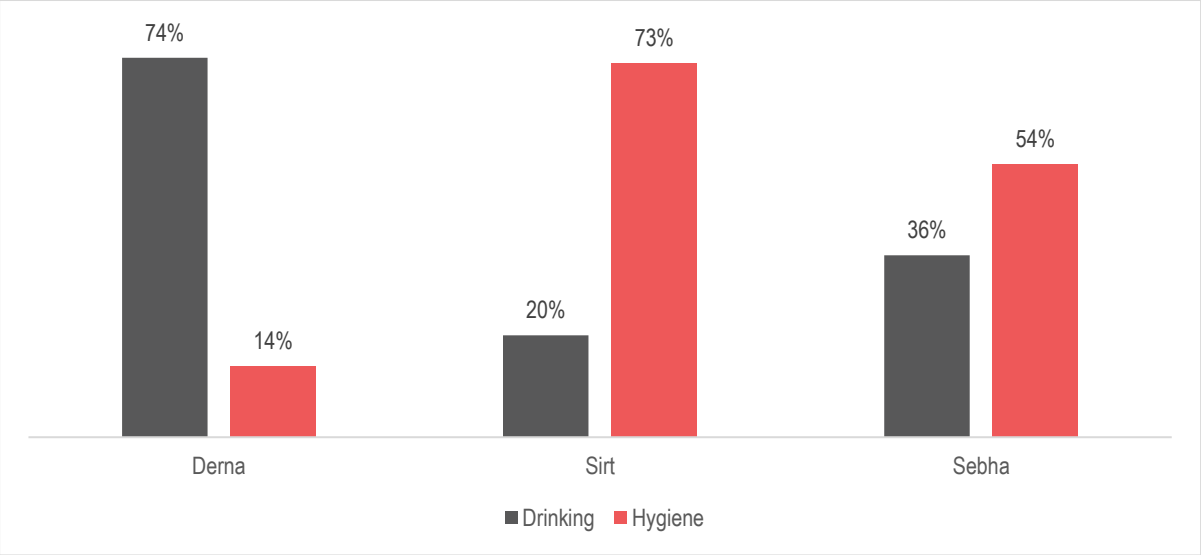
Household water needs in Derna, Sirt, and Sebha:

According to the quantitative data collected for this assessment specifically through household surveys conducted in the three assessed municipalities (Sebha, Sirt, and Derna) within the assessment on accessibility to sufficient and quality water in water-stressed areas in Libya, 73% of households have **enough water to meet their needs**. However, 27% reported not having been able to fully meet their water needs during the 30 days prior to data collection. In Derna, the percentage of households not fully meeting their needs is higher. Indeed, only 57% of households in Derna indicated that they had enough water to meet their needs during the month prior to data collection.

[52] The MSNA household-level surveys were conducted remotely over the phone between 14 June and 2 August 2021.

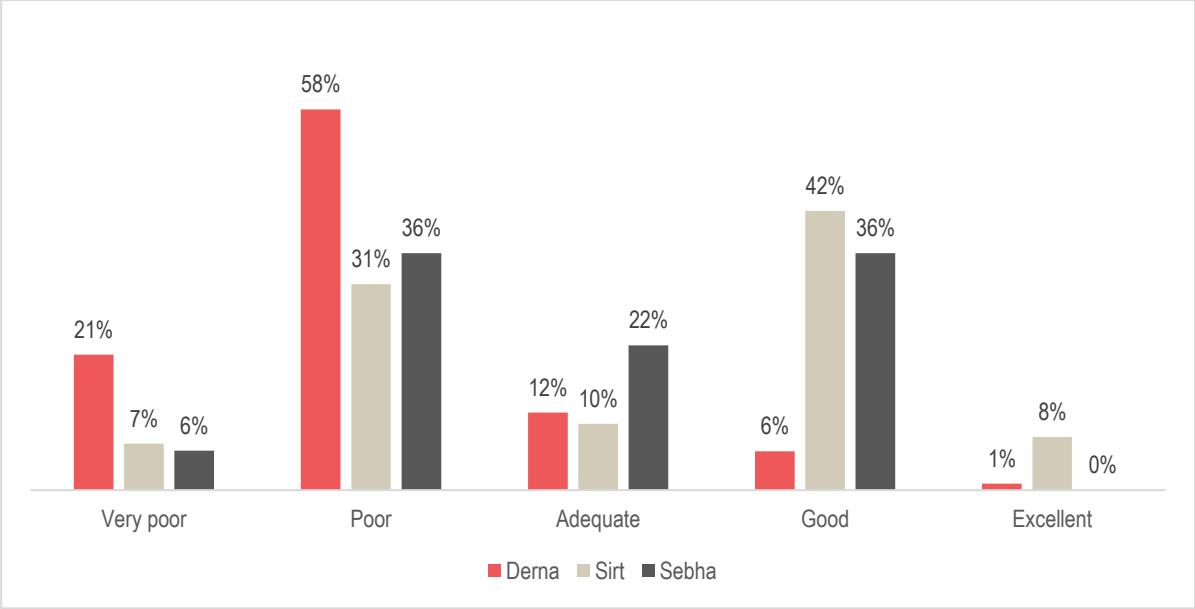
The main **needs that are reportedly not fully met** are drinking and hygiene needs. In Derna, among households who reported not having been able to meet their needs, 74% mentioned that during the previous month they had not enough water to satisfy their drinking needs. By contrast, in Sirt and in Sebha, households more often reported that insufficient access to water had prevented them from satisfying basic hygiene needs.

Figure 17: Reported unmet needs in Derna, Sirt, and Sebha according to the surveyed households who declared not fully meeting their water needs



The households' inability to fully meet their needs was generally explained by referring to the irregular water supply. Households mentioned, for example, that water is not available for a sufficient number of hours during the day (22%), that the amount of water available is not enough to meet the household's needs (17%), that supply is inconsistent (17%), and that water sources are not functioning or are closed (12%). In addition, 19% of households reported that the quality of water is poor, while 14% mentioned that the water pressure is not high enough and they would need additional pumps. Indeed, 52% of the surveyed households described the regularity of water supply as poor or very poor, as shown in the figure 18 below.

Figure 18: Reported regularity of water supply according to the interviewed households in Derna, Sirt, and Sebha



As shown by these figures, the situation is more critical in Derna. This may be linked to the lower rate of access to water from the public network in Derna as compared to the other two municipalities as evidenced by household surveys (see section on barriers to access to water – frequency on access to water). In addition, data from KIIs highlights that a further potential reason causing frequent interruptions in water supply in Derna may be the lack of maintenance of water infrastructures.

Factors increasing household water consumption:

Rising water demand in summer:

Household water demand **and needs reportedly vary between summer (May-October) and winter (November-April),** with water consumption increasing over the summer due to higher temperatures. Indeed, 74% of households reported that they need more water during the summer, which can aggravate their ability to meet their needs. In addition, as the water supply network relies on the electricity system, the heightened demand for water during the summer increases the load on power supply units (transformers, wires), putting them at risk of breakdown[53]. This is particularly the case in Sebha as explained in the Sebha Area-Based assessment conducted by REACH in 2021. Indeed, the overwhelming majority of KIIs interviewed in the three assessed municipalities mentioned that the water supply is less regular during the hot season due to more frequent electricity cuts and that it therefore does not meet the higher demand for water. **The use of air-coolers** (requiring the use of water) in the summer also increases household water consumption. In Sebha, particularly, given the hot and arid climate, the use of air-coolers is more common as 20% of the surveyed households in this Baladiya reported using water-consuming air coolers in summer. The average number of hours air-coolers are functioning reported by households using air-coolers in the three assessed municipalities is around 17 hours per day. The use of air coolers implies a higher electricity consumption. A study published in 2017 stated that the electrical energy used in cooling accounts for more than 60% of the total energy consumed in homes.[54] As shown in the section on "barriers accessing water", the increased electricity consumption in summers due to climate parameters causes frequent and long-lasting power cuts and consequently water outages. This was specifically highlighted by all KIs interviewed in Sebha who stated that power cuts represent the main issue hindering the water supply from the public network. In addition, the study published by the

[53] REACH Initiative, Sebha Area-Based Assessment (ABA), 2021
[54] Benghazi University, Calculation of Annual Heating and Cooling Energy Requirements for Residential Building in Different Climate Zones in Libya, 2017

University of Benghazi also noted in 2017 that Libya's power demand is growing rapidly (around 6%-8% annually) and is particularly higher between the months of May and October when air-coolers are mostly frequently used.

Gardening and livelihoods activities:
In addition to seasonal variation and air cooler usage, household water consumption increases due to leisure or livelihoods activities requiring the regular use of water. Overall, 34% of the surveyed households reported engaging in **gardening activities and/or growing crops**, which increases their water consumption – a figure rising to 42% in the case of Sirt. The main sources of water used for gardening activities are reportedly the public network (47%), protected wells (22%), boreholes (13%), and water trucking (14%).

Furthermore, 38% of households reported regularly using water for their livelihood activities, such as farming (44%), livestock breeding (29%), and cleaning activities, such as house cleaning, or car wash stations (54%). Some households (28%) reported that **their livelihood activities had been negatively affected by lack of sufficient water six months prior to data collection.**[55] In this sense, 53% of households explained that the stress related to getting enough water affects the way they perform at work, while 43% mentioned that the lack of water decreases the profit they can earn from their livelihood activity. In addition, 20% mentioned that they cannot keep their workplace sufficiently clean, as they must be careful of their water consumption. Similarly to the water source for gardening, water for livelihoods activities most commonly comes from the public network (50%), water trucking (25%), and boreholes (15%).

Access to water and domestic uses:

Main sources of water:

Overview of the main sources of water per assessed municipality:
In Derna, households rely on bottled water for drinking and cooking purposes and on water from wells for other domestic purposes. Water from the public network reportedly derives from desalinated water, groundwater, and springs such as Ain Abu Mansour located seven kilometers away from Derna in the southern area of the city. KIs reported that this source feeds about 10% of the water supplied through the public network. As explained in the section on barriers to accessing water, the neglected infrastructure damaged by the armed conflicts and the on-going maintenance of one of the key water infrastructures, namely the desalination unit, limits the water supply from the public network. The poor quality of groundwater, found to be contaminated by seawater intrusion[56], constitute another major issue hindering the supply of water through the public network in Derna. According to most KIs, water trucking has also become one the major water sources in Derna since maintenance work started in the desalination unit at the end of the 2021 (seven months prior to data collection took place in May 2022). The water supply issues from the public network in Derna contributed to an increase in the demand for and rising prices of water trucking.
In Sebha, water is entirely derived from underground basins, including water trucking and bottled water that is sold in water treatment shops as explained most KIs (GCWW representatives and community leaders). These shops treat water from the public network through treatment devices and sell this water through bottled water with reasonable prices compared to bottled water sold in supermarkets. In Sebha, water from the public network is the primary source for all uses as shown by the household surveys data (except in the some Muhallas, namely, Al Jadida and Hajara). Bottled water is also one of the most frequently used water source for drinking purposes (34%).

[55] Data collection of the household surveys conducted within the assessment on accessibility to sufficient and quality water in water-stressed areas in Libya took place between the 17th of April and 13th of May.
[56] Abdulmonem Elhassadi, Seawater intrusion in Derna located in the Green Mountain region, Libya — a threatening recurrent phenomenon calling for desalination, 2008

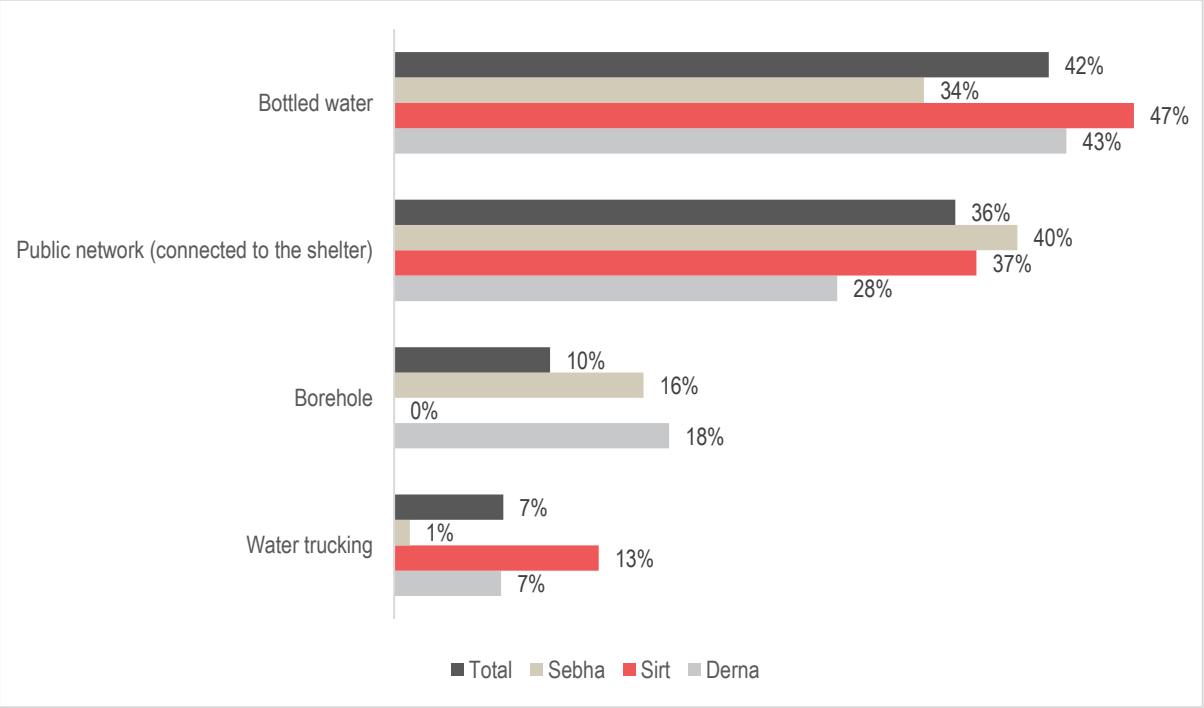
In Sirt, KIs indicated that while the main source of water overall is the public network, bottled water remains the most preferred solution for drinking purposes. With regards to water from the public network, some KIs mentioned that it mainly originates from the Al Karzabeya reservoir located in the southeast of Sirt.

Overview of the water sources used for the different domestic purposes (drinking, cooking and hygiene):

The following sections provide a brief overview of household reported reliance on different sources of water for drinking, cooking, and hygiene purposes, across the three locations surveyed.

Water sources for drinking purposes:

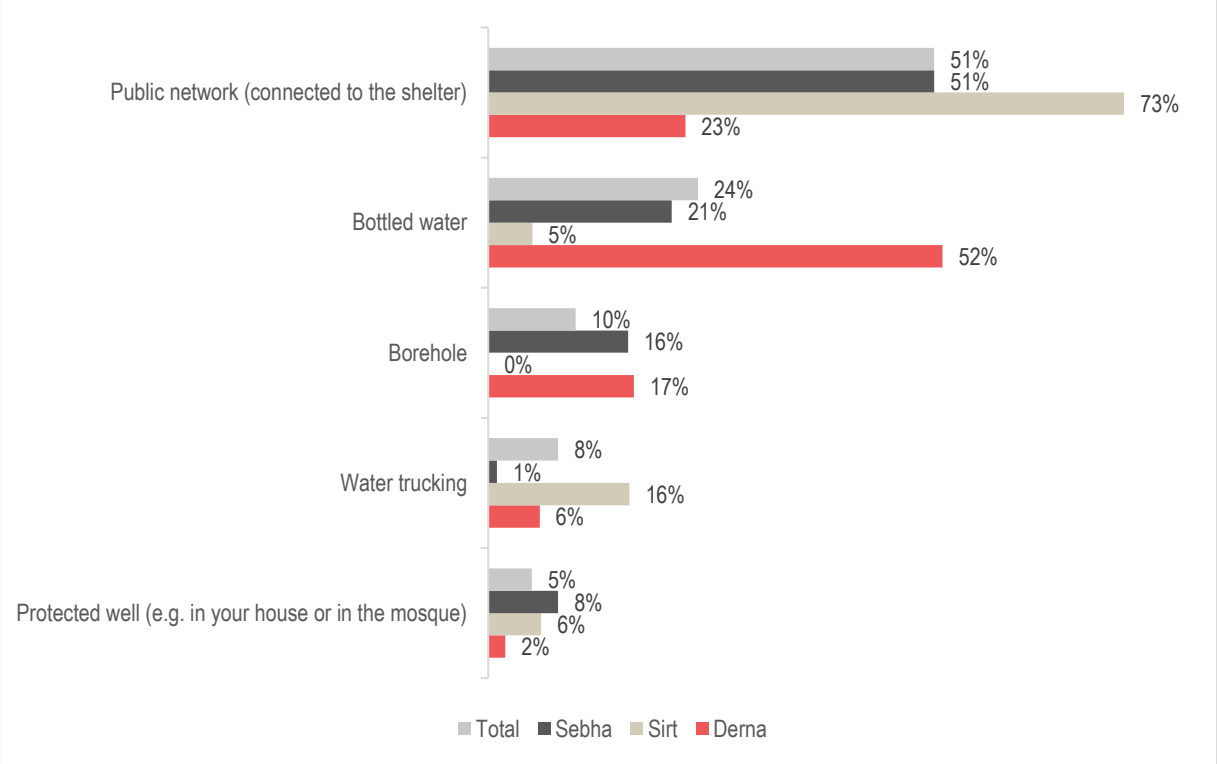
Figure 19: Most reported sources of water used by surveyed households for drinking purposes



The quantitative data shows that households mainly rely on bottled water (42%) and the public network (36%) as their main sources for drinking purposes. Households most often reported that the reason why their main source of drinking water is bottled water is that the quality of water from other sources is poor (44%).

Water sources for cooking purposes:

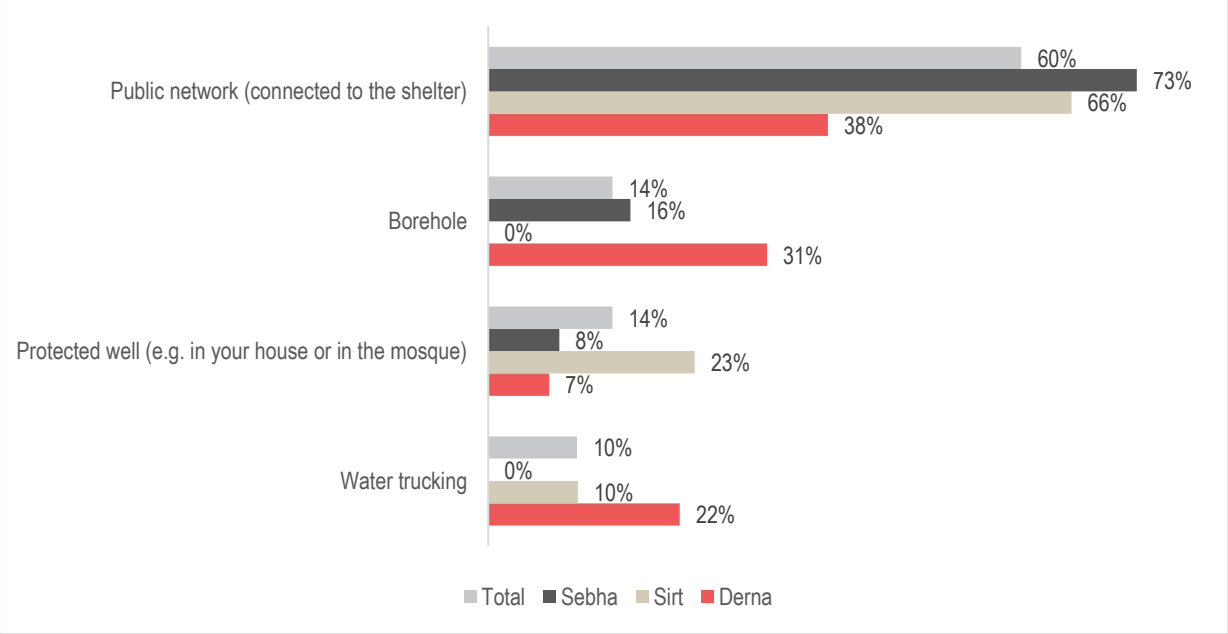
Figure 20: Most frequently reported sources of water used for cooking purposes as reported by surveyed households



The main source of water for cooking and preparing food in Sirt and Sebha is reportedly the public network. In Derna, the main source used by households for cooking uses is bottled water (52%). In Sebha, the proportion of households relying on bottled water for cooking purposes is also relatively high (21%).

Water sources for hygiene purposes:

Figure 21: Most frequently reported sources of water used for hygiene purposes reported by surveyed households



The main water source of water for hygiene and bathing purposes is reportedly the public network in all three municipalities. In Derna, however, households reported that other sources such as boreholes (31%)

and water trucking (22%) are also widely used for these purposes. This can be explained by the more frequent interruptions from the public network in Derna compared to Sirt and Sebha as highlighted by the KIs and shown by the figures on the frequency of access to water from the public network (see below the section on barriers to accessing water – frequency of access to water).

Barriers to accessing water:

Water quality issues:

The increasing water demand from underground water resources not only affect the availability of groundwater but also its quality. The coastal region of Libya is the most densely populated area and the intensive extraction of groundwater from coastal aquifers causes groundwater contamination in the form of **seawater intrusion**. When asked about the quality of water that is available through the main sources, some KIs, especially in Derna, mentioned that households in certain neighbourhoods, such as Al Sayyida Khadija which is close to the coast, cannot for example use water from wells for drinking or cooking purposes because of the high water salinity rates. As explained in an article published in the Open Hydrology Journal, the city of Derna is facing severe water shortages due to seawater intrusion. "The intrusion has steadily increased from 1960 to 2005, a period during which potable water was available. Since 2005, a loss of 75% in well production in this aquifer system has been observed and this can be an indicator of the degradation and salinization of groundwater resources".[57] According to some KIs, among the issues hindering access to water, the poor quality of the water supplied through the public network or private wells is a recurring problem that leads households to undertake coping strategies such as treating water or relying on more expensive solutions, such as bottled water and water trucking.

Besides salinization, other factors affect the quality of water, such as the lack of maintenance of infrastructures, wastewater treatment issues, or the lack of policies and initiatives to monitor the quality of water. In particular inadequate **wastewater treatment** and management represent a serious threat to public health in Libya. Reportedly, wastewater treatment plants have not been maintained regularly after being exposed to the effects of a decade of conflict and targeted attacks on water infrastructure that contributed to negatively impact their state.
This problem is also present in other regions and municipalities in Libya (not covered in this study) as shown by the assessment of water supply systems and institutions in Libya conducted by UNICEF and published in 2019. In Benghazi, one the most conflict-affected cities in Libya, armed conflict and difficulties in maintaining infrastructure have resulted in dysfunctional electricity and sewage systems, with a consequent accumulation of wastewater in the streets, which constitute a serious public health threat. In addition, it was reported that there is no treatment of wastewater in the Benghazi Municipality because of the dysfunctional sewage system and damaged infrastructure. This same study conducted by UNICEF mentioned that the Western region has also been affected by a similar destruction of infrastructure, with considerable environmental and public health impacts. For example, in the Municipality of Abu Saleem, where the largest conflict events took place in 2018, water distribution pipes and wastewater collection pipes were destroyed: "corrosion of water and wastewater pipes caused serious leakage and cross-connection between water and wastewater in the area of Bab Ben Ghashier, causing serious contamination and potential public health risks in addition to losses of water supply and structural damages".[58] As a consequence of the lack of maintenance and upgrading of the damaged infrastructure and wastewater treatment facilities, UNICEF specified that only 45.5% of households in Libya are connected to the public sewage network.[59] As reported by KIs interviewed to report on the

[57] The Open Hydrology Journal, Simulation of Seawater Intrusion in Coastal Aquifers: Forty-Five Years Exploitation in an Eastern Coast Aquifer in NE Tunisia, 2012.
[58] UNICEF, Assessment of water supply systems and institutions in Libya, 2019
[59] UNICEF, Over 4 million people, including 1.5 million children are about to face imminent water shortage in Libya, 2021

water management situation at a national level, informal sewer manholes are also a widespread problem as the rest of households are connected to cesspits and lead to the contamination of groundwater with wastewater. Furthermore, as explained by UNICEF, most of the wastewater is discharged directly into the sea without treatment, negatively impacting the environment and marine life.[60]

In Derna, the main reported factors affecting the quality of water are **the lack of maintenance or damage of WASH infrastructure**. Infrastructure was severely affected by armed conflicts and has been in disrepair since then. *Al Bilad* and *Al Maghar* neighbourhoods have been most affected by the consequences of war. In particular, contamination of water caused by wastewater overflow is an important factor affecting the quality of water in these areas. One KI specifically mentioned that "sewage water reaches the lower layers of the groundwater" and thus affects the quality of water used for domestic uses. In Derna, the sewage networks were established in the sixties and sewage overflowing is reportedly a major problem that has led to soil pollution and leaking into the aquifer situated below the city. As explained in a study conducted by the University of Tobruk, "all sewage lift stations except one have been disrupted and exposed to neglect and stealing and finally became garbage landfill and thus polluted the beach and leaked to groundwater. Besides that, the sewage treatment plant, which was established in 1980, has not been completed and has been exposed to neglect and destruction and is now at a dilapidated stage with little actual value".[61]
In Sebha and in Sirt, most KIs also mentioned that the lack of maintenance of infrastructure and wastewater overflow has contributed to a deterioration in the quality of the water supplied.

Picture taken in Al-Jadeed, Sebha, showing a street flooded with wastewater.

According to the Sebha Area-Based assessment conducted by REACH in 2021[62], there is only one main sewage lifting station that is partially functioning, and a treatment plant that is not operational. The untreated sewage is unloaded into a lake in the north of Sebha. Sewage flooding was declared an environmental emergency by the municipality in 2018 and the topic has even been raised during social movements in the city.

The factors mentioned above (seawater intrusion, lack of maintenance, and sewage overflow) can have a direct impact on household access to good-quality water. Regarding household satisfaction towards the quality of water from the public network for domestic (including drinking) purposes, households in

[60] UNICEF, Over 4 million people, including 1.5 million children are about to face imminent water shortage in Libya, 2021
[61] University of Tobruk, Groundwater Pollution and Wastewater Management in Derna Region-Libya, 2012
[62] REACH Initiative, Sebha Area-Based Assessment (ABA), 2021

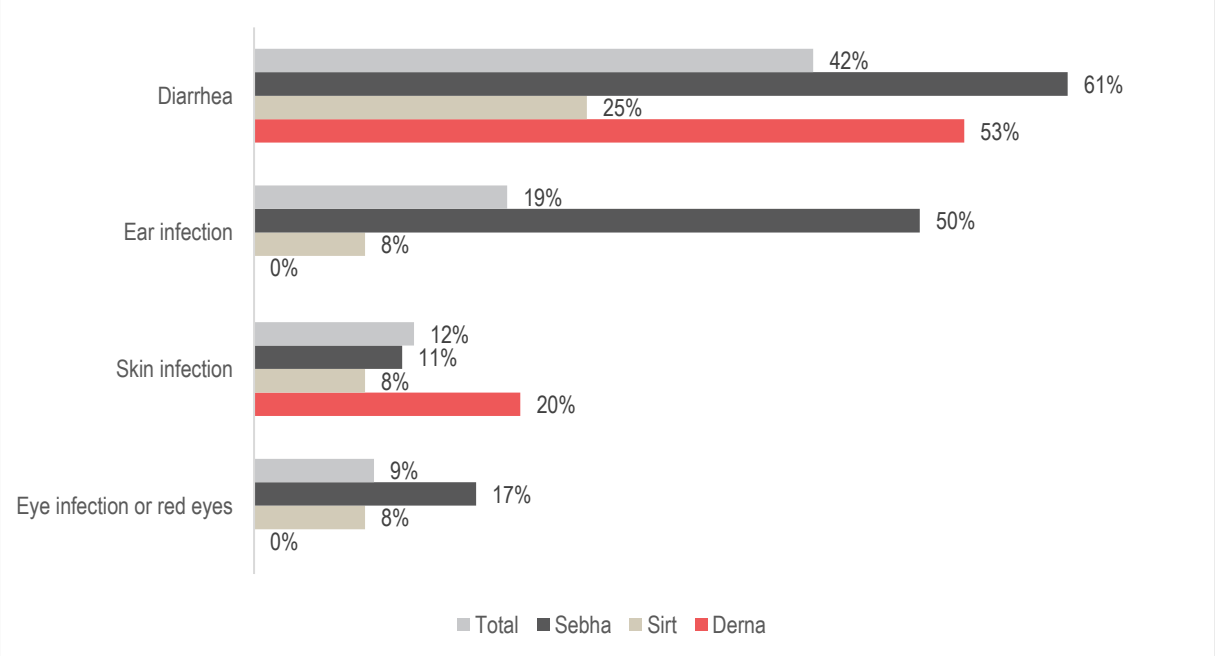
Derna are the least satisfied with the quality of water from the public network as 21% of households are very dissatisfied and 21% are somewhat dissatisfied. According to 25% of surveyed households, the quality of water used for drinking purposes is not acceptable because of its taste.

Even though the KIs mentioned that there are some measures taken and institutions responsible for the monitoring of water quality, the lack of financial and technical resources is an obstacle to ensure an effective monitoring. Monitoring of water quality is often done by the GCWW before water is pumped into the network. In Derna, the General Desalination Company (GDC) is also involved in monitoring water quality through the analysis of water samples. It has been noted that the GDC would need additional resources and equipment to be able to monitor the quality of water (such as a phosphate analysis system and a caustic soda system). Some KIs in Derna further reported that support has been provided to key public institutions by INGOS, such as The International Committee of the Red Cross (ICRC), to support the monitoring of the quality of water. In Sebha and Sirt, most KIs agreed that the quality of water is being monitored by the GCWW but with limited resources.

Public health issues resulting from poor water quality:

About one fifth of households reported having a family member exhibiting symptoms that could be associated with waterborne illnesses. Specifically, 24% of households with family members above the age of 5 years old and 19% of households with family members aged below 5 years old reported this. Waterborne illnesses are most commonly associated with symptoms like diarrhea and vomiting but can also cause skin, ear, respiratory, or eye problems.[63]
Among the households who reported a family member under the age of 5 exhibiting symptoms that could be associated with waterborne illnesses, 42% declared that this family member was exposed to diarrhea, 19% were affected by ear infections, 12% by skin infection, and 9% suffered from an eye infection or had red eyes 30 days prior to the data collection phase.

Figure 22: Most frequently reported symptoms associated with waterborne illnesses that family members aged below 5 have exhibited according to the interviewed households in Derna, Sirt, and Sebha

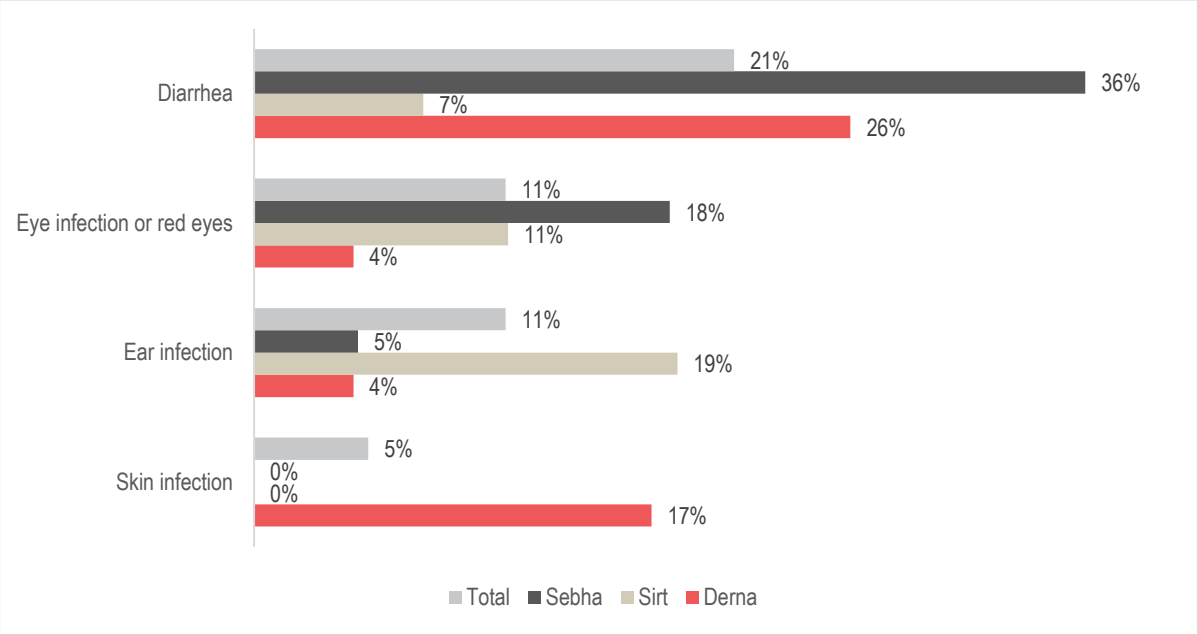


Concerning the population aged above 5 years old, diarrhea is the most frequently reported symptom that can be associated with water related illnesses as 21% of households (among the 24% who had a

[63] University of Minnesota, Department of Health, Causes and Symptoms of Waterborne Illness

family member aged above 5 years old exhibiting the above-mentioned symptoms in the 30 days prior to data collection) reported exhibiting this symptom.

Figure 23: Most frequently reported symptoms associated with waterborne illnesses that family members aged above 5 have exhibited according to the interviewed households in Derna, Sirt, and Sebha



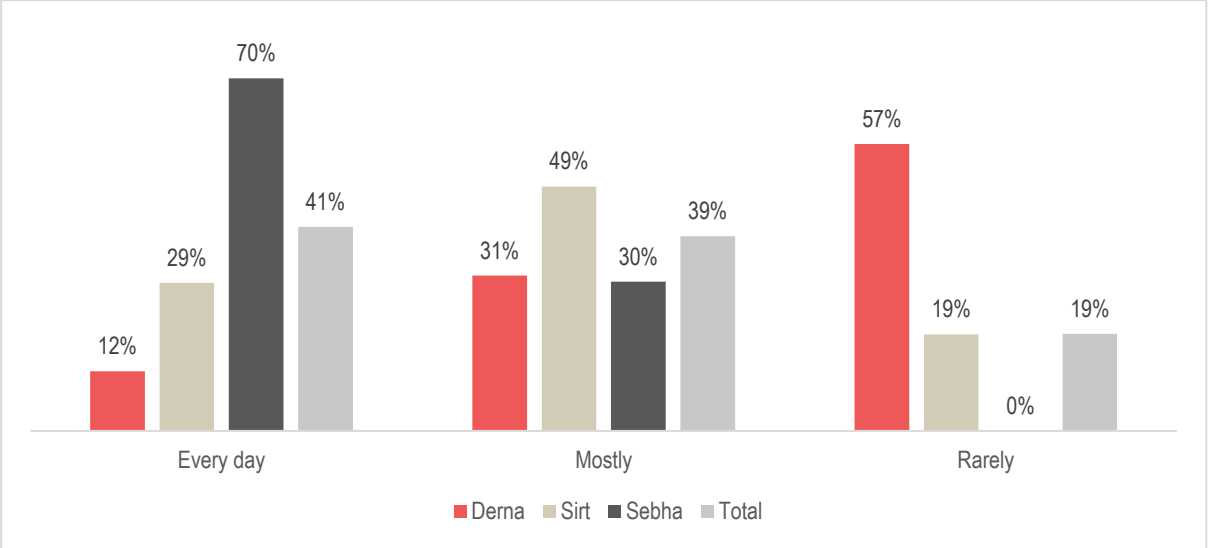
Figures 22 and 23 show that diarrhea and skin infections are particularly prevalent in Derna. In Sebha, the most frequently reported symptoms that can be associated with water related illnesses are Diarrhea, ear, and eye infections. In Sirt, these symptoms have been less frequently reported by the surveyed households. However, 25% of the households that reported a family member under the age of 5 was affected, reported that the child in question had diarrhea and 19% of the households which reported that a family member above the age of 5 years old was exhibiting a symptom, reported that this person had an ear infection in the 30 days prior to data collection.

Frequency of access to water:

Aside from the quality of water, the frequency of water supply further represents a barrier hindering household access to water resources.
As highlighted by the KIs reporting on the national level, regular power outages, especially in the summer or during clashes, highly affect the frequency of the water supply. In addition, the lack of effective maintenance and the extensive damage to key infrastructure are reportedly other factors causing water outages and contribute to the increase of prices of other sources as shown by the quantitative data on the evolution of prices of water sources.

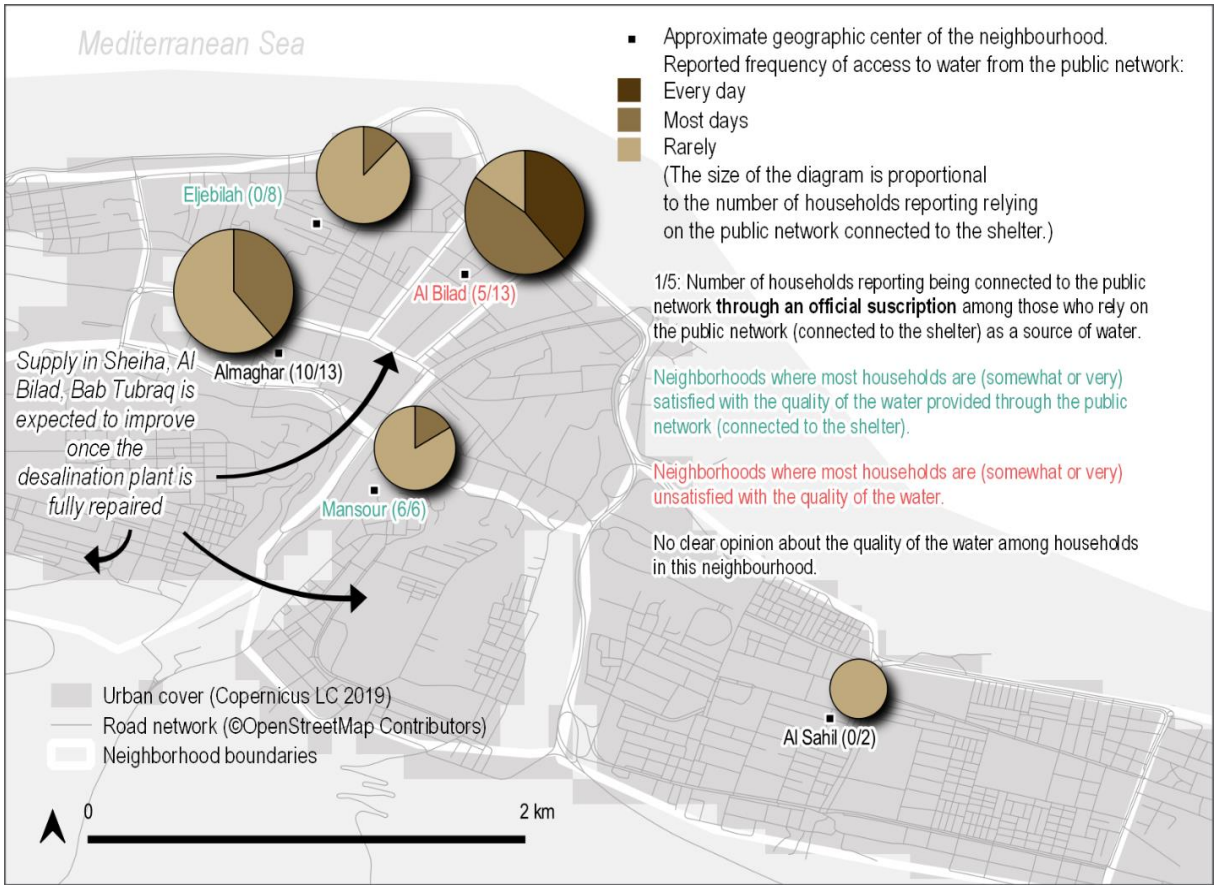
According to the household surveys, 19% of households have access to water from the public network rarely (1-3 days per week), while 39% have access to this source most of the time (4-6 days a week), and 41% reported having access to water from the public network every day. On the days that water from the public network (connected to the shelter) is available, it is available 15 hours a day on average.
In Derna, the water supply from the public network is the most problematic as 57% of the surveyed households reported rarely having access to it.

Figure 24: Frequency of access to water from the public network as reported by the surveyed households in Derna, Sirt, and Sebha



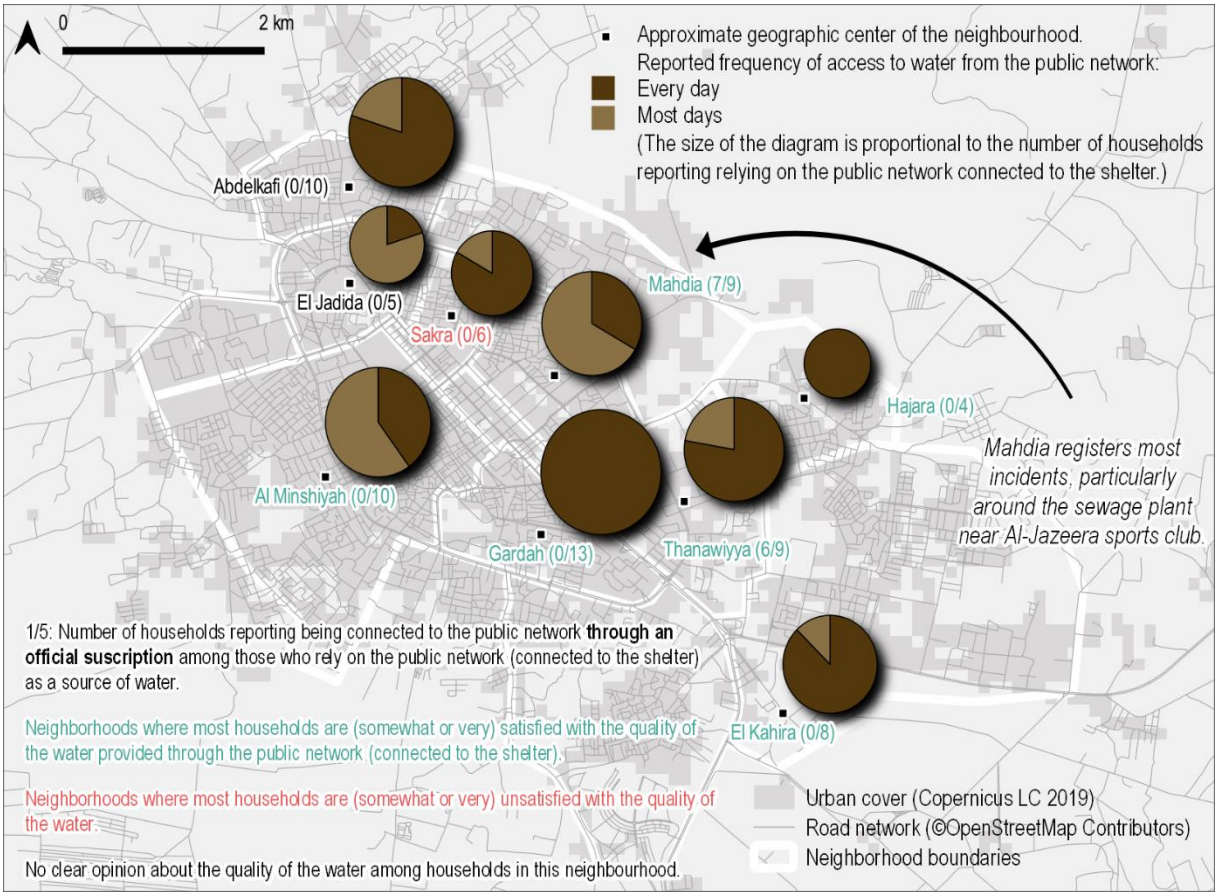
A majority of KIs reported that the most important issue is the irregular supply of water from the public network and the **frequency of water supply often differs from one neighbourhood to another**.

Figure 25: Modalities of access to the public network, households' satisfaction towards its quality, and frequency of its access in Derna reported by the surveyed households in Derna



For example, in Derna, some neighbourhoods such as Al Sahil Echarqi (and more specifically in the neighbourhood named "400") do not have any access to water resources from the public network. Access to groundwater in Al Sahil Echarqi through private wells or boreholes is also difficult as households must dig at least 150m to have access to water resources and the cost of such deep wells is significantly higher. In addition, the supply is very limited in Eljebilah, Al Maghar, and Al Bilad as shown in the map above.

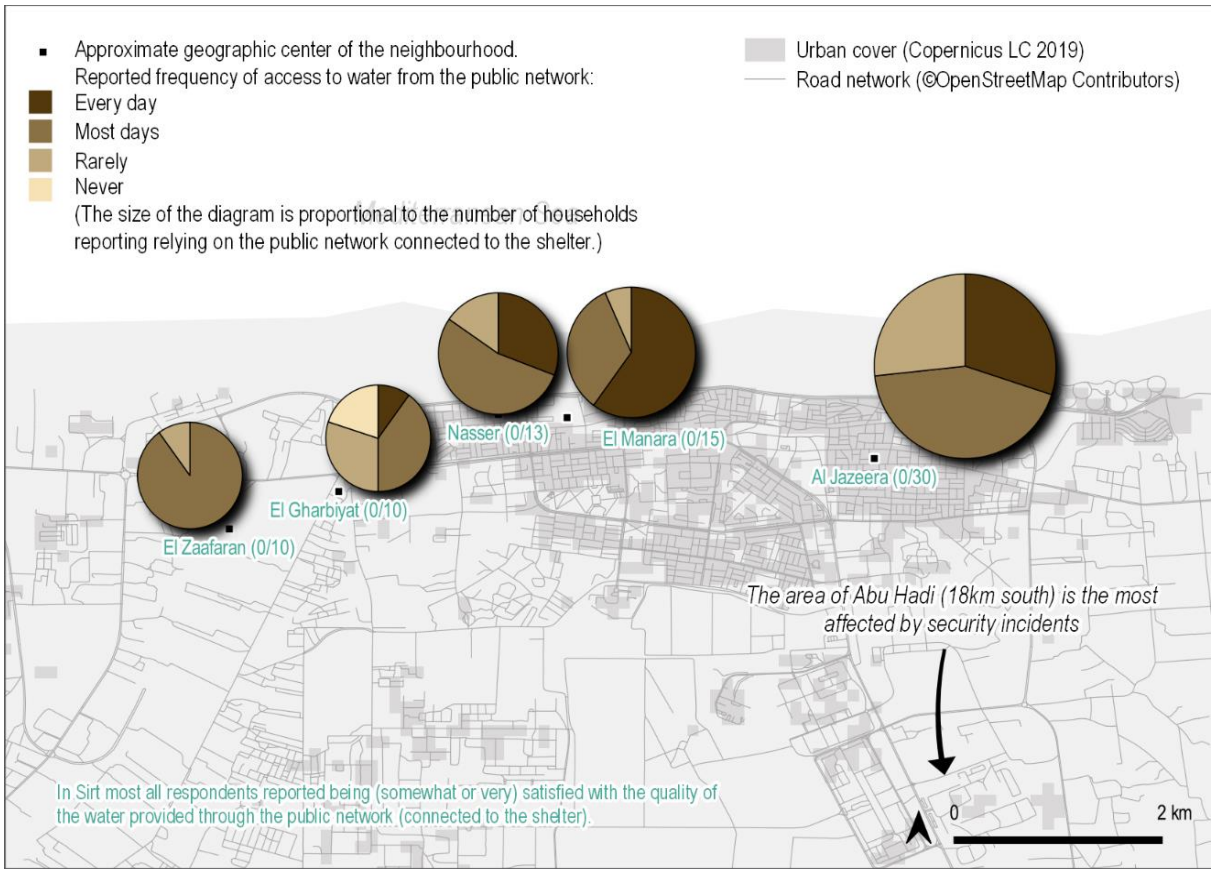
Figure 26: Modalities of access to the public network, households' satisfaction towards its quality, and frequency of its access in Sebha reported by the surveyed households in Sebha



In Sebha, even though the main source of water is the public network, and this source is generally available everyday as mentioned by 70% of the surveyed households, some Muhallas don't have a regular access to it. As shown in Figure 26, most households in Al Jadida, Mahdia and Al Minshiyah relying on the public network do not have a daily access to this source. The factors mentioned by the KIs hindering the regular supply of water from the public network in Sebha are related to electricity cuts and security incidents targeting water infrastructure, particularly frequent in the Muhalla of Al Mahdia as shown in the figure above.

Some neighbourhoods do not have or have fewer access to public network in Sirt as shown in the figure below. Figure 27 shows that more than half of the surveyed households in Al Gharbiyat have never or rarely access to this source.

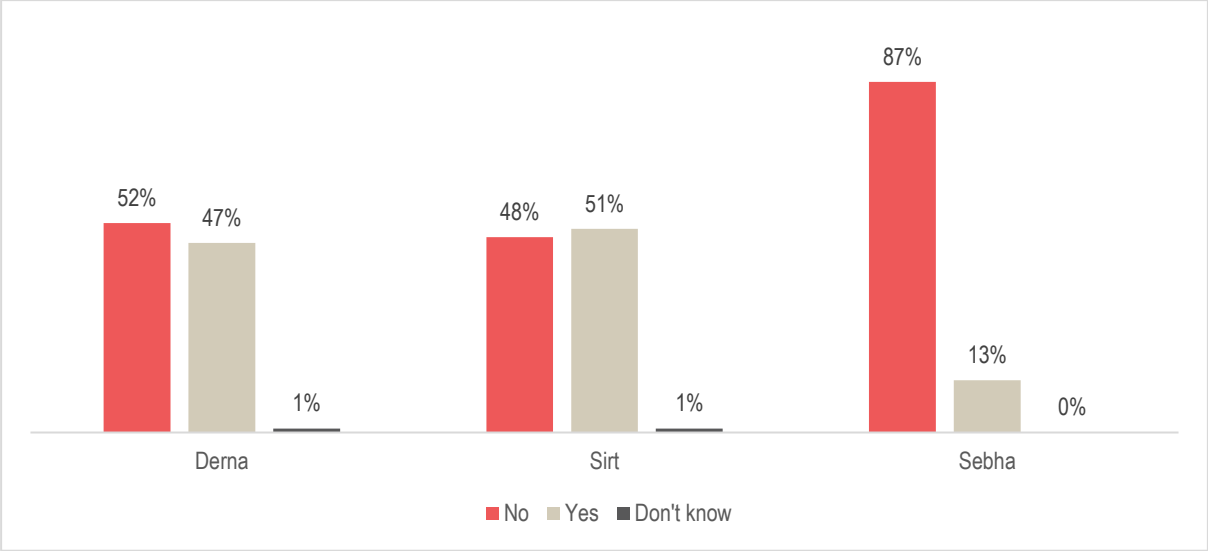
Figure 27: Modalities of access to the public network, households' satisfaction towards its quality, and frequency of its access in Sirt reported by the surveyed households in Sirt



High water expenditures:

When asked about the barrier encountered by households to regular access to water, some KIs explained that consequences of the irregular supply from the public network drive households to purchase water delivered by trucks (provided by private entities), that is considered as an expensive source, especially since water from the public network is generally free. Quantitative data shows how the use of alternative sources can be costly as 22% of households reportedly had to spend money (or credit) on water that should have been used for other basic needs and 38% affirmed that their current water expenditure is negatively affecting their savings.

Figure 28: Household savings affected by water expenditures according to the surveyed households



In Derna and in Sirt, **household savings are more affected by their water expenditures** than is Sebha, where households rely less on water trucking. Water expenditures were identified by all KIs in Derna as one of the most important factors that could affect the availability of sufficient and quality water in the six months after data collection in the municipality. They specifically mentioned the increasing prices of water delivered by trucks (or cars) due to frequent cuts from the public network.

"Water trucking expenses of households can reach up to 300 Libyan Dinars (LYD) per month".
Member of the Council of Elders in Derna

In Derna, water trucking is a common source, especially for hygiene and bathing with 22% of households reporting using it for this purpose. Water trucking is also a common source of water in Sirt where 13% of surveyed households use this source to meet their drinking needs and 16% use it for cooking and preparing food. The percentage of households that noticed a change in the price of their water is also higher in Sirt and Derna, where 41% and 36% of households respectively reported this. Among the 30% of interviewed households in Sirt, Sebha, and Derna who **noticed a change in price of their water sources** in the 12 months prior to data collection, 87% mentioned that water trucking prices have increased.
Finally, as mentioned above, a representative of the GCWW reported that the cost of drilling wells has become more expensive because in some neighbourhoods "it is now necessary to drill deeper to reach water from underground basins (300 meters deep instead of 80 meters)".

Electricity cuts affecting the water supply:

All KIs reported being aware of water outages caused by power cuts in the six months prior o tata collection. In Derna, KIs reported that the desalination plant relies on electricity to function, and water extracted from groundwater requires the use of electrical pumps. Water is also transferred from the lower regions to the higher regions through electrical pumps to ensure water supply to the higher regions. In Derna, **electricity was cut off for two consecutive months** until the end of the month of March 2022 and consequently water supply was also interrupted. Households therefore resorted to using water trucking as an alternative source.

In Sebha, KIs mentioned that power cuts are more frequent in the summer during which time they can even occur daily. These cuts can reportedly last up to 12 hours a day in summer, compared to 3 hours a day in the winter. Electricity cuts considerably affect the water supply as the main source is groundwater

and electrical pumps are required to ensure the supply. Some households use generators to cope with these frequent power cuts. The Area-Based Assessment (ABA) conducted by REACH in 2021 in Sebha[64] supports the idea that electricity issues are inimical to residents' water access, with power outages shutting down well pumps, or low voltage electricity damaging those pumps. The Sebha ABA also showed that some well pumps are connected to auxiliary generators, although the recurrent fuel shortages prevent generators from operating during prolonged power outages.

Frequent power cuts also occur in Sirt where security incidents can also affect the electricity supply and therefore can cause water outages as explained by all interviewed KIs in this area. In fact, all KIs reporting on Sirt stated that frequent power cuts highly affect the water supply as households use electrical pumps to have access to water. This also affects the water supply to key public infrastructure such as hospitals as reported by one KI that mentioned the Ibn Sina Hospital which highly depends on electricity to have access to water.
In all three locations, frequent power outages coincide with the increasing water demand during the summer months. As mentioned, 74% of interviewed households reported that they need more water in summer.

Coping strategies:

Interviewed households mainly adjusted to the lack of water in the six months prior to data collection by fetching drinking water from a less desirable or safe water source (55%), reducing water consumption for hygiene practices (48%), or by reducing their drinking water consumption (40%). In addition, water treatment techniques were reportedly used to gain access to good-quality water resources.

Water treatment techniques:

According to quantitative data, 40% of interviewed households treat the water before drinking it. According to most interviewed KIs, households generally treat their water through domestic desalination devices. The most reported treatment techniques are filtering (49%) and using chlorine or other disinfection products[65] (44%). Households reportedly also purchase water from water treatment shops.

An important proportion of surveyed households (35%) also choose to treat their water before cooking and preparing food. They usually filter it (38%) or use chlorine or other disinfection products (49%). In addition, 34% of households reported boiling water to make it safer to cook with. KIs reporting on the national level indicated that boiling water and letting it stand and settle are techniques used by households with less financial means.

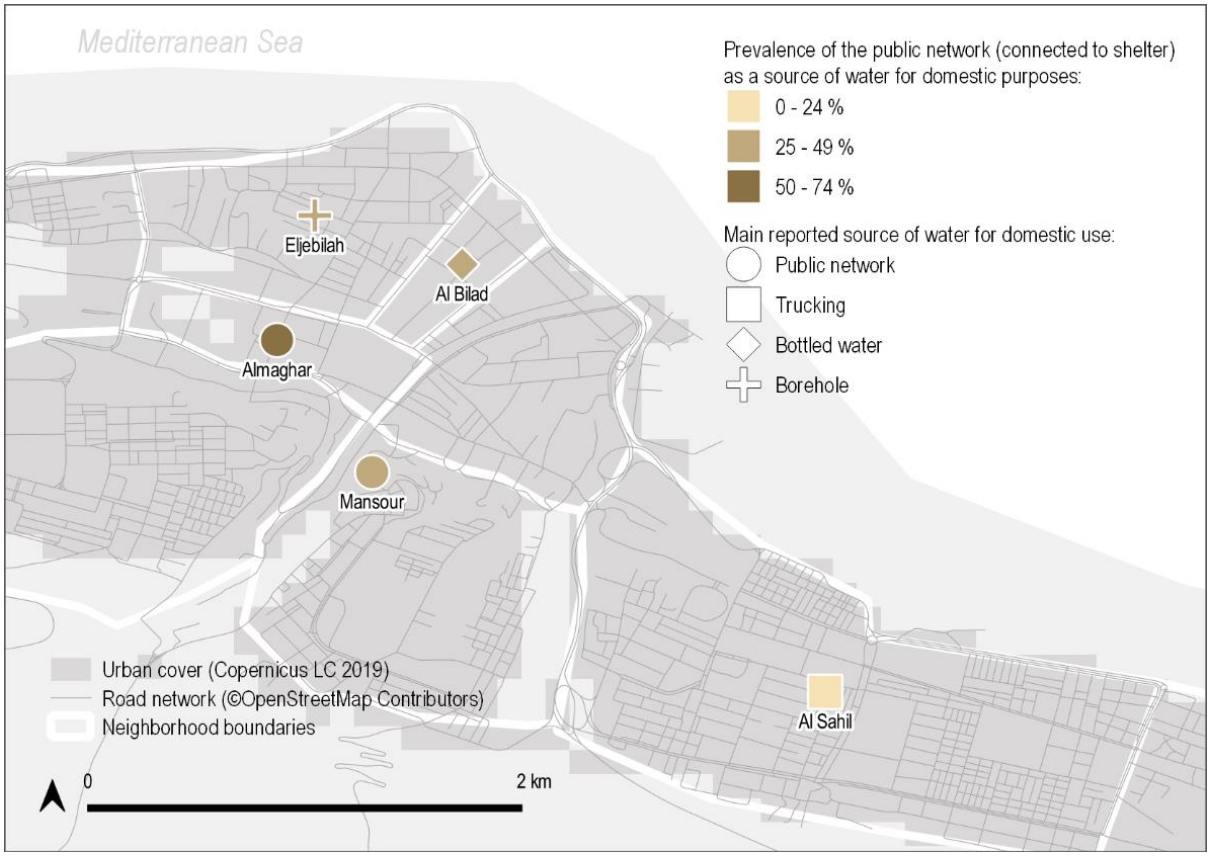
Use of alternative sources to cope with irregular supply of water from the public network:

In order to cope with difficulties in accessing quality and sufficient water from the public network in Derna, interviewed households reported usually relying on other water sources such as bottled water, water trucking, and domestic wells. Among the interviewed households using domestic wells, some people decide to share a well with other neighbours to reduce the high drilling costs.

[64] REACH Initiative, Sebha Area-Based Assessment (ABA), 2021
[65] Other disinfection products can refer to aquatabs/water purification tablets, PuR or watermaker sachets.

Quantitative data shows that household average expenses on protected wells and boreholes in Derna, Sirt, and Sebha are higher than expenses on other water sources, including water trucking. The average expenditure on protected wells is 1,416 LYD and goes up to 2,645 LYD for boreholes. Households may also use additional electrical pumps to accelerate water flow when it is available from groundwater resources. In three out of the five assessed neighbourhoods in Derna, the main water sources for domestic uses (including drinking) are sources other than the public network as shown in the figure 29.

Figure 29: Main reported water sources used and prevalence of the use of the public network as reported by the interviewed households in Derna



KIs also specified that access to the public network is less frequent in Eljebilah, Al Bilad and it is completely interrupted in El Sahil Al Sharqi (and more specifically in the 400 neighbourhood). Considering the high costs of drilling wells in some areas where households need to dig around 150 and 200 meters to reach water, households usually resort to using water trucking. One such neighbourhood is Al Sahil al Sharqi as shown in Figure 29. One KI also mentioned that access to trucks delivering water is sometimes difficult in neighbourhoods like Eljebilah and the 400 neighbourhood because the streets are narrow. In these cases, most KIs reported that households therefore rely on shared wells / boreholes.

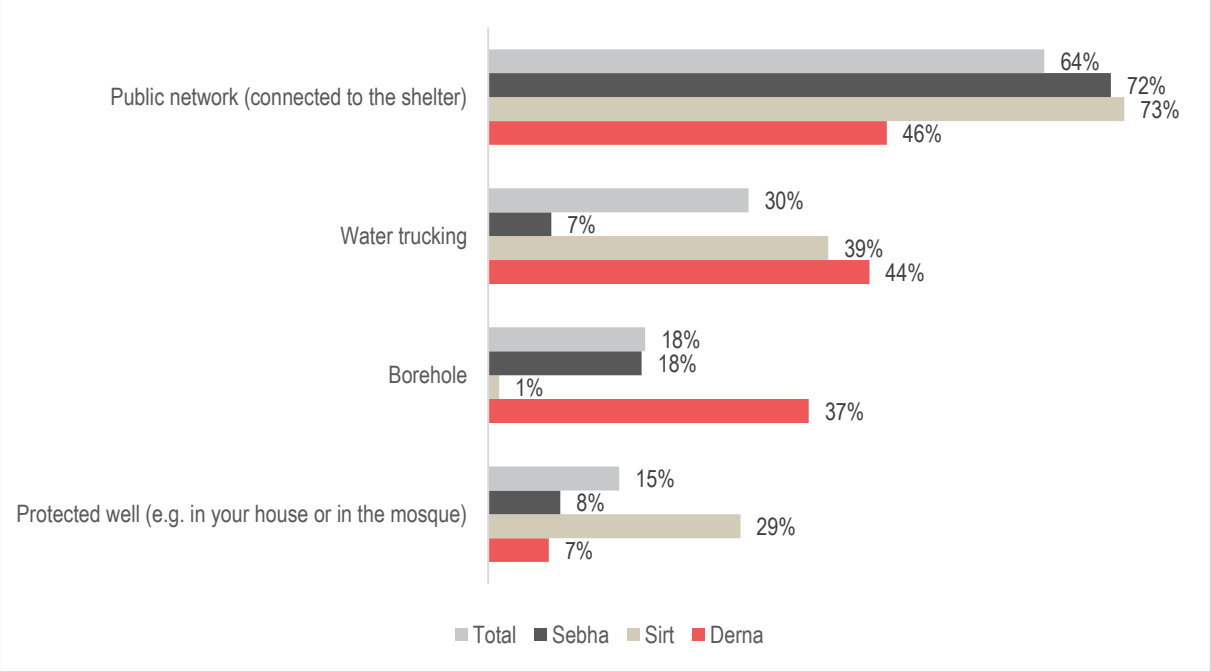
In Sebha, according to most KIs, households also drill their own wells to cope with difficulties in accessing water resources. Some households benefited from international aid organizations' support which equipped their wells with electrical generators to ensure their functionality considering the frequent electricity cuts in summer. It was specified by REACH field staff that in the framework of a UNDP implemented project, electrical firewall generators were distributed in neighbourhoods such as Al-Qarda, Al-Jadid, Abdul Kafi, Al-Fateh and Hajara. The power of the generators ranges between 30 to 50 KVA.

In Sirt, bottled water (generally bought from purification and water treatment shops) and water trucking "sometimes provided at excessive prices" as specified by a civil society organization representative are the main sources used to cope with water outages or poor quality of water from the public network. Quantitative data shows that bottled water is the primary source for drinking purposes. Bottled water is also the main source for cooking in Derna with 52% of the surveyed households reporting using it to prepare food.

Water storage techniques:

Almost all interviewed households reported resorting to using water conservation techniques. As shown by quantitative data, 92% of households reported that they have (a) water tank(s) (either private or shared). The average number of people sharing the water tank is around eight.
The use of water trucking to fill water tanks is very common in Sirt and Derna. This can also be an indicator of water scarcity showing that households rely on a costly and non-sustainable water source to fill in their water tanks. The most frequently reported water sources used to fill the tanks are water from the public network (64%), water trucking (30%), boreholes (18%), and protected wells (15%).

Figure 30: Most frequently reported water sources used to fill water tanks according to interviewed households[66]



On average, households fill their water tank 16 times per month. However, 25% of surveyed households reported that **the water tank (or water storage system) that they currently use is not sufficient to store enough water**. This percentage is higher in Derna where 37% of households reported that they do not store enough water.

[66] Concerning the question on most frequently reported water sources used to fill water tanks, respondents had the choice of selecting multiple options.

THE PUBLIC WATER SUPPLY IN LIBYA: MODALITIES OF ACCESS AND SERVICES PROVIDED TO MAINTAIN AND UPGRADE WATER INFRASTRUCTURE

Modalities of access to the public network and public water fees:

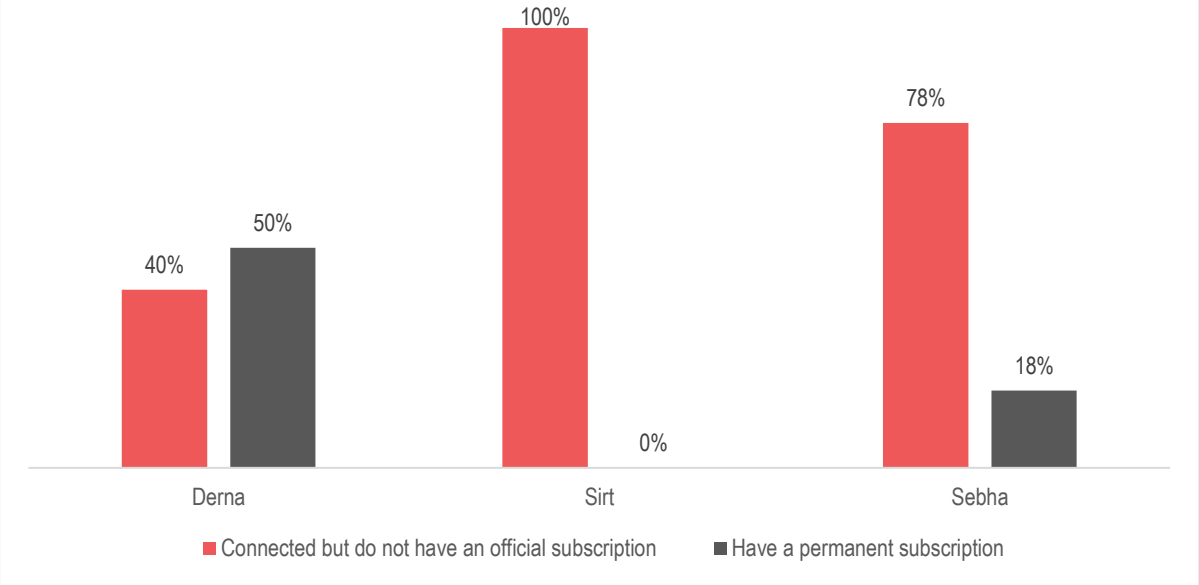
Connection process to the public network:

According to the interviewed KIs, not all households have an official connection to the public network through permanent subscriptions to the GCWW. An official subscription to the public network involves notifying and obtaining legal permission from the GCWW which supervises connection processes to the public network[67]. KIs further mentioned that an official subscription to the public network also implies the payment of monthly fees (around ten LYD), often paid through deduction from the consumers' salaries (see the following section on public water fees for more details). To this end, some water meters[68] have been installed in few neighborhoods in Derna. However, due to the irregular water supply from the public network and the deterioration of water infrastructures, these water meters are currently not used. According to analysis of the qualitative data, the findings showed that the management of subscriptions and payments to the public water and service provider vary according to the concerned municipalities and neighbourhoods. There are reportedly multiple factors that come into play determining the regulations and processes of connections to the public network including the level of water supply or the management capacities and policies applied in the concerned municipalities. In this section, connection modalities to the public network, the frequency and average fees, as well as the spread of informal (undeclared) connections will be explored to provide a contextualized overview of the management and household access to this water source in Derna, Sirt, and Sebha.

Although quantitative data indicates that the public network is one of the main water sources used for drinking and domestic purposes, 82% of surveyed households are reportedly **connected to the public network without a permanent subscription.** In Derna, 40% of households reported that they are connected but do not have an official subscription and 50% have a permanent subscription. In Sirt and in Sebha, most respondents are connected but do not have an official subscription. In fact, in Sirt, 100% of assessed HHs do not have an official subscription while in Sebha and Derna these proportions stand at ca. 80% and 40% respectively (see figure 31).

[67] The legal process of connecting to the public network was explained by representatives from the GCWW that took part in the KIIs.
[68] A water meter is an instrument for recording the quantity of water passing through a particular outlet.

Figure 31: Modalities of connecting to the public network reported by the surveyed households



In Derna, all KIs mentioned that there are both informal and formal (official) connections. **Informal connections** done without any technical supervision or legal permission from the GCWW are very common, difficult to control, and cause damage to the public network pipelines and leaks.

According to KIs interviewed about Sebha, the vast majority of households do not currently have any formal subscription to the GCWW and do not pay any water fees. One KI claimed that "water is free in Libya and all citizens are entitled to free access to water from the public network". The perception that water is a given and free resource seems to be culturally embedded since Gaddafi's regime. In fact, the MMRP was the promise of free water supply to all the populations in Libya. After the revolution of 1969, the Libyan government nationalised the oil companies and spent much of the oil revenues to harness the supply of fresh water from the desert aquifers. Access to water was regarded as a human right in Libya and therefore free.[69] This perception seems to be more embedded in the southern region of Libya as Gaddafi encouraged the people to move to the desert after the discovery of groundwater resources with the promise of providing freshwater to everyone and to develop agricultural projects in the south, creating livelihood opportunities and ensuring food security.

As explained in the Area-Based Assessment conducted by REACH in 2021[70] in Sebha, there are two types of water networks in this city: formal and informal. The formal network is the public network, consisting of 270 km of pipes prevalent in areas near the city center. According to the same report, residents in some areas outside the reach of the public network have worked to solve water access issues by constructing their own private wells and piped networks. On top of that, some informal connections reportedly stem from the formal network, extending access to nearby areas. Like informal connections to the electricity network, these informal wells, networks, and connections speak to the resilience of Sebha residents in developing alternatives to formal service provision. However, the presence of informal networks complicates development and maintenance of the formal network causing leaks and damage to the pipelines (see section on "water infrastructure: effects of the conflicts and maintenance issues".

In Sirt, there are both formal and informal connections to the public network but some KIs specified that informal connections are more frequent in the peri-urban areas.

[69] Opednews, The GMMR project, 2011
[70] REACH Initiative, Sebha Area-Based Assessment (ABA), 2021

Overall, informal connections to the public network are a widespread practice to access water resources and are encouraged by the perception of water as a free resource in Libya as explained by a community leader in Sebha:

> *"Water is free in Libya, and citizens have the right to deliver water to their homes from the nearest public water pipeline network"*
>
> Community leader (Sebha)

Informal connections to the public network are connections done without notifying and receiving a legal permission from the GCWW as explained one of the KIs.

> *"The water company is constantly urging citizens to comply with the obligation to notify them (GCWW) before any connecting operation to avoid accidents".*
>
> GCWW representative KI

This data shows that informal connections done without the supervision of the GCWW are therefore very common and affect the water supply as well. **Informal connections are considered as a major issue affecting the water supply** from the public network as it causes damage to pipelines, provokes leaks, and puts existing water infrastructure at risk.

The quantitative data collected in the three assessed locations shows that **98% do not have a water meter installed in their house**. Among households who have a permanent subscription to the public network, 37% of households are willing to have a water meter in their house. In line with this, one KI mentioned that before 2010, the GCWW planned to install water meters in each official connection to the public network (as it is the case for electricity consumption) but the project was not fully implemented. No further explanation was provided by the KI who reported the interruption of this project.

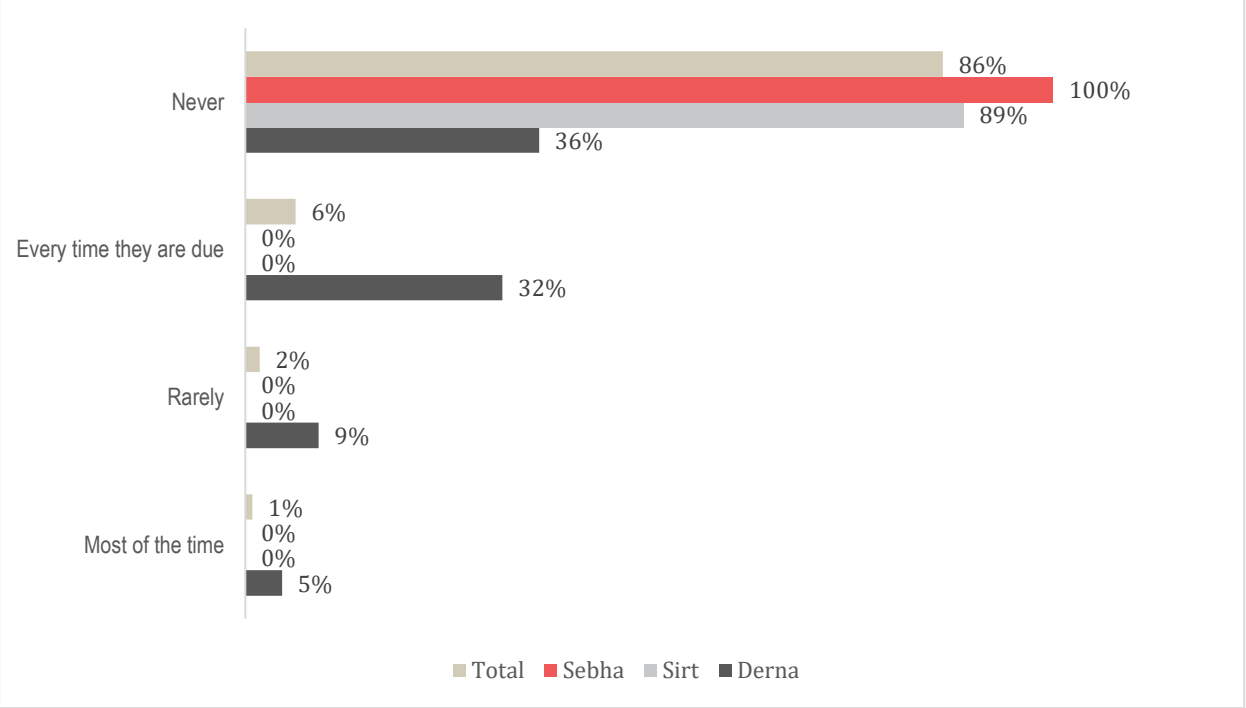
According to a majority of KIs, **no substantial measures were taken to prevent informal connections**. These types of connections are difficult to track as they are abundant because of the "citizens' lack of awareness of the danger of these connections".[71] Generally there are no measures to prevent informal connections and the perception of water as a given source seems more rooted. The main existing measures reported by KIs consist in monitoring informal connections through security institutions (municipal guard, police, etc.). Fines and awareness raising campaigns through radio programs also exist to preserve the public water network but KIs explained these are limited, especially given the uncontrollable spread of informal connections. These awareness raising and coercive initiatives were particularly mentioned by KIs in Sirt.

Regularity and amount of public water fees: a free source of water despite some initiatives to regulate its supply

When asked about the **regularity of payments from households** using the public network as one of their main water sources, 86% of respondents indicated that they never pay water fees. In Derna, the situation is different as 32% of households pay water fees every time they are due.

[71] This was reported by a KI working with a local CSO in Derna on April 2022.

Figure 32: Regularity of payment of water fees reported by interviewed households in Derna, Sirt, and Sebha



The main reason households reported for rarely or not paying water fees is that they were never asked to do so (69%) or that the government has a responsibility to provide free water (26%).

As explained by KIs, **most households do not pay water fees**. In Derna, one KI specified that subscriptions to the public network are old, and the amount paid thought deductions from the residents' salaries does not match the current water consumption of households.

> *"The fixed value that is deducted does not match the current consumption of these families, in addition to the change in the value of the local currency. Imagine that the current deductions for most of the residents are only 10 dinars per month per house, which is an old valuation as a water bill and is a symbolic price".*
>
> GCWW representative in Derna

According to the interviewed households which have a permanent subscription to the public network, which are all located in Derna, 50% think that the price is lower than the service provided from the public network and 88% are reported being willing to pay more for the subscription if the service was improved. However, all KIs mentioned that some neighbourhoods are not asked to pay water charges because of the frequent water cuts and the resulting near unavailability of water resources. One KI particularly said that households in Essahel Echarqi and in Sayyida Khadiya do not pay water fees because of the irregular water supply. In Sebha, most KIs confirmed that households do not pay any water fees. Only one KI said that a "small percentage" of households pay water fees, which are deducted from their bank accounts, to the GCWW. In Sirt, according to most KIs, there are currently no water charges and one KI said payments are not done in a regular way. Some KIs working in public institutions responsible for the management and monitoring of water supply pointed out that fees used to be paid on a regular basis, particularly before 2011.

> *"Currently there are no fees, but before 2011 the fee was 11 dinars per month".*
>
> GCWW representative in Sirt

The most reported reason driving the lack of payment for water fees by households in Derna is the irregular public water supply as well as the frequent and long water cuts. One KI mentioned that some families decided to cancel their subscription to the public water network and the GCWW also stopped charging the population because of the irregular supply, mainly caused by infrastructure maintenance issues. In Sebha and Sirt, most KIs affirmed that households do not pay for water fees because it is not required as there are no regulations stipulating paying these fees.

Water infrastructure: effects of the conflicts and maintenance issues

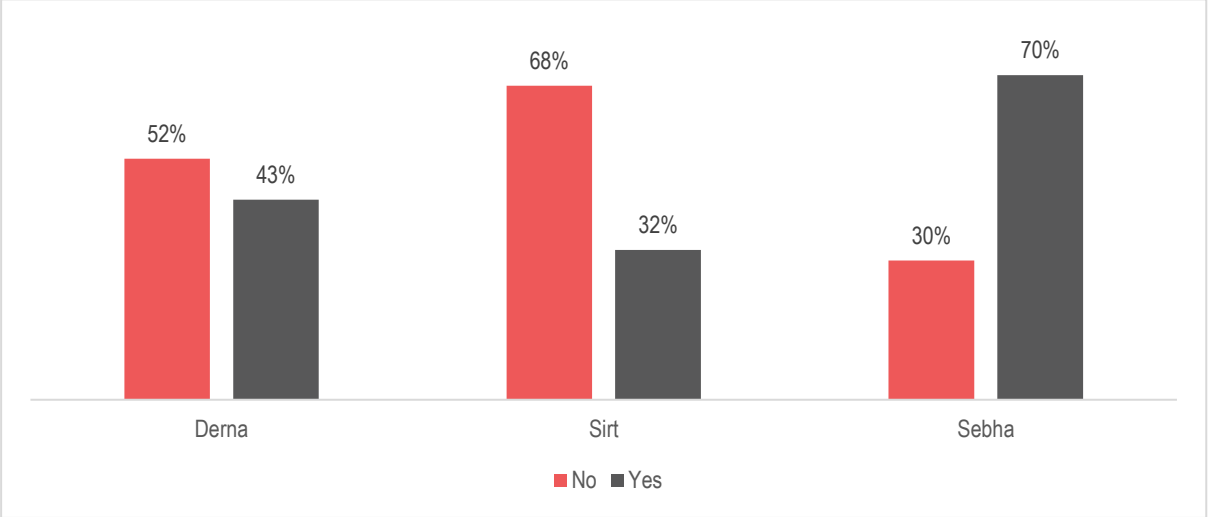
The threat of a lack of WASH infrastructure maintenance on the water supply:

As previously mentioned, the irregular supply of water through the public network is one of the most important issues identified by interviewed KIs hindering households' access to sufficient water. In fact, when asked to **rate the regularity of the water supply from the public water supply system**, 52% of surveyed households reported that it is poor or very poor.

When asked about **the major issues causing the poor regularity of water supply from the public network**, the KIs interviewed in Derna mentioned the lack of timely and effective maintenance of water infrastructure which notably leads to frequent leaks, informal connections causing damages to pipelines, and overflow of wastewater affecting the quality of the water supplied to households. In Sebha, the most reported issues are power cuts, the lack of effective maintenance, overflow of wastewater, and leaks. Finally, in Sirt, the major issue reported is a lack of maintenance of damaged infrastructure.

Overall, quantitative data shows that 54% of households in Derna, Sirt and Sebha have ever **encountered problems such as water cuts, leaks, decreases in the quality of water, unpleasant smell, or unusual color** with their main source of water. Amongst these, the **most frequently reported complaint raised by households** in Sebha (56%) and Sirt (34%) are that the water supply network is often broken or leaking. In fact, 47% of the surveyed households in Derna, Sirt, and Sebha reported that they noticed leaks in the public water supply system. As shown in figure 33 below, this type of issue is considerably more common in Sebha where 70% of households noticed leaks. In Derna, the most frequently reported complaint raised by households is about the inadequate quantity of water supplied to meet basic household's needs (32%).

Figure 33: Percentage of surveyed households that noticed leaks from the public network by city



Maintenance work affecting water supply and household water access:

Although some maintenance works have been implemented to ensure a better water supply, they have at times been reported to be delayed and thus have sometimes increased the frequency or duration of water outages, thus negatively affecting household capacity to fetch sufficient water. For example, KIs in Derna argued that neighbourhoods, such as Al Sahel Al Sharqi or Al Sayyida Khadija, which rely on desalinated water are the most affected by water outages because maintenance works on the desalination plant have been ongoing for several months. According to some KIs, the maintenance works started seven months prior to data collection (May 2022) and one KI reported that the works are now at an advanced stage. The suspension of its operation reportedly caused severe water shortages and led to the use of costly alternative sources. In a press release published in 2021, UNICEF highlighted the impact of the lack of timely and effective maintenance of the desalination plant on households and their ability to access water:

> *"Desalination Plants suffer from lack of equipment needed to carry out maintenance and chemicals to sustain operations, thus decreasing their operational efficiency. For instance, the Bomba Bay plant has been rendered completely out of service, depriving over 63,000 people living in the five cities - Al-Tamimi, Bambah, Ras al-Tin, Umm al-Razm, Murtaba, and the eastern coast (Al Sahil Echarqi) of Derna - from access to safe water. The estimated cost for the rehabilitation of the plant is $ 12 million. This is taking place against the backdrop of the prevailing liquidity crisis that has put additional pressure on the financial ability of families to afford purchasing water by trucks, and, hence increasing their economic burden. Furthermore, the remaining 7 plants that provide water to cities of Abu Trabah, Sousa, Derna, Tubrok, Zletin, Alzawya, and Zwara are operating at 28 per cent of their design efficiency. They too will break down if no immediate intervention is undertaken".*
>
> UNICEF, 2021[72]

Originally, the desalination plant in Derna was completed in August 2010 but according to some KIs, the operation of this plant is currently and has been suspended for a long time. This data can be triangulated with information from the Derna Rapid Situation Overview published by REACH in 2018,[73] which specified that the desalination plant located near the Karsah gate, suspended its operations in May 2018 due to nearby clashes and insecurity affecting its staff. As a result, the main water network largely stopped functioning throughout the city and the supply remains problematic currently, as is highlighted in this assessment.

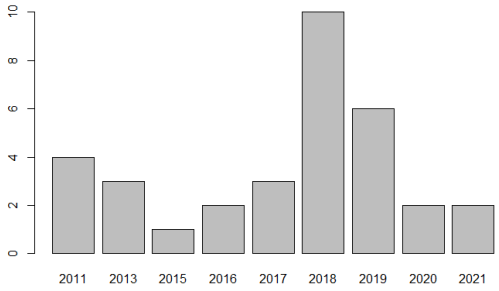
The lack of/or ineffective maintenance of outdated and/or damaged infrastructure is therefore a recurrent problem. Besides informal connections to the public network which were created without the supervision and guidance of the GCWW and which can cause leaks or damage to pipelines, security incidents targeting the water infrastructure further affect the functionality of water infrastructure.

[72] UNICEF, Over 4 million people, including 1.5 million children are about to face imminent water shortage in Libya, 2021
[73] REACH, Derna Rapid Situation Overview Libya, 2018

Security incidents targeting water infrastructures and its equipment:

Since the start of the Libyan conflict, water has been used as a means of exerting pressure between fighting parties.[74] Events such as the sabotaging of water stations, cutting the flow of the MMR to put pressure on services, took place.[75] In addition, water infrastructure was damaged by armed attacks during conflict while the MMR was deliberately targeted and never repaired.[76] The effects of armed conflict on access to basic services created animosity among the population and several protests were held to denounce difficulties accessing water. As highlighted in an article published in the Arab Reform Initiative "long-held grievances over water access have risen to the surface in the form of popular protests – such as in the eastern city of Tobruk, close to the Libyan-Egyptian border, whose residents took to the streets in 2017 to protest long-standing water shortages".[77]

Figure 34: Number of security incidents targeting water infrastructure by year



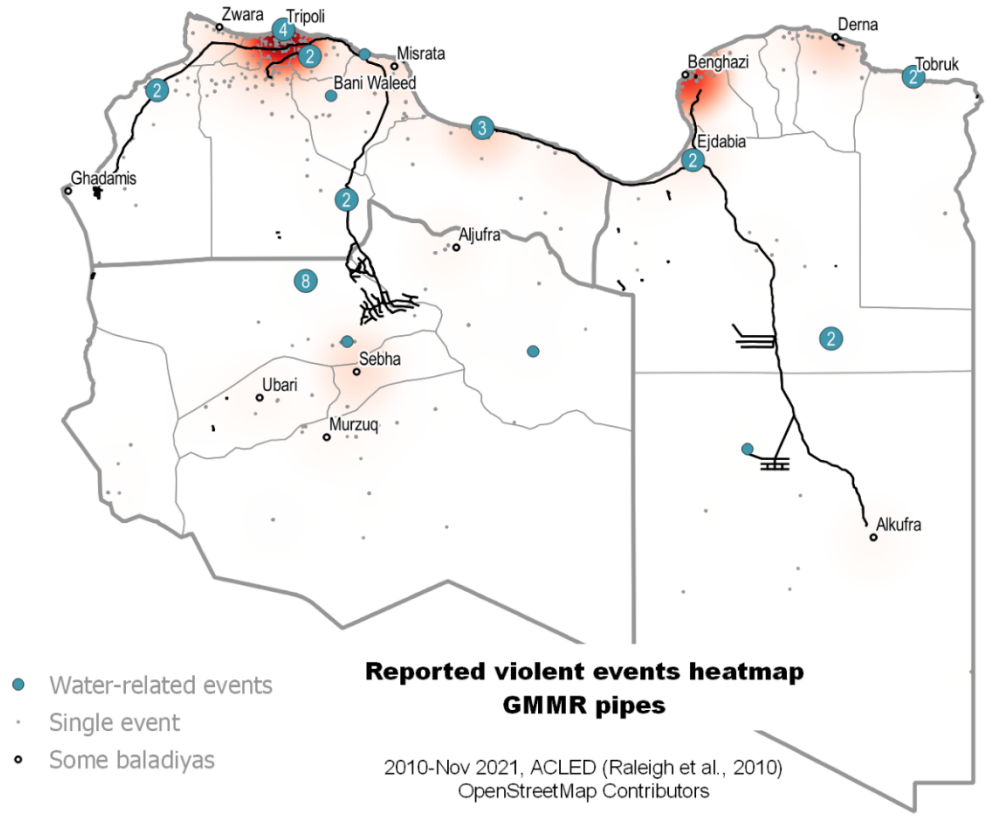
Derived from Raleigh et al., 2010

Using ACLED data from the past 10 years, thirty-three security incidents affecting WASH infrastructure were identified for the period between 2011-2021. An annual aggregation can be seen in Figure 34 where 2018 clearly stands out as the year with the most security-related events. This trend was in fact denounced by the UN Humanitarian Coordinator in 2019, reminding all parties to abide by international law in what relates to civil infrastructure, especially such an essential one.

Regarding the spatial variability, Figure 35 highlights all events which have been classified as violent as well as the associated water-related events. The former are mostly found in the main cities simply because of population and political power concentration in urban areas. In the case of security incidents affecting WASH infrastructure, though they are also found in cities such as Tripoli, where more key infrastructure can be found, they may be linked to the MMR pipeline and pumping stations.

[74] Journal of Peace Research, Introducing ACLED: An Armed Conflict Location and Event Dataset: Special Data Feature, 2010
[75] ACLED, official website
[76] FAO, Aquastat Report – Libya country profile, 2016
[77] Arab Reform Initiative, Water Politics in Libya: A Crisis of Management, not Scarcity, 2021

Figure 35: Occurrence of security incidents on water infrastructures



OCHA described the overall dysfunctional state of the water infrastructure as follows: "96 out of 366 wells feeding the Man-Made River were out of service in 2019 with such attacks against civilian infrastructure being considered a war crime".[78] Updated information says that sabotage has destroyed about 36% of the water-wells, which in turn has caused "water shortages in the north and the emergence of a freshwater market".[79]

According to the quantitative data collected in the assessed Baladiyas, security incidents causing water cuts were more frequent in Sebha, compared to Derna and Sirt in the six months prior to data collection. In Sebha, 32% of surveyed households are aware of water outages caused by security incidents that occurred six months prior to data collection as compared to 4% and 12% in Derna and Sirt respectively. This trend is further highlighted by KIs interviewed in Sebha who reported being aware of security incidents targeting water infrastructure. According to them, the purpose of these attacks is generally to steal equipment such as pumps, electrical cables, cars, etc... It was also mentioned that the GCWW local offices have been attacked more than once. One KI explained:

> *"All the equipment of the central sewage treatment plant in the city was also stolen, which caused flooding of the sewage inside the city"*.
>
> GCWW representative in Sebha (KI)

Within Sebha, it was highlighted that the attacks were more likely to occur in Al Mahdia and incidents also targeted the sewage plant near Al-Jazeera Sports Club. According to most KIs in Sebha, these security incidents sometimes occur four to five times a year.

[78] OCHA, UN Humanitarian Coordinator for Libya strongly condemns the blockage of the Great Man-Made River, cutting off water supply for hundreds of thousands of Libyans, 20 May 2019
[79] Brubacher, Climate fragility risk brief, Libya, 2021

Similarly, some KIs in Derna, also reported being aware of security incidents that had occurred during the year prior to data collection and had affected the water supply system . Similar to some reported incidents in Sebha, these security incidents consisted in the theft of equipment from water infrastructure. In addition to damage to infrastructure, KIs reported that 18 cars were stolen, including maintenance trucks. However, KIs also specified that security incidents generally occur very rarely (one incident a year) in Derna.

In Sirt, some KIs reported that armed conflicts had had long-lasting consequences for water infrastructure and supply. The area of Abu Hadi is reported most affected by security incidents. Attacks on the MMR pipelines are reportedly the most frequent. Some attacks had caused the suspension of water supply from Ajdabiya water reservoir. Nevertheless, KIs did also note that incidents such as these generally occur rarely (2 to 3 incidents a year) in Sirt.

Public water services:

Maintenance services:

According to 71% of surveyed households and all KIs interviewed for this assessment, the GCWW is the main institution **responsible for the maintenance** of water infrastructure and repairs. In addition, interviewed KIs stated that the municipality and community members/leaders are also involved in maintenance works through different types of interventions.

In Derna, Respondents roughly agreed that entities responsible for and working on water infrastructure maintenance in the three assessed cities are the GCWW and the municipality, and for minor issues, privately contracted plumbers. According to one KI, community members can also fix problems themselves or may recruit a plumber if the maintenance is minor. In Sebha, the KIs reported that the department responsible for maintenance works within the GCWW is "the Department of Operation and Maintenance of the Southern Region and the Sebha Services Office".[80] Some KIs mentioned that, similar to Derna, the municipality is also involved in maintenance works and sometimes contracts private companies to carry out these types of projects. In Sirt, 48% of interviewed households mentioned that the GCWW is mainly responsible for maintaining water infrastructure. In addition, respondents also mentioned the municipality (29%) and the MMRA (21%). However, besides the solicitation of plumber to undertake minor maintenance work as explained by the some of the KIs across the three assessed municipalities, private sector participation in the management of water supply and sanitation projects is limited overall.[81]

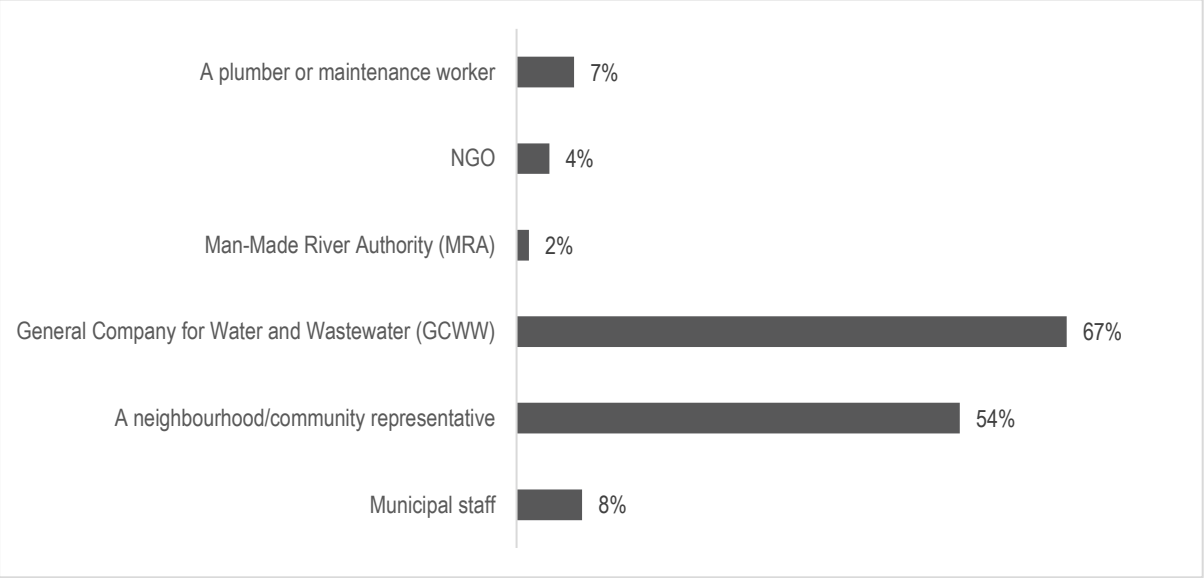
When surveyed households encountered issues, 56% declared that they **report water supply related issues to the GCWW**. Households usually **report issues in-person** by going to the GCWW offices as outlined by most of the KIs. When asked about the overall satisfaction of households towards public institutions responsiveness to maintenance issues, most KIs said that households are showing understanding towards public institutions (GCWW, GDC municipalities) given their limited resources to ensure a timely and quality maintenance of infrastructures. The community is also sometimes giving support to public institutions to ensure a regular maintenance and services provision as mentioned by some KIs.
A further 31% of surveyed households approached a community/neighbourhood representative and 22% contacted the municipality. In addition, the data shows that community dynamics play a key role in addressing the issues that commonly affect the quality of life in the neighbourhood. For example, KIs in Sebha reported that community leaders are often the first contact point to report issues to. With this in

[80] This was specified by a representative of the GCWW local office in Sebha in May 2022.
[81] Fanack Water, Water Resources in Libya, 2020

mind, some KIs highlighted the important role played by community leaders such as the local council members or the council of elders as an intermediate to communicate the reported issues to the competent authorities (mainly the GCWW).

However, 42% of households reported that no action was taken based on the complaint, indicating a low response rate to registered complaints. The main actors that were reported to attend to household complaints were the GCWW (67%) and community/neighbourhood representatives (54%).

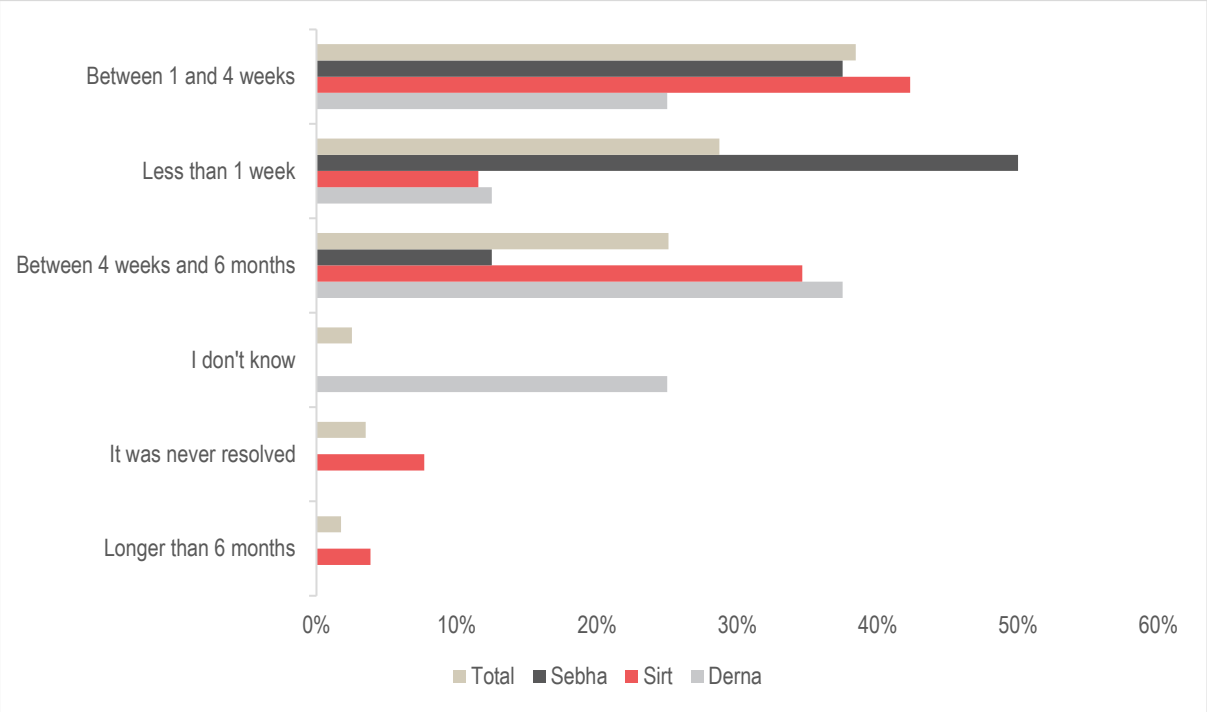
Figure 36: Main actors who attended to household complaints according to surveyed households in Derna, Sirt, and Sebha



Disaggregating by city, the vast majority of households in Derna (75%) and Sirt (85%) reported that the GCWW attended to their complaints. In Derna, **most complaints reportedly take between four weeks and six months (38%)** to be addressed. According to the surveyed households in Derna, the GCWW's receptiveness to complaints is generally good (37%) or adequate (26%). In Sirt, most households reported that their issue was addressed in less than four weeks (42%) or between four weeks and six months (35%). The GCWW's receptiveness to complaints was generally rated as good (49%) or excellent (27%).

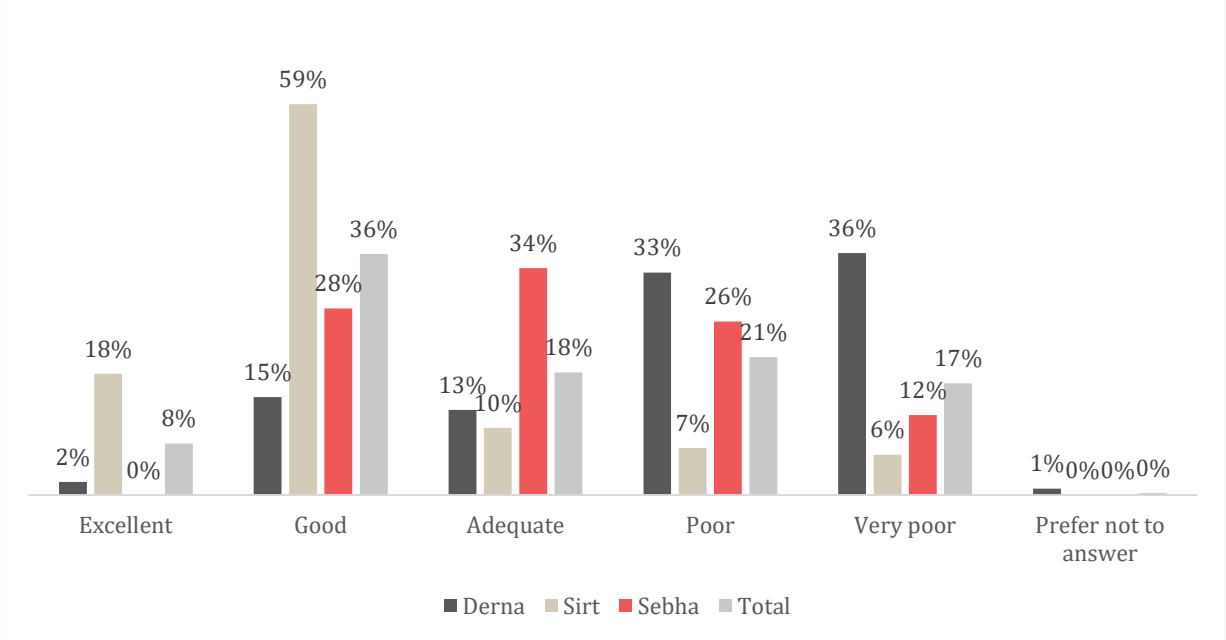
In contrast to the other two assessed areas, community dynamics in Sebha are comparatively more important to ensure the continuity of services since 84% of households reported that their issue was addressed by a neighbourhood or a community representative and the complaints were mostly addressed in less than one week (50%) or less than four weeks (38%).
This is in line with the 62% of households in Sebha who rated the GCWW's receptiveness to complaints as poor and the 18% of households who rated it as very poor. Similarly, 79% of households in this city think that public institutions do not attend to water cuts or leaks in the public water supply system in a timely and effective way. Finally, half of the interviewed households in Sebha think that public institutions do not maintain and upgrade the public water supply system on a regular basis further highlighting the relative importance of community structures in the maintenance of water infrastructure in this area.

Figure 37: Main reported duration for a maintenance issue was addressed by the municipality according to the interviewed households in Derna, Sirt, and Sebha.



According to the surveyed households, the level of service provided to maintain and ensure an adequate water supply is moderated as 36% of respondents in all three localities reported it is good, while 21% stated that it is poor. In Derna, according to 69% of interviewed households, public services provided to maintain infrastructure and ensure a regular water supply are mostly poor or very poor. This may be a reflection of the difficulties with and the lack of resources to complete maintenance works on damaged key infrastructure such as the desalination plant that have reportedly caused long-lasting water outages from the public network.

Figure 38: Reported level of service from the public water supply system



The main reported reasons why public institutions are not able to provide adequate water supply service are that the water network is in disrepair (76%) and the infrastructure is outdated (63%). A lack of financial resources (59%) and a lack of concern to upgrade the services (43%) were also mentioned by the surveyed households. Only 19% of surveyed households reported that **public institutions attend to water cuts or leaks in the public water supply system in a timely and effective way further highlighting the inadequate response rate to complaints**.

Infrastructure development and upgrading measures:

Although some initiatives have been taken to upgrade and maintain water infrastructure, financial resources, necessary equipment, and durable political resolutions are missing to implement measures to improve the quality and regularity of water supply. As mentioned by the national KIs[82], there are development plans that are still waiting for approval and resource allocations.
One KI specified that:

> *"The GCWW is in the process of communicating with the Housing and Utilities Project Implementation Authority to complete the previous contracts with the companies that were contracted".*
>
> National KI: researcher and technical advisor to the GCWW

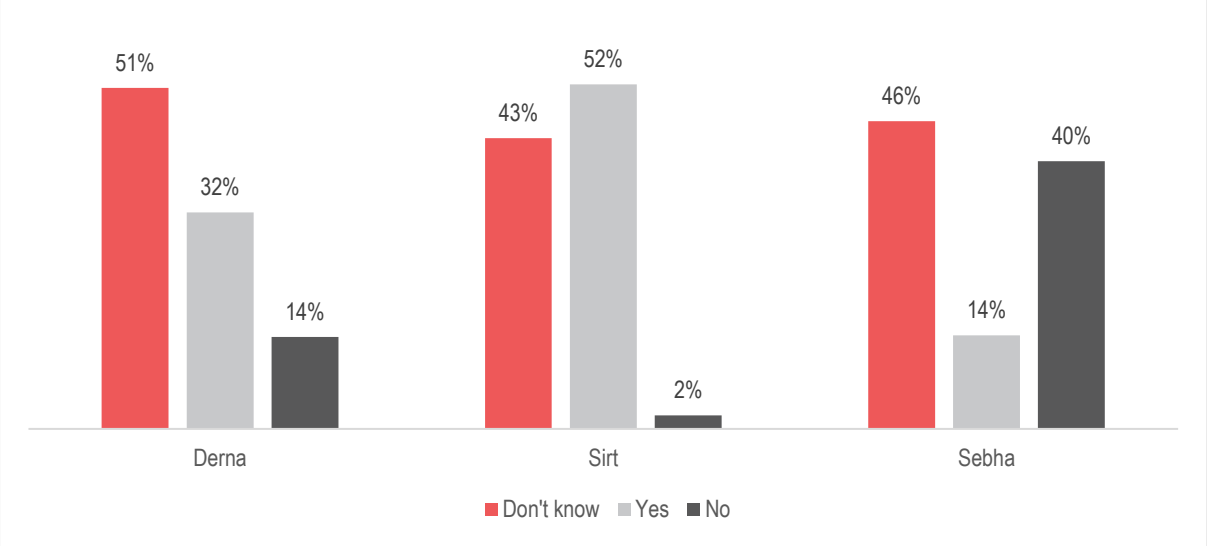
Measures on the municipal level:
In Derna, maintenance of key water infrastructure is crucial and urgent to be able to ensure a regular water supply to the city. one KI mentioned that there are four main groundwater fields supplying the public network that need to be developed and/or maintained. He specifically referred to four groundwater wells in the main station of Al Fatayeh, the Al Wadi station, the Al Fatayeh el Alf station, and the Al Shiha Al Gharbya station.
All KIs interviewed in **Derna** also mentioned that there are currently development plans to improve water infrastructure in the city. The main initiative consists in maintaining the desalination plant in Derna. The maintenance of this plant will contribute to provide water to the Essahel echarqi, Al Shiha, Bab Tubruq, Al-Mubkhabba, and Al Bilad areas. However, it seems that maintenance works are taking more time than expected because some problems have been encountered hindering the works.
Similarly, in **Sebha**, some KIs mentioned that there have been development plans. According to one KI, there were plans to expand, maintain, and extend a network of new pipes in few neighbourhoods such as Abdul-Kafi and Nasiriyah.
Finally, in **Sirt**, improvement plans are reportedly implemented jointly by the GCWW and the Municipality of Sirt. One KI specified that the GCWW recently improved the treatment process of wastewater before it is discharged into the sea.

Household perception on public services and suggestions for improvements

Most interviewed households showed understanding towards the difficulties and lack of resources of public institutions to upgrade WASH infrastructure and services. Even though, 46% remain uncertain regarding public institutions' willingness to try to improve the water supply services, 34% of households across the three Baladiyas stated that they trust the institutions (mainly the GCWW and the municipality) responsible for local water supply management. In Sebha, surveyed households are the least confident that public institutions will try to improve the water supply services as 40% respondents reported that they do not trust these institutions.

[82] Among the two KIs reporting on the water situation at a national level, a representative of the Sebha local office of the GCWW and a researcher – consultant working with the GCWW were interviewed.

Figure 39: Proportion of surveyed households reporting they trust in public institutions to try to improve the water supply services



The main suggestion to public stakeholders given by surveyed households to improve the water supply service is to improve the existing infrastructure of the water supply system, especially in Derna where 85% of respondents made this suggestion.
In Sebha, the reported priority amongst interviewed households is to construct new infrastructure for the water supply system (75%), and in Sirt households suggested to improve the regularity of the water supply (78%) and to increase the number of hours per day that water is supplied (30%). Further, the role of citizens is reportedly key in the efforts to improve public services. The surveyed households suggested that they themselves can help local stakeholders by conserving more water (86%) and by reporting leaks when discovered (59%).

Six-month forecast of the water situation and overview of the factors affecting the water supply in the assessed locations:

As mentioned in the section on barriers to accessing sufficient and good-quality water, one of the main factors that could affect the water supply in Libya is the availability of electricity. Other factors highlighted by half of the KIs[83] are linked to the need of structural changes such as the stabilization of the political and security situation in the country, the importance of sensitizing citizens on responsible water consumption, and the need to develop strategic plans to manage existing resources in order to implement concrete improvements.
One additional important factor is linked to the environmental context in Libya. In this sense, KIs highlighted the tangible effects of global warming that have contributed to an increase in the demand for water supplied through the MMR pipelines and which in turn will gradually reduce the level of groundwater on a long-term basis.

KIs local to the three assessed areas also touched on these overarching issues but elaborated further to give context-specific perspectives. For example, **in Derna**, the most important factor identified by KIs affecting the water supply are the increasing prices of water delivered by trucks (or cars) due to frequent cuts from the public network. Household-level water trucking expenses can reportedly be an important economic burden and can reach up to 300 LYD per month. Another concern shared by these KIs is groundwater resource depletion and quality degradation that may be caused by climate factors as well

[83] Those KIs are representatives of public institutions responsible for the development and management of water resources (GCWW, GDC) and community leaders.

as by human factors. Some KIs also warned about the functionality and lack of maintenance of infrastructure that "could collapse if not renovated" also because it is already fragile due to the consequences of 10 years of conflict and the lack of citizens' awareness connecting to the public network in an informal way causing leakages and damaging to the pipelines. The fragile infrastructure affects the water supply but also contributes to the degradation of the quality of water and intrusion of sewage water into groundwater.

In Sebha, the main reported factors affecting water supply and quality are the sporadic power supply which directly affects the water supply and the lack of maintenance and upgrading of infrastructure. Security incidents have also been mentioned by some KIs as an important element threatening the functionality and sustainability of infrastructure. To overcome the water supply and quality issues in Sbha, some respondents stressed the need to develop alternative sources of energy, such as wind and solar energies and to develop research in this field to be able to implement sustainable policies. Some initiatives have been implemented with this in mind but remain limited. A pilot solar-powered water pumping station has for example been implemented at the Znata Pumping Station in Tripoli by UNICEF in collaboration with the Ministry of Water Resources and Germany's Federal Ministry for Economic Cooperation and Development (BMZ).[84] Awareness raising activities presenting the benefits of the use of renewable energies and developing the capacity and know-how of employees of institutions and companies in the energy sector could help trigger this energy transition. The need to evaluate and develop new regulations, laws, and policies is essential to promote the renewable energy sector.[85]

In Sirt, the factors are mainly related to the security context and the maintenance of public infrastructure. One KI mentioned that important climatic factors, specifically rising temperatures and reduced rainfall, can also affect the availability of water. The increase of water prices, referring to water trucking, was also mentioned.

Overall, the future social, economic, and humanitarian situation **in Libya** will depend on the evolution of the political context that is still uncertain even though armed conflicts have considerably decreased since the 2020 ceasefire agreement between the two authorities. The potential outbreak of new political confrontations could increase the fragility of public structures and their capacity to deliver basic services considering they have already been negatively impacted by 10 years of conflict as has evidenced in this assessment (maintenance issues, damaged infrastructures causing leaks or sewage overflow, etc.). A lack of political stability could thus constitute a major obstacle to upgrading the country's core infrastructure. Water infrastructure that already face maintenance issues and have been targeted several times by armed groups could be at risk of collapsing. It remains difficult to make reliable forecasts on climate events, but Libya is also exposed to the effects of climate change that could have a direct impact on access to water services.[86] This may be particularly relevant due to a lack of preparedness to natural disasters due to the political and institutional instability, thus further endangering the Libyan population. The major natural hazards that Libya is exposed to are floods, drought and desertification, sandstorms, and dust storms.[87] The risk of coastal flood hazards is particularly high.

To summarize, there are both climate and human / political factors affecting the water supply in Libya. On one hand, low precipitation trends and increasing temperature are a treat to water availability and to the sustainability of surface water and renewable aquifers. On the other hand, the increasing water demand causing the depletion of fossil aquifers coupled with a lack of functioning and effective maintenance of water infrastructure within a post-conflict context will remain the main obstacles to ensure the supply of sufficient and quality water to households in Libya.

[84] Libya Herald, Solar water pumping station installed by UNICEF in Tripoli, 2021
[85] Omar Ahmed Mohamed and Syed Hasan Masood, A brief overview of solar and wind energy in Libya: Current trends and the future development, 2018
[86] REACH, Research Terms of Reference: WFP Climate and Livelihoods Assessment, 2021
[87] World Bank, Climate Change Knowledge Portal, Libya

CONCLUSION

This assessment focused on the accessibility to sufficient and quality water in water-stressed areas in Libya and aimed to provide an overview of the water situation in Libya by exploring water availability issues at a national scale, the impact of climate change, and the human factors causing water scarcity. It also explored household ability to access sufficient and quality water resources in the municipalities of Derna, Sebha, and Sirt and the factors causing insufficient water supply.

Data included in this assessment showed that there are both natural and human factors affecting the availability and frequency of water supply. Reliance on and over-exploitation of groundwater resources to meet irrigation and municipal water demands were also highlighted as important issues which have reportedly led to the need for developing alternative water sources and technologies such as desalination or wastewater treatment. On the other hand, long-term effects of damages on water infrastructure in Libya are also "putting a heavy burden on those economies, severely hampering the possibilities for reconstruction"[88] as highlighted by the World Bank. As shown in this assessment, water has been used as a weapon of conflict fueling the political division and fragmentation between the Eastern and Western factions. The drinkable water supply in Libya has decreased from approximately 149 to 101 water distribution canals because of their destruction during conflict.[89]
Political instability had considerable effects on the supply of basic services and has reportedly hindered the development of sustainable public water policies and the effective management of the water supply system.
In fact, this report includes evidence showing that the neglect of water infrastructure remains a key challenge in Libya and its negligence could further negatively impact quality of life for Libyan citizens. Further, this assessment showed that these factors directly and negatively impacted household water consumption in Derna, Sirt, and Sebha and has caused these populations to resort to alternative and more expensive water sources and to adopt water treatment and conservation strategies as coping strategies to meet their water needs. These alternative water sources, namely bottled water, water trucking or private (and sometimes shared) wells and boreholes, used for drinking, livelihood activities and other domestic purposes, were reportedly used to cope with regular water outages from the public network. Finally, findings showed that informal connections to the public water system are common. This, coupled with limited resources of public institutions, often led households to undertake alternative measures that speak to the lack of resilience of the residents. Climate factors have also had an impact on the availability of groundwater. Rising temperatures and a reduction in rainfall levels constitute a driver of the depletion of groundwater resources, particularly renewable aquifers (found in shallow aquifers in the Northern underground basins) that are replenished annually through rain.[90]

It is essential to further explore the management of the water supply system to ensure household access to water, maintenance of infrastructure, as well as the development of sustainable policies governing an efficient management of the water supply in Libya. More specifically, it is imperative to further explore the benefits of alternative water sources and technologies such as desalination or wastewater treatment to help trigger reflection on potential solutions to groundwater over-exploitation. The use of renewable energies could address the problem of water outages caused by power cuts. Water infrastructures such as desalination plants or water pumps could for example run on solar or wind energy to ensure a more sustainable water supply as well as the protection of the environment.[91]

As explained throughout this report, the main structural issues related to the water supply in Libya is the reliance of groundwater resources which is already threatened by depletion, and the difficulties to

[88] World Bank, Water in the shadow of conflict in the Middle East and North Africa, 2021
[89] World Bank, Water in the shadow of conflict in the Middle East and North Africa, 2021
[90] B. Brika, Water Resources and Desalination in Libya, 2018
[91] The Tahrir Institute for Middle East Policy, From the River to the Sea: Water Management in Libya, 2022

ensure a regular and efficient maintenance of key water infrastructure. This assessment shows that fossil aquifers found in the southern regions of the country are non-renewable groundwater resources and that increased water demand is threatening their sustainability as primary sources of water in Libya. Renewable, i.e., shallow, aquifers found in coastal areas are also over-exploited and their recharge level does not correspond to the increased water demand for irrigation and domestic uses. This issue is further complicated by low precipitation and increased temperatures which also negatively impact the availability of water in shallow aquifers.

In addition, maintenance of key infrastructure within a post-conflict context is reportedly hindered by a lack of resources and the absence of strong public reforms to ensure the sustainability of key institutions involved in the development, management, and monitoring of water resources. These issues have a direct and tangible impact on the water supply from the public network and consequently on household ability to have access to sufficient and quality water. These challenges also urge key public institutions to explore alternatives to groundwater, such as desalination. In addition, this assessment has shown that further exploring the use of renewable energy could be a solution to power shortages in Libya which are highly impacting the water supply. This point has previously been stressed in other publications such as "Policy Corner" magazine which stated that, "continuing to rely on oil is not an option as resources are further depleted and emissions increase".[92] This direction would also contribute to achieving the Libyan Government's Renewable Energy Strategic 2013-2025 Plan consisting of achieving 7% renewable energy contribution to the electric energy mix by 2020 and 10% by 2025.[93]

[92] Policy Corner, Libya – A Potential Powerhouse for Clean Energy, 2021
[93] IAE, Key energy statistics, 2019