Northeast Syria's Water Infrastructure in Conflict: Assessing Damage and Understanding Implications

By

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ABSTRACT

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In the backdrop of the Syrian conflict, Northeast Syria, encompassing the governorates of Al-Hasakeh, Ar-Raqqa, Deir-ez-Zor, and parts of Aleppo, has witnessed profound ramifications on its water infrastructure. The war has not only physically damaged water systems but has also disrupted the socio-cultural fabric of the region. The direct targeting of vital water systems, such as dams and water stations, coupled with collateral damages, has led to a significant alteration in human settlements, forcing communities to adapt to new patterns of water demand and access. This disruption has heightened health risks and intensified pre-existing water scarcity, emphasizing the need for sustainable management strategies. The intricate relationship between infrastructure degradation and the conflict has profound implications on the quality of water, access to water, public health, socio-economic impacts, and the livelihoods of the populations. Addressing this crisis requires a multifaceted approach, focusing not just on infrastructure rehabilitation but also on restoring communities, rebuilding trust, and charting a sustainable path forward.

Keywords: Water Security, Conflict Zones, Water Infrastructure, Northeast Syria, Infrastructure Damage.

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1. Introduction

1.1. Introduction to Syria's Situation and the Importance of Water Security:

Syria, a nation once known for its abundant water resources, has been embroiled in a decade-long civil war that has left the country's infrastructure in ruins and its population struggling to access safe drinking water (Abbara et al. 2021). The Syrian water crisis is a multifaceted issue that has been exacerbated by various factors, including climate change, political disputes, and violent conflict (Sottimano and Samman 2022). This crisis has had a devastating impact on the country's economy, food security, and public health, necessitating immediate attention and intervention.

Prior to the conflict, Syria was already grappling with significant environmental challenges, including periods of severe drought linked to climate change (Skaf and Mathbout 2010). Climate change has led to unpredictable weather patterns, resulting in less rainfall and contributing to the depletion of vital water sources such as the Euphrates River (Gleick 2014; Adamo et al. 2020). The reduction in the Euphrates River's water level, a consequence of both climate change and Turkey's control over its flow, has drastically affected Syria's agricultural sector and threatened the country's food security (Giovanis and Ozdamar 2021; Sottimano and Samman 2022).

Water access, a basic human right, has been used as a weapon during the Syrian conflict, with control over water infrastructure a focal point of violent disputes (UN-OCHA 2018). Poor water management, inadequate investment in rural areas by the Syrian regime, and the direct targeting of water sources during the conflict have caused extensive damage to Syria's water infrastructure and led to a dramatic decrease in the availability of safe drinking water (Abbara et al. 2021; Sottimano and Samman 2022; Lund 2023).

Fig. 1 Map of Syria
Source: Fanfakwater.

Over the first decade of the war, access to safe drinking water fell from 98% and 92%, in urban and rural areas, respectively, to around 40% [It is worth mentioning that these figures may differ across the Syrian governorates] (Lund 2023). And 50% of the water and sanitation infrastructures across the country are not operating properly (Lund 2023).

The resulting scarcity of safe water has had a profound impact on Syrians' livelihoods and welfare. With only 50% of water and sanitation systems functioning properly across Syria (ICRC 2021), the population has become more dependent on public water sources, which are often contaminated

or over-pumped, leading to a surge in waterborne diseases (Abbara et al. 2021). These deteriorating circumstances have pushed many Syrians to leave their homeland, while others have become wholly reliant on international aid (Wendle 2016).

Water security covers multiple dimensions, including the quantity and availability of water for human use, water quality, human health, and ecological concerns (Cook and Bakker 2012). This broad conceptual framing of water security brings governance issues into focus, which are often overlooked in narrow and discipline-specific approaches (Cook and Bakker 2012). Therefore, considering the Syrian context, it is clear that water security is not just about physical access to water, but also about the policies, infrastructure, and societal factors that affect the ability to use and manage water effectively.

Adding to the complexity, water security and its implications extend beyond immediate water availability and access. Water-related risks can undermine human well-being and contribute to political instability, violent conflict, human displacement and migration, and acute food insecurity, thereby impacting national, regional, and even global security (Gleick and Iceland 2018). And these risks are increasingly exacerbated by factors such as global population growth, economic expansion, and threats from climate change (Gleick and Iceland 2018).

Applying these insights to the Syrian context, it becomes evident that the war's impact on the country's water infrastructure affects more than just the physical systems that deliver water. It also affects Syria's water security, which, as described above, has far-reaching implications for human well-being, social stability, economic activities, ecological health, and even international security.

Northeast Syria (NES), often considered the breadbasket of the country due to its vast agricultural resources, has borne the brunt of the water crisis, making it a focal point of this study. This region,

encompassing the governorates of Al-Hasakeh, Deir-ez-Zor, Ar-Raqqa, and parts of Aleppo, holds approximately 80% of the nation's annual wheat and barley production (IFRC 2021). Unprecedented reductions in water levels and frequent droughts have drastically impacted agriculture, the primary livelihood of most residents in the region, intensifying the struggle for water security (Schwartzstein and Zwijnenburg 2022). These circumstances have led to substantial harvest loss, diminished electricity generation, and severely affected access to safe drinking water, thereby threatening the food, energy, and health security of millions (OCHA 2021). The intensified water crisis in Northeast Syria, which has been subjected to the compounded pressures of civil unrest, displacement, and economic instability, presents a complex and urgent issue that this study aims to address and understand.

This research seeks to explore the depth and breadth of the war's impact on Northeast Syria's water infrastructure. By doing so, it aims to shed light on a critical yet underexplored dimension of the Syrian crisis, contribute to discussions on protecting and rebuilding Syria's water infrastructure, and underscore the broader implications for peace, stability, and sustainable development in Syria.

1.2. Introduction to Northeast Syria's Context:

Northeast Syria (NES) is recognized for its unique ecological landscape, encompassing parts of the Aleppo, Deir-ez-Zor, Al-Hasakeh, and Ar-Raqqa governorates. The region is characterized by its semi-arid climate, enduring hot summers and milder winters. A notable geographic feature is the Euphrates River, a crucial water resource for the region. However, recent years have witnessed a drastic decline in the river's water levels, exacerbated by unpredictable rainfall patterns and higher-than-average temperatures (OCHA 2021).

Socio-economically, agriculture and pastoralism have been at the core of Northeast Syria's livelihoods. Before the war, these sectors accounted for around 19% of Syria’s GDP, with the majority of jobs in rural areas centered on crop cultivation and animal herding (Schwartzstein and Zwijnenburg 2022). However, the ongoing water crisis, primarily caused by reduced water levels in the Euphrates and drought conditions, has severely impacted these sectors. This has led to significant losses in crop and livestock production, further straining the region's economic stability (IFRC 2021).

The region's water infrastructure, comprising dams, canals, water treatment plants, and irrigation systems, has also been severely affected. Diminishing water levels in the Euphrates River and its reservoirs have resulted in reduced energy production, triggering power blackouts across NES. This situation has disrupted the operation of water pumping stations, compromising safe access to and the availability of drinking water (OCHA 2021).

The Syrian Civil War has further escalated the water crisis in the region. Notably, the war has seen a significant drop in crop production, including barley and wheat, due to decreased rainfall and river water availability. The crisis has exerted tremendous pressure on the livelihoods and food security of millions, while simultaneously increasing the cost of basic goods and diminishing the purchasing power of the local population (IFRC 2021).

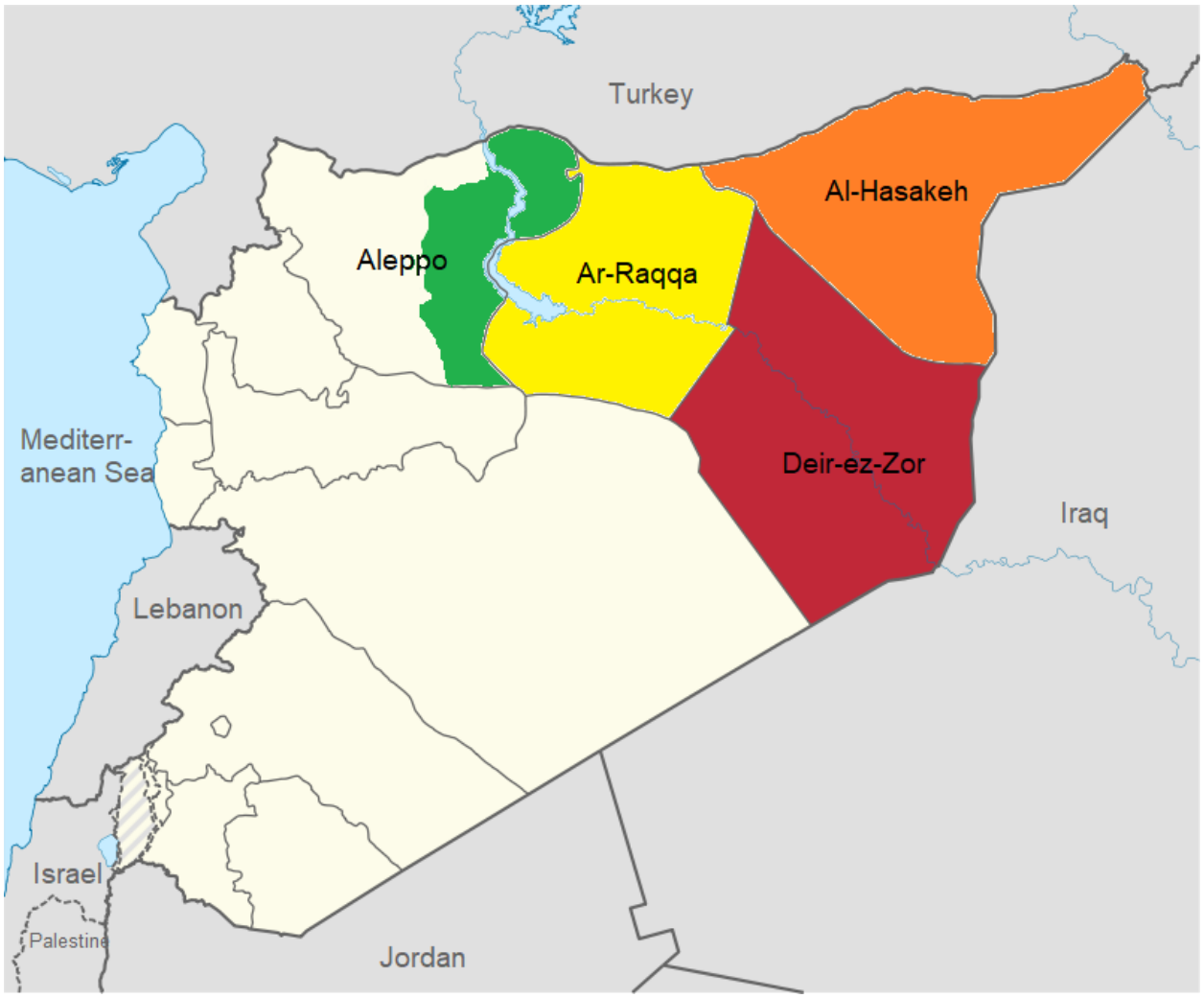

Fig. 2 Map of Syria, indicating Northeast Syria

Competing entities' control over water resources amid the civil war and the degradation of existing water infrastructure have intensified the water crisis. This has contributed to the scarcity of clean water, leading to the proliferation of water-borne diseases. In addition, the COVID-19 pandemic has further complicated the situation, with water scarcity affecting hygiene practices and other preventative measures (ICRC 2020).

International community responses, including those from NGOs and the United Nations, have attempted to address the water crisis. Nevertheless, despite these efforts, the number of people

needing immediate life-saving and continuous humanitarian assistance continues to rise. Further complicating the situation is the internal displacement of people and the return of households to areas with inadequate infrastructure (OCHA 2021).

Understanding this intricate context is critical to examining the water crisis in Northeast Syria. It informs the need for comprehensive, sustainable solutions to mitigate the hardships endured by the people in this region (IFRC 2021).

1.3. Statement of the Research Problem:

The ongoing conflict in Syria has significantly affected the nation's water infrastructure, exacerbating the issues of water security, particularly in Northeast Syria. This region, vital for its agricultural contributions, has witnessed some of the most severe impacts due to the destruction of water supply systems, sanitation facilities, and water treatment plants, resulting in decreased access to safe water for many inhabitants.

The complex problem of water security in NES can be understood through direct and indirect impacts. The direct impacts involve the physical destruction of water infrastructure due to the conflict, while the indirect implications include socio-economic and ecological dimensions, impacting public health, livelihoods, social stability, and the environment.

Despite the acute crisis, comprehensive research focusing on the conflict's impacts on Northeast Syria's water infrastructure and water security is sparse. Challenges such as limited access to the region for fieldwork, the difficulty in obtaining reliable data, and the dynamic ground situation pose significant roadblocks. As a result, existing studies often focus on specific facets of the issue or rely on outdated or incomplete data.

Confronting these challenges and gaps, this thesis addresses the research problem: "What has been the impact of the conflict on Northeast Syria's water infrastructure, and how has this affected the region's water security?" By conducting a desk study synthesizing available data and sources, this thesis will provide a more detailed understanding of the current situation and its implications. The research will focus on key aspects, including the extent of damage to water infrastructure, changes in water availability and access, implications for public health and livelihoods, and broader social and political repercussions. In doing so, it will contribute to the ongoing dialogue on water security in conflict situations and aid in informing policy decisions and humanitarian responses.

1.4. Research Questions:

In order to systematically assess the impact of war on Northeast Syria's water infrastructure and the subsequent implications for water security, the following research questions have been formulated:

1. What has been the extent and nature of the damage to Northeast Syria's water infrastructure as a result of the war?
2. How has the conflict impacted water availability and access for the population in Northeast Syria?
3. How has the conflict-induced water crisis in Northeast Syria impacted public health, and livelihoods, and contributed to broader social and economic in Northeast Syria?

These questions will guide the analysis in this thesis and will be addressed through a careful review and synthesis of existing literature, reports, and data.

1.5. Rationale for the Study:

The impact of conflict on a region's infrastructure is a well-established area of study. However, the specific focus on water infrastructure and its consequent effects on water security, especially within the context of an ongoing conflict as complex and protracted as the Syrian crisis, is less explored. This gap in research becomes especially critical in Northeast Syria, a region profoundly affected by water insecurity and significantly influenced by water's role in sustaining life and livelihoods, maintaining public health, and ensuring social and economic stability.

Northeast Syria (NES) presents a compelling case study for this research for several reasons. Firstly, the conflict has led to significant damage to infrastructure, including water systems, both as direct targets of warfare and as collateral damage. Secondly, the war has drastically altered the landscape of human settlement and livelihoods in the region, leading to shifting patterns of water demand and access. Lastly, NES is situated in a wider area already characterized by water scarcity and stressed resources, further amplifying the severity and potential implications of water insecurity.

Understanding the impact of conflict on water infrastructure and security in Northeast Syria not only contributes to the specific knowledge about the region but also carries wider implications. It can enhance the broader theoretical understanding of how conflict interacts with water security, providing insights that may be applicable to other conflict-affected regions around the world.

Furthermore, this research could inform humanitarian action and policy-making, both during and after conflicts. By shedding light on the nature and consequences of war-induced water crises in NES, the study could help in prioritizing interventions, designing more effective water-related

assistance programs, and developing strategies for post-conflict reconstruction and peacebuilding efforts in this and other similar contexts.

In summary, this study, focusing on the intersection of conflict, water infrastructure, and water security in the context of Northeast Syria, fills an important gap in knowledge, adds to the theoretical understanding of water security in conflict situations, and carries significant practical implications for policy and action.

1.6. Objectives of the Study:

The overall aim of this study is to assess the impact of the Syrian conflict on Northeast Syria's water infrastructure and explore the consequent implications for water security. To achieve this overarching aim, the study will focus on the following specific objectives:

1. To investigate the extent and nature of damage to Northeast Syria's water infrastructure due to the ongoing conflict. This objective involves cataloging the types and degree of damage that has occurred to different components of the water infrastructure, including sources, storage, treatment, and distribution facilities.

2. To analyze the direct and indirect impacts of water infrastructure damage on water security, public health, and livelihoods in Northeast Syria. The focus here will be on assessing how the degradation of infrastructure has affected various aspects of water security, such as availability, accessibility, and quality of water resources. As well as how that influenced other areas like public health, livelihoods, and social stability in this region.

3. To identify and evaluate the strategies implemented at the local, national, and international scales to mitigate the repercussions of war on Northeast Syria's water infrastructure and

security and suggest strategies for post-conflict recovery. This necessitates a detailed assessment and critique of the actions taken to mend the disrupted infrastructure, guarantee emergency access to water, and uphold water security throughout the period of conflict.

By pursuing these objectives, this study aims to present a comprehensive picture of the war's impact on Northeast Syria's water infrastructure and security, providing valuable insights to guide future academic research, policy-making, and practical action in conflict-affected settings.

1.7. Scope and Limitations of the Study

This study is ambitious in its scope as it seeks to assess the impact of war on Northeast Syria's water infrastructure, and the subsequent implications for water security. It encompasses an analysis of the damage inflicted on different aspects of water infrastructure, the direct and indirect impacts of this damage on water security, the broader socio-economic and public health implications, the response mechanisms employed to mitigate the effects, and the prospective strategies for post-conflict rehabilitation in this region.

Despite this broad scope, the study acknowledges some inherent limitations due to its nature as a desk-based research project and its focus on Northeast Syria (NES):

- Regional Focus: While the focus on NES allows for a detailed and nuanced understanding of the water security issues in this region, it also presents a limitation in terms of the broader generalizability of the findings. The unique sociopolitical, geographic, and historical context of NES may not necessarily reflect the conditions in other parts of Syria or other conflict-affected regions.
- Limited Access to Primary Data: The primary limitation of this study is the lack of direct access to Northeast Syria for fieldwork. In addition, lack of contact with individuals and/or

communities in NES made it impossible to acquire any online interviews. Consequently, the research relies heavily on secondary data, which may not fully capture the current and evolving realities on the ground in this region.

- Availability and Quality of Secondary Data: The study depends on existing literature, reports, and databases for information, which may be incomplete, outdated, or biased. The lack of consistent data, particularly during the years of conflict, may affect the comprehensiveness and accuracy of the analysis. Furthermore, pre-war data on water infrastructures are relatively scarce due to the fact that the discourse on water security in the region has not been researched properly or extensively and is poorly documented.
- Conflicting Information: Given the contested nature of the Syrian conflict, there may be differing accounts and data about the extent of damage to water infrastructure and the resulting water insecurity in Northeast Syria. This study will aim to triangulate information to the best extent possible but acknowledges the potential for discrepancies.
- Generalizability: While this study seeks to provide insights that may be relevant to other conflict-affected regions, the specificities of the Northeast Syrian context mean that the findings may not be fully generalizable. Each conflict and its impacts on water infrastructure and security are shaped by a unique combination of geographical, social, political, and historical factors.
- Despite these limitations, the study aims to make a significant contribution to the understanding of the impact of conflict on water infrastructure and security in NES, using the best available data and analytical methods.

2. Literature Review

2.1. Water Security: Concepts and Importance:

Water security is an intricate concept, underpinned by the premise that every person should have reliable and affordable access to sufficient quantities of acceptable quality water for sustaining livelihoods, well-being, and socio-economic development, while ensuring the protection and preservation of ecosystems (Grey and Sadoff 2007). It is the capacity of a population to safeguard sustainable access to adequate quantities of and acceptable quality water for sustaining livelihoods, promoting socio-economic development, and maintaining the integrity of ecosystems under the risk and uncertainty of change, including responding to environmental, social, and economic shocks (Cook and Bakker 2012).

Water security plays a crucial role in maintaining peace and stability within and between nations, as water scarcity or mismanagement can lead to conflict and social unrest (Gleick 2014). Moreover, water security is pivotal for public health, as access to clean water is a critical element for preventing diseases and improving overall health outcomes (UN Water 2013).

In the context of conflict and war water security gains even more prominence. Armed conflicts often damage critical water infrastructure leading to water scarcity, and the deterioration of water quality, thereby threatening the lives and livelihoods of the population (Shumilova et al. 2023). For example, damage to water infrastructure such as dams, reservoirs, and water supply systems can disrupt access to water, increase risks of flooding, and lead to the release of hazardous pollutants, impacting public health, agriculture, and the overall socio-economic structure of the country (Shumilova et al. 2023).

Further, water security is paramount for the stable functioning of critical infrastructures such as energy production and agriculture. For example, in Ukraine, the large reservoirs along the Dnieper River are essential for energy production, cooling of nuclear power plants, sustaining agriculture, and seasonal flow regulation. These reservoirs also serve as a source of water for the largest irrigation system in Ukraine, and a sudden loss of water can lead to severe consequences for regional agriculture and food production (Shumilova et al. 2023).

In addition to direct human needs, water security is also critical for maintaining the health of ecosystems. For instance, damages to reservoirs during conflict can lead to mass fish deaths, affecting biodiversity and the livelihoods dependent on these ecosystems (Shumilova et al. 2023).

Water security, therefore, encompasses not only the availability of water but also the potential risks and impacts associated with its disruption. Recognizing these multifaceted elements is fundamental to understanding the complexity and importance of water security in the context of both peace and conflict situations.

2.2. War and Water Infrastructure: Previous Studies and Models:

The study of war and its impacts on water infrastructure is a well-established area of research. Armed conflict can cause catastrophic damage to water infrastructure, resulting in long-lasting consequences for societies, economies, and the environment. Multiple models and frameworks have been developed to understand the impacts of conflict on water infrastructure, as well as to assess the potential risks and propose preventive and mitigating measures.

Previous research has demonstrated the direct impacts of warfare on water infrastructure, where physical damages can lead to immediate water shortages, sanitation issues, and the spread of waterborne diseases (Shumilova et al. 2023). Indirect impacts can also include disruption to routine

maintenance and management activities due to conflict, further exacerbating water shortages (Selby and Hoffmann, 2014).

The case of Ukraine, for example, provides an example of how war can significantly impact water infrastructure. In the initial three months of the conflict, significant damage was inflicted on dams and reservoirs, underground mines, and urban water supply and wastewater treatment systems, leaving numerous communities without wastewater treatment and causing pollution of surface waters (Shumilova et al. 2023). Furthermore, the Ukrainian conflict highlights how the breaching of dams along the Dnieper River poses a danger of secondary radioactive pollution due to the uncontrolled release of radioactive material from the Chernobyl disaster (Shumilova et al. 2023).

Damage to water infrastructure can also have serious environmental repercussions. For instance, the underwater decomposition of ammunition can lead to the release of heavy metals and toxic explosive compounds, with impacts lasting for decades (Shumilova et al. 2023). Additionally, intentional or unintentional bombing poses threats to regional agriculture, food production, and international food trade.

Studies also indicate that conflict can exacerbate pre-existing water-related issues. In Sudan, violence and instability have disrupted maintenance and development of water infrastructure, further reducing the national water supply coverage, which already stands at a concerning 60% (O'Brien 2023). In Ukraine, the concentrations of harmful substances in some rivers have increased due to the conflict (Shumilova et al. 2023). The conflict has also aggravated the threat of pollution of water sources with mine waters due to failures in operation of pumping equipment, worsening the quality of groundwater and surface water (Shumilova et al. 2023).

Previous research has employed a range of models to understand and predict the impacts of conflict on water infrastructure. These models vary in complexity and scope, incorporating factors such as the intensity and duration of conflict, the type and location of water infrastructure, and the vulnerability of populations (Van Loon et al. 2015).

In conclusion, the study of war and water infrastructure is of great significance, especially in conflict-prone regions. The impacts can be profound and multifaceted, affecting public health, food security, energy production, and ecosystems. Understanding these impacts through comprehensive research and modeling is crucial for devising effective strategies for conflict mitigation and post-conflict recovery.

2.3. Water Infrastructure and Security in Conflict Zones: Case Studies:

Exploring case studies of conflict zones can provide insights into the interplay between water infrastructure and security, and the ways in which this relationship can influence the severity and outcomes of conflicts. Investigating the state of water infrastructure in different conflict zones offers an opportunity to draw parallels and comparisons with the situation in Northeast Syria. The case studies provide valuable insights into the common challenges and threats faced by water infrastructure during conflicts, thus providing a broader context within which the specific circumstances of NES can be understood. This section will explore several key case studies offering an understanding of the significant implications of the war on water security.

- **Ukraine**

The Ukrainian conflict offers an illuminating case study on the impact of armed conflict on water infrastructure and security. In the initial months of the conflict, significant damage was reported to dams and reservoirs, underground mines, and urban water and wastewater treatment systems

(Shumilova et al. 2023). This had a profound effect on water availability and quality for the civilian population, and also posed serious environmental risks. The large reservoirs along the Dnieper River were particularly affected, which have wide-ranging implications for energy production, agriculture, and seasonal flow regulation (Shumilova et al. 2023). Eastern Ukraine has experienced 380 attacks on water infrastructure since 2017 — Up till 2021 — leaving around 3.2 million people in need of water and sanitation services (UNICEF 2021).

Moreover, the conflict exposed a potential hazard of secondary radioactive pollution due to breaching of dams along the Dnieper River. This would involve the uncontrolled release of radioactive material accumulated in the sediments following the Chernobyl disaster (Shumilova et al. 2023).

The impact on wastewater treatment plants and pollution of surface waters also came into focus, affecting not only water availability and quality, but also contributing to environmental degradation. Examples include the release of polluted wastewater into the Kakhovka Reservoir and contamination of rivers with ammunition waste leading to release of heavy metals and toxic compounds (Shumilova et al. 2023).

Furthermore, the Ukrainian conflict underscored the threat to human health due to water insecurity. By April 2022, it was reported that 6 million people were struggling to get access to drinking water, and there were concerns about the danger of a cholera epidemic due to the mixing of sewage and drinking water in cities like Mariupol (Shumilova et al. 2023).

- **Libya**

Libya, a country afflicted by protracted conflicts following the 2011 fall of the Gaddafi regime, presents a compelling case of how conflict and socio-political instability can detrimentally impact

water infrastructure and security. The country's ongoing turmoil serves as a case in point illustrating the interconnectedness of water security, human security, and national stability.

Firstly, the dire state of the water infrastructure in Libya cannot be overstressed. The Great Man-Made River (GMMR), an engineering marvel which was once the primary source of water in the country, suffered extensive damage over the years due to neglect, lack of maintenance, and direct attacks (Timakova 2023). Additionally, issues related to pollution and environmental degradation caused by armed confrontations have led to the contamination of freshwater sources, making them unsuitable for human consumption (Timakova 2023).

With the destruction and breakdown of the legal system, law enforcement, and judicial institutions, internal security remains a grave concern (Human Rights Watch 2023). This has fueled the rise of local militias, adding to the precariousness of ordinary citizens, particularly in economically marginalized urban areas. This situation has severely compromised the delivery of basic services such as water, healthcare, and electricity. In fact, electricity shortages are reported in three-quarters of Libya's regions, hampering water treatment processes, and thus exacerbating water insecurity (REACH 2016; al-Warfalli and Elumani 2018).

Critical infrastructure, including health facilities, has borne the brunt of continuous hostilities. The UN OCHA's report in 2019 highlighted an alarming rise in civilian casualties, displacement, and infrastructural damage, which included health facilities (OCHA 2020). The health sector's inability to cope is further exacerbated by an ongoing COVID-19 pandemic. Libya's National Center for Disease Control (NCDC) registered 51 confirmed cases, including one death, as of April 2020, yet even amid this health crisis, attacks on hospitals and critical infrastructure continue (OCHA 2020).

The impact of conflict on the environment and public health is profound. Damage to critical water infrastructure, coupled with an increase in temperatures, has likely led to a rise in waterborne diseases. Reduced public administration capacity has resulted in decreased garbage and solid waste collection, thereby escalating the risk of disease outbreaks (Garrity 2014; Weir 2015). The polluted ruins of war, household products, combustion by-products, and possible explosive residues pose inhalation risks to civilians and contaminate water supplies.

The case of Libya underlines the importance of maintaining water infrastructure and security in conflict zones. It exemplifies the complexity of state-building in a post-conflict society and demonstrates how external intervention, if not followed by robust leadership measures, can inadvertently create power vacuums and further destabilize the region. The experience of Libya underscores the need for a comprehensive, collaborative approach by the international community to address these challenges and work towards sustainable development, keeping in mind the pivotal role of natural resources in recovery strategies.

- **Yemen**

The protracted conflict in Yemen has led to severe damage to the nation's water infrastructure, further exacerbating the already acute water scarcity issues faced by the population (Sowers and Weinthal 2021). Yemen, already classified as one of the most water-scarce countries in the world (FAO, 2021), has seen a drastic degradation of its water infrastructure due to the ongoing conflict.

With the war affecting both urban and rural areas, access to clean water has become severely limited where the water network reaches only 30% of the population — leaving out 70% of the people with no access to safe drinking water (ICRC 2022). The situation is particularly dire in the capital, Sanaa, which relies heavily on rapidly depleting groundwater sources, where people turned

to informal sources of water such as private tanker trucks, wells, and kiosks (Sowers and Weinthal 2021). Due to the conflict, maintenance and modernization of water infrastructure, crucial for sustainable water management, have been neglected. This has resulted in an accelerated depletion of water sources and a decline in the quality of water (Sowers and Weinthal 2021; FAO 2021).

Direct attacks on water infrastructure have also been reported, including the bombing of water treatment plants, pipelines, and wells (Amnesty International 2015). 122 airstrikes on water infrastructure were reported between March 2015 and February 2021 (UNICEF 2021). Such attacks not only disrupt the immediate supply of water but also contribute to the longer-term decline in water security by damaging the infrastructure necessary for water distribution and purification (Amnesty International 2015).

The scarcity of water has given rise to water-related conflicts at the local level. In a country where agriculture still plays a vital role, access to water can be a matter of life and death. The struggle for this precious resource has further fueled tensions and violence, creating a vicious cycle of conflict and water insecurity (Sowers and Weinthal 2021).

Moreover, the combination of damaged water infrastructure and conflict-induced displacement has led to appalling sanitary conditions, making the population vulnerable to waterborne diseases. The cholera outbreak in 2017, which affected over a million people, has been attributed to the decimation of water and sanitation systems due to the conflict and lack of access to safe water (Dureab et al. 2019).

In essence, the Yemen case demonstrates how conflicts can escalate pre-existing water issues, highlighting the urgent need for concerted efforts in conflict resolution and water infrastructure

reconstruction. Its similarities and differences with Northeast Syria can help contextualize and anticipate the potential outcomes of the ongoing conflict on water infrastructure in the latter region.

- **Afghanistan**

Afghanistan, a country suffering from decades of conflict, has been facing tremendous challenges regarding the state and security of its water infrastructure. 79% of households in the country reportedly suffer water shortage, and only 20% of the country's rural population, which is around 80% of the total population, has access to clean water (Business Standard 2023; Mahaqi et al. 2020).

The decades of conflict and civil war have significantly damaged the water supply infrastructure in the country due to continuous fighting and bombing directly affecting water availability and accessibility (Aydin-Kandemir and Yildiz 2023; Habib 2014; Banks 2002). In addition, inadequate maintenance due to conflict-induced insecurity and a lack of institutional capacity has led to the degradation of existing water facilities, exacerbating the water supply crisis (Aydin-Kandemir and Yildiz 2023; Habib 2014).

Furthermore, the insecurity in the region has hampered the efforts to repair and rehabilitate water infrastructure. Engineers and laborers are often deterred from working on water infrastructure projects due to being targeted by insider and outsider terrorist groups (Ashraf et al. 2022). In some cases, these groups have even intentionally sabotaged water projects, particularly dams, to challenge the government or exert control over the population (Ashraf et al. 2022).

Water scarcity, partly due to infrastructure degradation, has also been weaponized during the conflict. Water sources have been purposefully polluted or destroyed by conflicting parties to gain strategic advantages (Aydin-Kandemir and Yildiz 2023; Veilleux and Dinar 2018). The

deteriorating water infrastructure, coupled with climatic changes, has also intensified water-related issues in Afghanistan. The country is highly vulnerable to climate change, experiencing extreme weather events such as droughts and floods. These events have further strained the water supply and led to a decline in water quality, increasing the risk of water-borne diseases (FAO 2016). The decades conflict, political unrest, and climate change have led to the displacement of communities, huge adverse impacts on livelihoods, and exacerbating the humanitarian crisis in the country (Rosvold et al. 2021).

The case study of Afghanistan emphasizes the interconnectedness of water infrastructure, conflict, and security. The protracted conflict in the country has demonstrated how warfare can destroy water infrastructure and impede its repair and maintenance, leading to severe water scarcity and, in turn, contributing to the perpetuation of conflict and instability.

These case studies highlight the intricate relationship between water infrastructure, security, and conflict. The destruction of water infrastructure can lead to significant humanitarian crises, environmental degradation, and long-term socio-economic challenges. Therefore, in conflict prevention and resolution, as well as in post-conflict reconstruction, a thorough understanding and integration of water security considerations is of paramount importance.

2.4. Syria's Pre-war Water Infrastructure: A Focus on Northeast Syria:

Syria's water infrastructure before the war, including Northeast Syria, was heavily influenced by the country's political and economic dynamics. The Syrian government, under the Ba'ath party, had a significant role in shaping the country's water infrastructure (Barnes 2009). Agriculture has always been the main water-consuming sector (Mourad and Berndtsson 2011). However, the government's agricultural development policies, which were heavily focused on water-intensive

practices, led to a situation of water scarcity (Barnes 2009). The government's support for the agricultural sector was linked to the ruling Ba'ath party's rural roots and the influential Peasants Union (Barnes 2009). In addition to these factors, there were two key objectives of the Syrian government that significantly impacted the development of the country's water resources: enhancing national security by attaining self-sufficiency in the main food staples and increasing agricultural production through the expansion of irrigated agriculture (Barnes 2009).

- **Geographical and Climatic Considerations**

Syria's water infrastructure has always been closely linked to its geography and climate. The northeastern part of the country, in particular, is characterized by its semi-arid climate and is heavily dependent on the Euphrates River.

The Euphrates River, which is the most important river in Syria, originates in Turkey and runs through Northeast Syria and Iraq. Turkey contributes around 90% to the Euphrates while Syria contributes 10% (Kibaroglu and Scheumann 2013). In the past, the Euphrates' annual flow at the Syrian-Turkish border was approximately 30 billion cubic meters (UN-ESCWA and BGR 2013). However, a downward trend has been observed in the data collected over the past 80 years, suggesting a reduction in the average annual flow to roughly 25 billion cubic meters (UN-ESCWA and BGR 2013). Historically, Syria has signed agreements over the Euphrates River with Turkey, in 1987 and 2009, and with Iraq, in 1990, regulating the river flow and the joint activities on the river (UN-ESCWA and BGR 2013). The Euphrates passes through the governorates of Aleppo, Ar-Raqqa, and Deir-ez-Zor, respectively (Ali 2010). The river is broadened by three principal tributaries: the Sajur, Balikh, and Khabur, with its largest tributary, the Khabur River, running across Al-Hasakeh (Altinbilek 2004; Glass 2017).

The Tigris River forms a boundary with Turkey and Iraq and has potential for irrigation expansion in northeastern Syria (Kibaroglu and Scheumann 2013). Despite its limited flow within Syria, the country has an agreement with Turkey to withdraw a small amount of water annually (1.25 cubic kilometers), marking its significance in transboundary water politics (Kibaroglu and Scheumann 2013).

This region's water resources are significantly influenced by seasonal and annual rainfall variations, which affect river flows, groundwater recharge, and water availability for agriculture and other uses (Al-Quraishi and Kaplan 2021).

- **Key Water Infrastructure**

Northeast Syria's pre-war water infrastructure was diverse and comprised several key components. The Euphrates River was — and still is — a central part of this infrastructure, supporting several large dams, including the Tabqa Dam (also known as the Euphrates Dam or al-Thawra Dam) and the Tishrin Dam, as well as Baath Dam. These dams played a crucial role in electricity generation, irrigation, and flood control (Altinbilek 2004).

The Tabqa Dam was completed in 1974/1975 with the help of the Soviet Union as a part of the Euphrates Valley Project — a project whose aim was to irrigate an area as large as 640,000 hectares in Northeast Syria (Roberts 1991; Altinbilek 2004; Kibaroglu and Scheumann 2013). The dam was designed to generate electricity for urban use and industrial development, as well as to regulate the flow of the Euphrates to prevent seasonal flooding (Kibaroglu and Scheumann 2013). It has a height of 60 meters, gross storage of 11.7 cubic kilometers, a surface area of 610 square kilometers, and hydroelectric power (HP) capacity of 800 MW (Altinbilek 2004). The dam holds behind it an

artificial lake, named Lake Assad, which is around 80 kilometers long and about an average of 8 kilometers in width and used to hold nearly 12 billion cubic meters of water (Collelo 1987).

Fig. 3 Major dams on the Euphrates River in Syria
Source: The Arab Weekly.

The Baath Dam, located downstream of the Tabqa Dam, was constructed in 1988 for hydroelectric power generation, irrigation, and flood control (Altinbilek 2004). It has a gross storage capacity of 0.09 cubic kilometers, a surface area of 27.2 square kilometers, and a hydroelectric power capacity of 75 MW (Altinbilek 2004).

The Tishrin Dam, located upstream of the Tabqa Dam, was completed in 1999 and is primarily used for hydroelectric power generation (Altinbilek 2004). It has a height of 40 meters, a gross

storage capacity of 1.9 cubic kilometers, a surface area of 166 square kilometers, and a hydroelectric power capacity of 630 MW (Altinbilek 2004).

Furthermore, a complex network of canals, pipes, and pumping stations distributed water from these dams and other sources to agricultural lands, industrial facilities, and residential areas. Irrigation systems, both traditional and modern, enabled the cultivation of a wide range of crops, from cereals to cotton, in this otherwise arid region (Hole and Zaitchik 2007). The transformation of northeastern Syria's agricultural landscape can be largely attributed to the introduction of these extensive irrigation systems in the steppe region. Before that, irrigation was primarily limited to natural depressions and river floodplains; winter-fed agriculture and year-round grazing dominated the steppe (Hole and Zaitchik 2007). However, the introduction of diesel-powered wells, and later the state-controlled dam and canal systems, has facilitated the expansion of irrigation during both winter and summer seasons, extending beyond the floodplain and into the steppe (Hole and Zaitchik 2007). Though it is worth mentioning that the sustainability of these projects has always been questionable (Hole and Zaitchik 2007).

In urban areas, water treatment and distribution systems ensured the supply of potable water to most residents. However, these systems were often strained due to high demand, inadequate maintenance, and inefficient use.

While this section of the literature review strives to offer a comprehensive examination of Northeast Syria's water infrastructure before the conflict, it must be acknowledged that obtaining credible, comprehensive data pertaining to the pre-war status of said infrastructure poses significant challenges. The scarcity of such information is attributable to a confluence of factors. First, despite the substantial implications of water infrastructure on public health, economic

stability, and societal welfare, prior to the conflict, the discourse on water security in the region was relatively under-researched and poorly documented. Second, it is worth noting that the lack of transparency and access to verifiable data in Syria, particularly regarding public utilities and infrastructures, adds to the complexity of establishing a reliable baseline of the pre-war conditions. Recognizing these constraints, this section nevertheless offers an illuminating exploration of Northeast Syria's pre-war water infrastructure.

- **Water Usage and Demand**

Water usage in Northeast Syria, and Syria in general, before the war was dominated by the agricultural sector, which accounted for an estimated 87% of the total water demand (Haddad et al. 2008). The domestic and industrial sectors accounted for much of the rest, 9% and 4% respectively, with industry using water for processes such as textile production and oil refining, and households for drinking, cooking, cleaning, and other personal uses (Haddad et al. 2008).

- **Governance and Management**

The Syrian law defined water as a "public good", meaning that it is a resource that is owned by the public and managed by the state on behalf of the public (Salman and Mualla 2008). As such, it is not typically subject to market forces like supply and demand in the same way that private goods are. Instead, its distribution and use are often regulated by the government to ensure equitable access and sustainable use. The Syrian law stipulated that the rights to use water are tied to land ownership (Salman and Mualla 2008). This means that if one owns a piece of land, they have the right to use the water resources on or under that land. This is different from some other jurisdictions where water rights are separate from land rights and can be bought, sold, or leased independently. Though the law confirmed these established rights to use public water, it also gave the government

the authority to revoke these rights if necessary. If the government does revoke these rights, it is required to provide compensation to the affected parties (Salman and Mualla 2008)

Water management before the war was largely centralized, with several government agencies responsible for various aspects of water resource management, from irrigation to drinking water supply (Salman and Mualla 2008). Laws and policies related to water were also in place, although their effectiveness varied. Water resources management in Syria was supply-driven, which focused on the construction of some water infrastructure, such as dams, and the expansion of agricultural activities to achieve self-sufficiency in essential food products and food security — the sustainability of these policies was questionable (Salman and Mualla 2008; Hole and Zaitchik 2007).

A variety of ministries and establishments oversee the water sector in Syria, with some overlap in their duties. Each Ministry has associated local entities, such as local directorates or institutions. These local bodies are connected to the central body of each respective Ministry and are spread across Syria's fourteen administrative units (Kaisi et al. 2005). These ministries include:

1. **Ministry of Irrigation (MoI)**: is tasked with water management and development, and the regular assessment and monitoring of the quality of surface and groundwater, as well as ensuring the supply of water for irrigation needs (Kaisi et al. 2005).

2. **Ministry of Agriculture and Agrarian Reform (MAAR)**: is responsible for the economic utilization of water in agricultural regions. This includes the exploration of techniques to minimize water loss and the cultivation of crops that require less water and can tolerate salinity (Kaisi et al. 2005).

3. **Ministry of Housing and Construction**: has the responsibility of providing drinking water to both rural and urban areas, as well as managing wastewater treatment (Kaisi et al. 2005).

4. **Ministry of Environment and Local Administration**: is tasked with the monitoring of water quality and the development of necessary standards for the protection of water resources (Kaisi et al. 2005).

This legal framework is designed to balance individual rights to use water with the broader public interest and the need to manage water resources sustainably. However, it also means that the government plays a central role in managing water resources and can intervene in the market as needed.

- **Challenges and Issues**

Despite the extensive water infrastructure, NES faced several water-related challenges before the war. Water scarcity, driven by both natural factors and human activities was a major issue. Even before the conflict, drought had increasingly become a regular occurrence in Syria, with the intervals between each drought cycle diminishing compared to previous years (Ali 2010). This has resulted in a considerable decrease in agricultural yield, a sector that relies heavily on the presence of water. The drought prompted a substantial portion of the population from the eastern and northeastern parts of Syria to migrate toward the central provinces in pursuit of sustenance and accommodation (Ali 2010).

Overuse of groundwater resources led to falling water tables in many areas. For example, before the conflict, decreasing water levels in the springs that fed into the Khabur River — the largest tributary of the Euphrates in Northeast Syria (Ali 2010). This has adversely impacted both public

and private irrigation initiatives that rely on the Khabur River and its springs, with numerous government projects dependent on the river being halted, and agricultural strategies reliant on the government's irrigation system facing unpredictable water supplies (Ali 2010). This further resulted in a decrease in groundwater levels, due to the extensive amounts of water being drawn for thousands of irrigation wells established in this basin (Ali 2010).

Some other unsustainable agricultural practices had also led to huge water losses, for example, transferring water from the water sources to the fields due to transportation, leakage, and evaporation (Hinnebusch et al. 2011; Oweis et al. 2011). While pollution from agricultural runoff, untreated wastewater, and industrial effluents threatened the quality of both surface and groundwater resources (Kaisi et al. 2005; Haddad et al. 2008).

Infrastructure-related issues, such as the aging of water supply networks and treatment facilities, as well as the inefficiency of irrigation systems, also posed significant challenges (ICRC 2015). Furthermore, institutional and governance issues, such as weak enforcement of water-related laws and regulations, inadequate investment in infrastructure maintenance and development, and lack of public awareness about water conservation, contributed to the overall water challenges (Haddad et al. 2008).

- **Impact on Communities**

These challenges had direct implications for local communities. The overexploitation of groundwater, due in part to the water-intensive agriculture, to irrigate crops such as wheat and cotton had contributed to the scarcity of water in the region (Salman and Mualla 2003). Insufficient or unreliable water supplies affected not only households' access to clean water but also the productivity of agricultural lands and thus the livelihoods of many farmers (Ali 2010). This

resulted in some sort of internal migration from the northeast toward central areas of Syria for better livelihoods (Ali 2010). Furthermore, poor water quality due to pollution such as industrial and municipal wastewater effluents also posed serious health risks (Kamizoulis et al. 2003).

This comprehensive review of the state of Syria's pre-war water infrastructure, particularly in the northeastern region, provides the necessary context for understanding the impact of the war on this vital sector. It underscores the pre-existing vulnerabilities and issues that were likely exacerbated by the conflict and highlights the importance of considering these factors when assessing the war's impact on water infrastructure.

This analysis also underscores the human dimension of water infrastructure, emphasizing its role not just as a physical network of dams, canals, pipes, and treatment facilities, but also as a socio-economic system that supports livelihoods, public health, and overall well-being. This perspective is crucial in assessing the war's impact on water infrastructure and its broader implications for society and the economy (Grigg 2019).

As we transition into the next sections of this thesis, we will delve into the impact of war on these already established structures and resources, comparing the pre and post-war scenarios, and examining the implications of these changes on the population, and the potential for recovery and reconstruction.

However, it is worth noting that while this analysis provides a detailed account of Syria's pre-war water infrastructure, there is a need for further research and data collection, especially at the local level, to fill in gaps and provide a more complete picture.

In the end, the value of examining the state of water infrastructure in NES prior to the conflict is that it provides a baseline from which to measure the war's impacts. This is crucial for accurately

assessing the extent of the damage, informing reconstruction efforts, and contributing to broader discussions about the interplay between conflict and water security.

3. Methodology

3.1. Introduction

The core essence of any scholarly investigation is its research methodology. This is not merely a set of procedures but serves as the backbone, providing the framework for gathering and analyzing information in a systematic manner. Bryman (2012) defines research methodology as a structured set of practices and processes used to find answers to research questions. By adhering to a rigorous research methodology, scholars can enhance the reliability, validity, and generalizability of their findings (Creswell 2017).

Research in conflict zones presents a unique set of challenges, most significantly in terms of access to primary data and ethical considerations. Wood (2006) discusses the intricate ethical challenges faced by researchers while conducting field research in volatile regions, emphasizing the need for heightened sensitivity and prudence. Such areas can be sources of biased or incomplete information due to their volatile nature, thereby demanding an added layer of scrutiny and triangulation of data sources (Autesserre 2014).

Given these challenges, especially in a region like Northeast Syria, the chosen methodology needs to be both resilient and adaptable. This study's reliance on a desk-based approach, heavily centered around secondary data, is not merely a logistical decision. Such an approach ensures that the data used is comprehensive and peer-reviewed, ensuring an added layer of credibility and trustworthiness (Tashakkori and Teddlie 1998). Furthermore, the utilization of secondary sources, such as UNICEF, OCHA, and REACH reports, provides valuable insights into the broader context, lending weight to the assertions and findings presented in the research.

The multifaceted nature of water infrastructure, especially in conflict zones, means that our research requires a balanced blend of qualitative and quantitative methods (Gleick 2006). Qualitative methods, as described by Flick (2022), allow for a deeper exploration of contextual, on-ground realities, narratives, and experiences. In contrast, quantitative methods, backed by datasets and statistical analyses, offer empirical evidence that can be critically evaluated and benchmarked (Miles and Huberman 1994).

In sum, the objective of this section is more than just detailing the methodological procedures employed. It seeks to underscore the importance of a well-rounded, ethically sound, and robust research methodology in the challenging context of Northeast Syria.

3.2. Research Design

Research designs serve as the architectural blueprint for any investigative endeavor. They guide the researcher in the process of data collection, ensuring consistency and a systematic approach to the topic under investigation (Bryman 2012). This becomes especially pertinent when researching topics set within conflict zones, which, as Wood (2006) contends, come with their own set of unique logistical and ethical complexities.

In the context of Northeast Syria (NES), direct fieldwork and primary data collection are fraught with challenges, not just due to the ongoing conflict but also because of the sensitive nature of the subject – water infrastructure, a resource intrinsically tied to survival, wellbeing, and potential strategic vulnerabilities (Gleick 2006). It is in this backdrop that a desk-based research design was chosen as the optimal approach for this study.

A desk-based approach is not merely a workaround to physical inaccessibility; it has its own merits. By relying on existing literature, reports, and datasets, this study leverages vast pools of

accumulated knowledge, ensuring a comprehensive and multi-faceted perspective. This can be instrumental in painting a full picture, tapping into both macro-level policy discussions, as found in PAX report (Schwartzstein and Zwijnenburg 2022) and REACH report (2023), and more granular, community-level insights that qualitative narratives often provide.

The integration of both qualitative and quantitative research methods was a conscious decision. Creswell (2017) emphasizes the benefits of such a mixed-method approach, especially for studies with multi-dimensional subjects. Qualitative methods, as expounded by Flick (2022), allow the researcher to dive into the lived experiences, societal narratives, and ground realities that may not be immediately apparent in cold data. On the other hand, quantitative methods lend empirical weight to the study, offering tangible, measurable insights that can be benchmarked, compared, and analyzed for patterns (Miles and Huberman 1994).

The choice of a mixed-methods approach is further bolstered by the work of Tashakkori and Teddlie (1998), who assert that in contexts where the research topic is embedded within complex socio-political landscapes, such as conflict zones, having a blend of narrative and empirical data can significantly enhance the depth and breadth of the investigation.

Moreover, Autesserre (2014) points out that in regions with longstanding conflicts, understanding the everyday politics and underlying dynamics is crucial. A mixed-methods approach, with its blend of qualitative narratives and quantitative datasets, is well-suited to capture these nuances, ensuring a holistic understanding of the interplay between war, infrastructure damage, and its wider implications.

In conclusion, the research design for this study was shaped by both the challenges of the research environment and the multifaceted nature of the topic. By adopting a desk-based, mixed-methods

approach, the study ensures that its findings are comprehensive, grounded in evidence, and sensitive to the myriad dynamics of Northeast Syria.

3.3. Data Collection

Data collection forms the backbone of any academic endeavor. For this study, primary reliance was placed on secondary data sources, including:

- Peer-reviewed academic articles that offered deep insights into global water security issues, conflict dynamics, and their interplay.
- Grey literature, often overlooked, but crucial for comprehensive perspectives, especially in regions with limited academic publications.
- Reports from reputed international and non-governmental organizations known for their on-ground assessments and interventions.
- Publicly accessible datasets that provide quantifiable metrics to gauge the scale and scope of infrastructure damage.
- Media reports, which, while needing rigorous verification, offer real-time snapshots of evolving situations.

Essential resources like the United Nations (OCHA, UNICEF), REACH, the Red Cross (ICRC), and others provided a bulk of the data, their reliability and credibility established through their longstanding work in conflict zones and water security domains.

Furthermore, data collected between 2 July to 15 July 2023, publicly available on the Syrian Water Resources Platform, was considered to provide a contemporary perspective on the situation. These

data provided a detailed understanding of the situation of water stations in Northeast Syria, and were crucial to the quantitative aspect of this study. While the comprehensive tables obtained from these datasets are exhibited in the Appendix, the implications of the data in the tables are elucidated in the body of the thesis (in section 4. The Impact of War on Northeast Syria's Water Infrastructure).

3.4. Data Analysis

The data analysis phase employed a mixed-method approach, integrating both qualitative and quantitative techniques — employing mainly the qualitative approach:

- Qualitative Analysis: Central to understanding the broader narratives, this involved a meticulous coding process, theme extraction, and interpretation of textual data. Researchers such as Miles and Huberman (1994) emphasize the importance of systematic qualitative analysis in identifying underlying meanings, patterns, and relations within data.
- Quantitative Analysis: Quantitative data, primarily in tables, offered tangible metrics on the functioning status of water stations across Northeast Syria. Such quantitative assessments are crucial for establishing the scale of damage and identifying potential areas of intervention (Bryman 2012).

3.5. Ethical Considerations

Ethics, especially in conflict research, is paramount (Clark-Kazak 2017). Given the nature of secondary data analysis, stringent adherence to ethical guidelines has been maintained throughout the study. These include ensuring proper citation and acknowledgment of all data sources, respecting the intellectual property rights of original authors, and maintaining the confidentiality

and privacy of any sensitive information. The research has striven to provide an objective analysis that contributes to the understanding and potential resolution of a grave humanitarian issue.

This comprehensive methodology has guided the study in its endeavor to provide a detailed and reliable assessment of the impact of war on Northeast Syria's water infrastructure.

4. The Impact of War on Northeast Syria's Water Infrastructure

4.1. Infrastructure Damage: A Detailed Assessment

The conflict in NES has had a profound impact on its water infrastructure, causing substantial damage to various components vital for the region's water security.

Key water infrastructure components that have been subjected to destruction include dams, water treatment facilities, pumping stations, wells, pipelines, and reservoirs (Tabor et al. 2023). The conflict has rendered many of these facilities non-functional or significantly reduced their operating capacities. As a result, access to safe and reliable water has been compromised for a significant portion of the region's population (UNICEF 2019).

4.1.1. Dams

To provide an in-depth understanding of the factors influencing the damage to water infrastructure during the conflict, this section presents two case studies: The Tabqa Dam and the Tishrin Dam. These two dams, both significant components of the Northeast Syrian water supply and electricity infrastructure, have suffered extensive damage during the conflict due to their strategic locations and roles. By examining the series of events that unfolded at these two sites, we can gain insight into the multifaceted nature of the conflict's impact on water supply infrastructure, underscoring the complex interplay of factors influencing the extent of damage.

Tabqa Dam

The Tabqa Dam, also known as the Euphrates Dam or al-Thawra Dam, is a significant water infrastructure in Northeast Syria. It has been a strategic asset due to its role in electricity generation

and water supply. However, the dam has been a focal point of conflict and has suffered considerable damage over the years, impacting its functionality and the lives of the people dependent on it.

The dam was captured by ISIS in February 2013, marking a significant achievement for the group (Daoudy 2020). ISIS threatened to retaliate against any attacks on its forces by destroying this highly strategic infrastructure (Daoudy 2020).

In 2017, the dam was a target of a major offensive by the Syrian Democratic Forces (SDF) against ISIS, which had taken control of the dam (Staff 2022). The fighting caused significant damage to the dam's structure and its operational capabilities. The SDF, with air support from the U.S.-led coalition, managed to recapture the dam from ISIS. However, the conflict led to the displacement of thousands of people living in the area due to fears of the dam's potential collapse (Staff 2022).

The dam was also struck by a U.S. Special Operations unit called Task Force 9 using some of the largest conventional bombs in the U.S. arsenal, including at least one BLU-109 bunker-buster bomb designed to destroy thick concrete structures (Philipps et al. 2022). The strikes were so severe that they knocked dam workers to the ground and caused everything to go dark. One bomb reportedly punched down five floors, causing a fire to spread and crucial equipment to fail. The Euphrates River's flow was suddenly blocked, causing the reservoir to rise and local authorities to warn people downstream to flee (Philipps et al. 2022).

The aftermath of the strikes revealed that the dam had been hit with three 2,000-pound bombs. The U.S. Central Command, which oversaw the air war in Syria, denied targeting the dam or sidestepping procedures. However, the dam workers discovered an unexploded American BLU-109 bunker-buster deep in the dam's control tower. If it had exploded, experts say, the whole dam

might have failed (Philipps et al. 2022). The strikes did damage the dam's main control room and resulted in the shutdown of the self-feeding system that controls the gates of the dam, subsequently halting all its equipment and taking the electricity generations out of service (Hanoush 2017).

Fig. 4 An image published by the Islamic State's news agency on the day of the bombing in 2017. Source: The New York Times

Fig. 5 An image published by the Islamic State's news agency the day of the bombing
Source: The New York Times

Fig. 6 A coalition missile penetrated five stories of the dam's north tower. Two missiles on the southern tower penetrated three floors down
Source: Azmat Khan, The New York Times

Fig. 7 Critical equipment was in ruins and the dam stopped functioning entirely

Source: Delil Soleiman, The New York Times

The damage to the dam was not only physical but also had significant socio-economic implications. The dam's operation was completely halted, affecting the water supply and electricity generation for the region. The strikes also led to the displacement of people due to the fear of flooding (Philipps et al. 2022).

The Tabqa Dam has suffered significant damage due to the conflict, impacting not only its physical structure but also the lives of the people dependent on it. The scale of the damage and the parties involved in the conflict highlight the complexity of the situation in NES (Staff 2022; Philipps et al. 2022).

Tishrin Dam

Following the conflict at the Tabqah Dam, which had been a stronghold for ISIS, the Tishrin Dam similarly became a battleground (Sümer 2016). ISIS controlled the dam from 2014 until late December 2015, when the Kurdish YPG (People's Defense Units) forces launched a successful

offensive, capturing control of the dam (Sümer 2016). Despite this victory, threats from hidden Daesh cells remained, including planted explosives within the dam's structure (Sümer 2016).

As tensions escalated, concerns about the potential destruction of the dam mounted. Experts, however, noted that collapsing a large structure like Tishrin Dam, which stands at 40 meters high, would require significant amounts of powerful explosives, and such a total collapse is considered unlikely (Sümer 2016). Despite this, the potential for damage due to rising water levels within the dam remained a concern, particularly if threats from ISIS were to materialize (Sümer 2016).

By the end of December 2015, the U.S.-backed Democratic Forces of Syria, which included the Kurdish YPG militia and an Arab tribal alliance, had advanced within 20 km of the Tishrin Dam, with the aim of capturing Raqqa, a stronghold of the Islamic State (Al-Khalidi 2017). This advancement resulted in the seizure of several villages in the northeastern corner of Syria (Al-Khalidi 2017).

Fig. 8 A fighter from the Islamic State group poses next to Tishrin Dam
Source: Middle East Eye

The dam did not suffer any direct damage from the conflict. However, due to the heavy fighting and airstrikes in the area around the dam, it was believed that tremors from explosions affected the foundations and impacted the integrity of the dam (Sakran 2017). In addition to the continuous fighting, the changing control over the dam by the different parties involved affected its operations and functionality.

In the subsequent sections of this thesis, I will delve deeper into the broader implications of the damages inflicted on these critical dam structures. Recognizing that these infrastructures are intertwined with various socio-economic and environmental dynamics, it is paramount to evaluate how their disruptions reverberate across different spheres of society. Thus, I will explore the cascading effects of these damages, examining their implications on water security, public health, agriculture, as well as local and regional stability.

4.1.2. Water Stations

The water stations in the region play a crucial role in the day-to-day access to clean, potable water for millions of residents. The damage inflicted on these stations during the conflict significantly contributes to the water crisis and exacerbates public health risks. Despite the magnitude of these impacts, there exists a noticeable lack of comprehensive and detailed information regarding the extent of damage to these smaller yet critical water infrastructures.

The complexity of the conflict, limited accessibility due to security concerns, and the priority placed on immediate humanitarian needs have likely contributed to this gap in knowledge. The limited documentation and reporting on the damage to these facilities have made it challenging to assess the full extent of the water crisis in the region, complicating efforts to develop strategies for restoration, management, and resilience.

Despite the challenging circumstances, it remains vital to grasp a holistic understanding of the state of water stations across Northeast Syria. In this pursuit, the research draws on data provided by the Syrian Water Resources Platform, captured between 2 July and 15 July 2023, presenting an up-to-date snapshot of the functioning status of these facilities (see Appendix for detailed information).

The data provides crucial insights into the operational and suspended water stations across multiple governorates in the region. As of mid-July 2023, this synthesized information will be demonstrated through comprehensive tables and graphical illustrations, offering a detailed view of the current scenario.

It is worth noting that the suspension of these water stations is attributed to various factors, deeply intertwined with the complex dynamics of the ongoing conflict. These include physical damage due to the conflict, disruption of supply lines, lack of maintenance and operational capacity, and strategic manipulation of water resources.

- **Al-Hasakeh**

An analysis of water station functionality in Al-Hasakeh governorate reveals that the region possesses 364 functioning water stations compared to 63 that are currently suspended, as detailed in Table 1 in the Appendix (Syrian Water Resources Platform 2023). This translates to a significant 85.2% of the total water stations remaining in operation, while 14.8% are suspended (Fig. 10).

While the majority of stations are operational, the percentage of non-functioning stations is not insignificant and suggests an area of focus for infrastructure rehabilitation efforts.

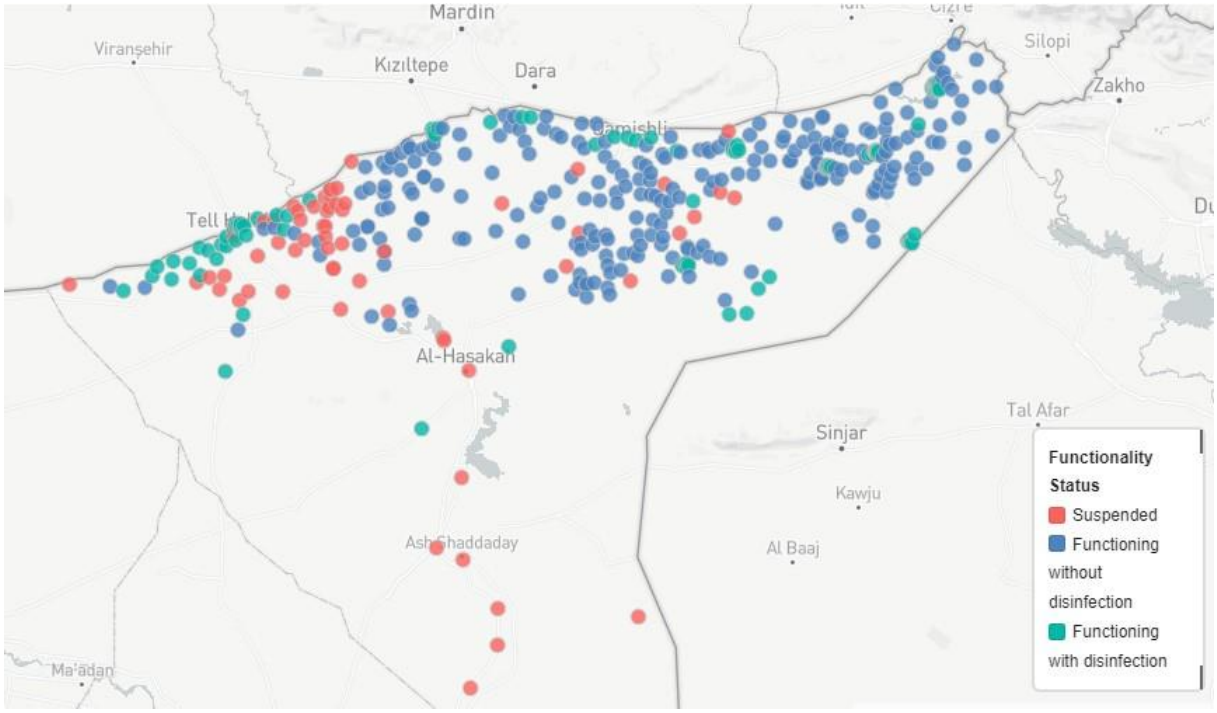

Fig. 9 Functionality status of water stations in Al-Hasakeh governorate

Source: Syrian Water Resources Platform

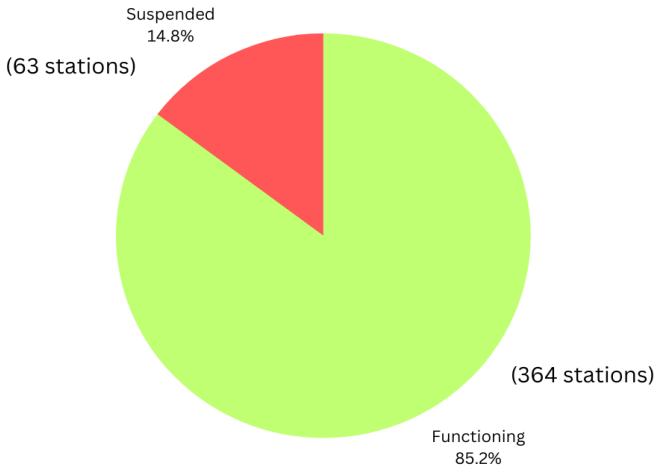

Fig. 10 The proportion of functioning and suspended water stations in Al-Hasakeh governorate as of July 2023

- **Ar-Raqqa**

In Ar-Raqqa governorate, the proportion of suspended water stations is somewhat higher than in Al-Hasakeh. Of all water stations within the governorate's subdistricts, 91 are functioning, while 31 are suspended, as shown in Table 2 in the Appendix (Syrian Water Resources Platform 2023). This results in 74.6% of the stations being operational, with 25.4% currently out of service (Fig. 12). This represents a significant challenge to ensuring consistent and sufficient water supply in the area.

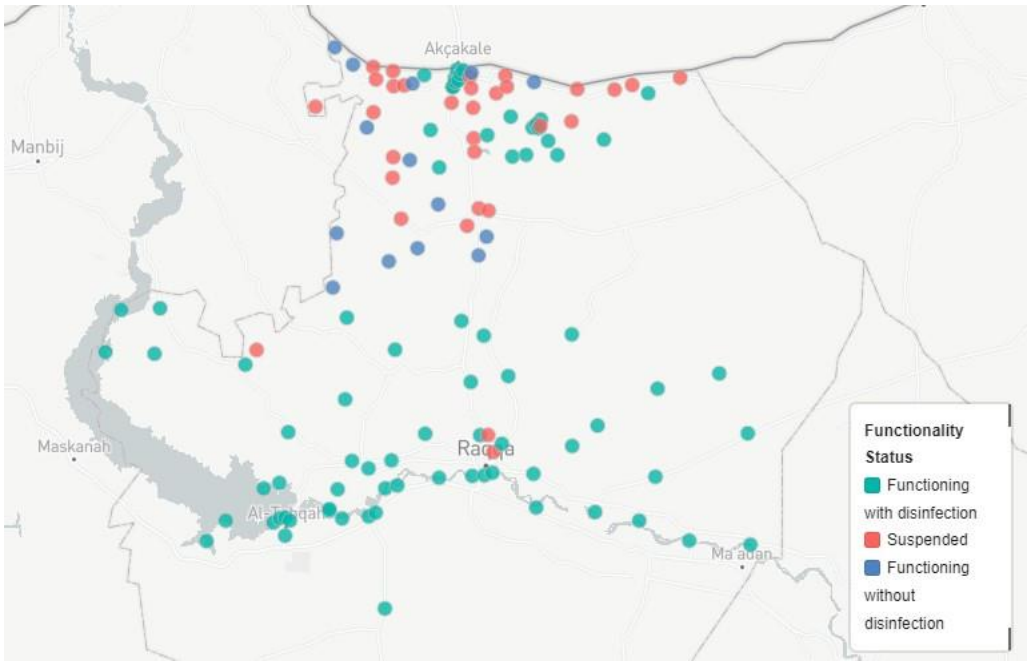

Fig. 11 Functionality status of water stations in Ar-Raqqa governorate

Source: Syrian Water Resources Platform

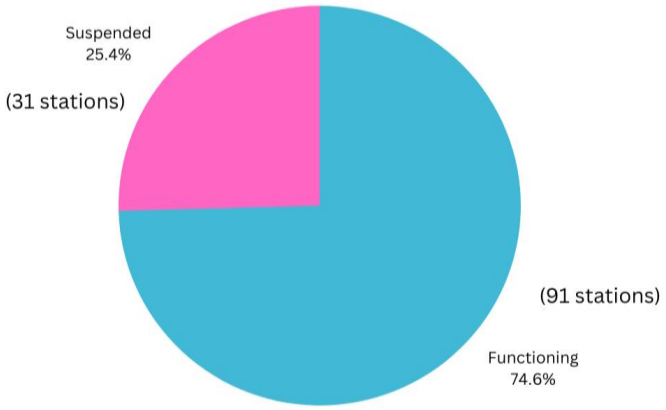

Fig. 12 The proportion of functioning and suspended water stations in Ar-Raqqa governorate as of July 2023

- **Aleppo (Northeast Syria subdistricts):**

The situation in the subdistricts of Aleppo within Northeast Syria is more severe compared to other areas. As delineated in Table 3 in the Appendix (Syrian Water Resources Platform 2023), there are 20 functioning water stations and 15 suspended ones. This means that only 57.1% of water stations are functioning, while an alarming 42.9% are suspended, as illustrated in Fig. 14. The high percentage of suspended stations underscores a critical concern in the region's water infrastructure.

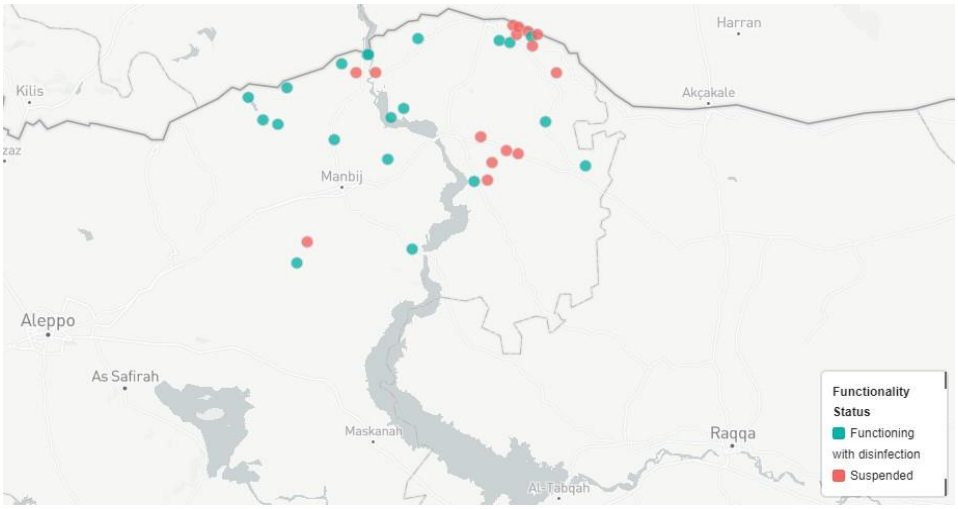

Fig. 13 Functionality status of water stations in Aleppo governorate (Northeast Syria subdistricts)

Source: Syrian Water Resources Platform

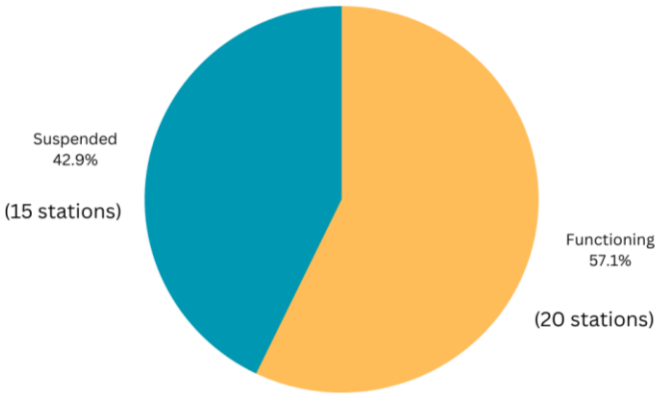

Fig. 14 The proportion of functioning and suspended water stations in Aleppo governorate (Northeast Syria subdistricts) as of July 2023

- **Deir-ez-Zor**

On a more positive note, the governorate of Deir-ez-Zor presents a unique case where all 61 water stations are currently operational, as laid out in Table 4 in the Appendix (Syrian Water Resources Platform 2023). This 100% functionality rate (Fig. 16) shows successful water station operation in the region.

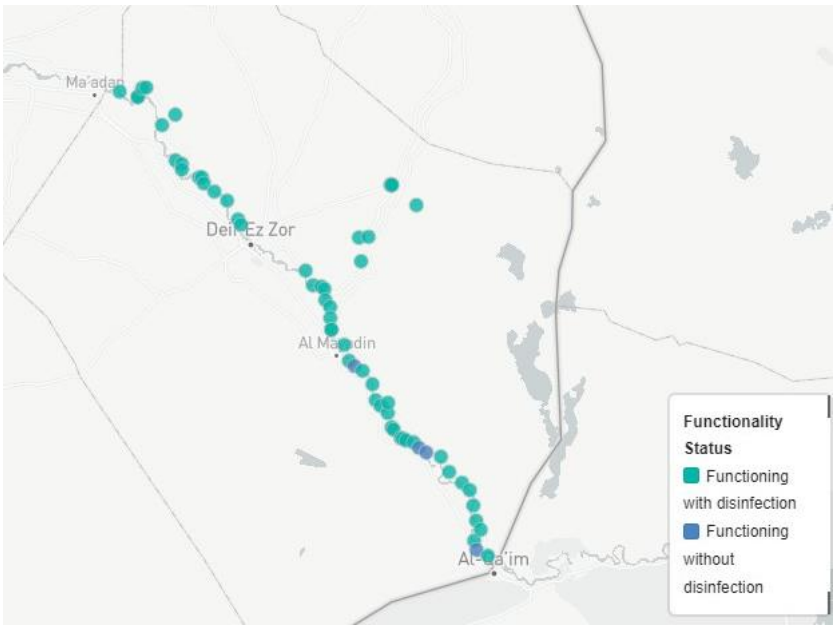

Fig. 15 Functionality status of water stations in Deir-ez-Zor governorate

Source: Syrian Water Resources Platform

However, it is essential to clarify that the functionality of these stations does not necessarily imply that they are operating at their full capacity or efficiency. Consequently, while the status is currently favorable, it remains critical to maintain and improve these stations' operational conditions, acknowledging that political, security, and maintenance factors may alter this status in the future. It is worth mentioning that this data from Syrian Water Resources Platform is from the current year and month, July 2023. However, according to other sources, there were other water stations in Deir-ez-Zor that were damaged or destroyed throughout the war such as Abu ‘Amr pumping water station (Triebert 2015). And some stations were rehabilitated by the time this data was obtained (SRTF 2022).

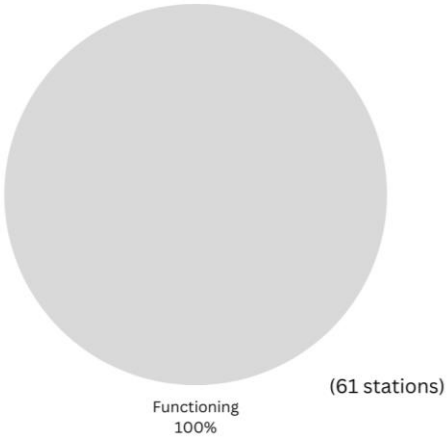

Fig. 16 The proportion of functioning and suspended water stations in Deir-ez-Zor governorate as of July 2023

4.1.3. Pipelines and Water Distribution Networks

In addition to the impairment of dams and water stations, the Syrian conflict has significantly disrupted pipelines and water distribution networks. These networks are crucial as they deliver water from sources like dams and water stations to households, industries, and agricultural lands.

Unfortunately, the extent of the damage to these pipelines and networks is not thoroughly documented, resulting in a lack of comprehensive information about the magnitude and implications of this aspect of the crisis.

During the turmoil of the Syrian conflict, vital water supply systems—including pipelines and water treatment plants—fell prey to repeated attacks, resulting in extensive damage and even total destruction. For example, a pivotal incident occurred on 10th May 2014, when a military assault halted operations at a water pumping station in Al Khafsah, Aleppo. The station and its connecting pipelines were severely damaged, thereby cutting off water access for nearly three million people and catalyzing a critical water shortage crisis (Zwijnenburg and te Pas 2015).

In 2014, vast swaths of the Aleppo and Deir ez-Zor governorates found themselves entirely devoid of running water. The region's infrastructure, including pipelines and pumping stations, had sustained significant damage, contributing to this alarming scenario. These circumstances dramatically increased the risk of disease epidemics and escalated water pollution levels. Areas that witnessed intense fighting, such as Aleppo, Deir ez-Zor, and al-Raqqa, bore the brunt of this crisis. Here, the water distribution and sanitation systems, along with power plants, were left debilitated due to the inflicted damages, leading to a crippling breakdown in the supply of electricity, water, and waste management services (Zwijnenburg and te Pas 2015).

Given the most recent data available from 2023, it's clear that the pipelines and water distribution networks within Northeast Syria remain in a state of considerable disrepair (Zaynab 2023). Despite the efforts of non-governmental organizations like People in Need, which have had substantial success in rehabilitating some water networks, a significant proportion of these infrastructures continue to be dysfunctional or inefficient (Zaynab 2023).

The ongoing water crisis is indicative of the larger infrastructural damage caused by the conflict, with numerous pipelines and water networks either severely damaged or altogether destroyed. A chronic lack of maintenance, exacerbated by the hostilities, has led to the continued disruption of these networks, making it challenging to restore these systems to full operational status. Consequently, vast swathes of the population still face difficulties in accessing clean and safe drinking water, highlighting the severity and breadth of the infrastructural damage inflicted on the region's water distribution systems.

Further aggravating the situation is the paucity of detailed documentation about the extent and nature of the damage inflicted on these water networks and pipelines. This lack of information hampers efforts towards their rehabilitation and further reinforces the urgency for comprehensive assessments of the damage to better inform subsequent restoration efforts.

4.2. Factors Influencing the Damage

The widespread damage sustained by water supply infrastructure in Northeast Syria during the conflict is attributable to several key factors, ranging from the nature of the conflict, the pre-existing condition of the infrastructure, and geographical considerations, to the actors involved in the conflict.

- **Nature of the Conflict**

The conflict's nature, characterized by intense and protracted fighting using both conventional and unconventional warfare techniques, was a critical determinant of the extent of infrastructure damage. In many instances, water infrastructure was a specific target. For example, in March 2017, the Tabqa dam found itself in the centre of a battle between ISIS, on one hand, and the SDF and the US on the other (Philipps et al. 2022). The offense resulted in great damage to the dam’s control

room and halted its functions (Philipps et al. 2022). The Al Khafsah water pumping station in Aleppo is another example — one of many. As the station became inoperable due to a military attack in May 2014, disrupting water access for nearly three million individuals (Zwijnenburg and te Pas 2015).

Indiscriminate attacks on populated areas further compounded this damage, particularly in cities like Aleppo, Deir-ez-Zor, and al-Raqqa. Beyond water supply systems, this destruction also encompassed power plants and waste management services, creating a domino effect on water infrastructure (Zwijnenburg and te Pas 2015).

It is also worth mentioning that the Syrian and Russian government forces have initiated deliberate and repeated attacks on water infrastructure in the country (Lund 2023).

- **Pre-Conflict State of Infrastructure**

The pre-existing condition of the water supply infrastructure also played a pivotal role in shaping the extent of the damage. Infrastructure in NES was already strained before the conflict due to underinvestment, inadequate maintenance, and outdated technology, making it more vulnerable to conflict-related damage. The state of pre-conflict water infrastructure in Syria is poorly documented — if documented at all.

While there is a limited amount of direct information concerning the pre-conflict state of water supply infrastructure in NES, it can be inferred based on the state of infrastructure in similar geopolitical contexts. Generally, in developing and conflict-prone regions, infrastructure is often insufficiently developed or outdated due to factors such as financial constraints, poor governance, lack of technical expertise, and inadequate maintenance. In the case of Northeast Syria, the region's arid climate and heavy reliance on the Euphrates River for water supply likely placed an additional

strain on the water infrastructure, necessitating regular maintenance and upgrades. The compounded impact of these factors might have rendered the infrastructure more vulnerable to damage once the conflict began. However, this inference needs to be substantiated with more concrete data, and the exact state of the infrastructure remains unclear due to the limited documentation available.

Furthermore, the understanding of the pre-conflict state of water supply infrastructure in Northeast Syria is informed not only by the paucity of available academic data but also by the author's personal experiences. Having resided in Syria, the author can attest to the general consensus among local inhabitants regarding the unsatisfactory state of infrastructure, reflecting the broader challenges faced by developing countries. Despite these first-hand insights, it is crucial to approach this subject with objectivity and to ground these observations in the wider context of economic and infrastructural development in Syria, as well as in similar geopolitical contexts. It is hoped that future research may corroborate these experiential insights with empirical data.

- **Geographical Factors**

Geographical factors were also crucial in determining the damage scope. Northeast Syria, with its arid climate and dependency on the Euphrates River for its water supply, saw many of its water infrastructures, such as dams and pipelines, located along this river become strategic targets during the conflict, incurring significant damage. The construction of large dams and the state's land policies, dictated by ideological and strategic concerns, benefited state-supporting elites at the expense of populations in north-eastern Syria, who suffered negative impacts including the displacement of villagers in the Euphrates basin and the exclusion of Syrian Kurds from the benefits of the agrarian reforms (Daoudy 2020, Hole and Zaitchik 2007). The north-east became

heavily dependent on agriculture and reliant on a small number of key waterworks such as the Tabqa dam. In the conditions of conflict after 2011, ISIS was able to exert legitimacy and domination over the north-east through a strategy that focused on the rapid capture of dams, in turn taking over the central government's critical function of delivering basic services such as drinking water, food supplies, and electricity (Daoudy 2020).

Moreover, the weaponization of water resources during the war was framed by key events such as the unilateral proclamation of an autonomous region of Western Kurdistan in north and north-east Syria in 2013; ISIS's public declaration of the 'Islamic State' on 29 June 2014, accompanied by the launch of massive campaigns to conquer large swathes of land and water infrastructures; and the capture by ISIS of the Tishrin and Tabqa dams in Syria in 2012 and 2013, and their recapture by the US-supported and PYD-dominated SDF in 2017 (Daoudy 2020).

- **Role of Conflict Actors**

The intricate dynamics of the Syrian conflict have resulted in a complex interplay between actors, each utilizing their own strategies to influence the course of events. Water supply infrastructures have been particularly affected by this, as they have been systematically weaponized by both state and non-state actors (Daoudy 2020). This has served to cement their control over local populations by manipulating water as a crucial resource, while also symbolizing power consolidation.

Daoudy (2020) explains that water resources and infrastructures have been used as mechanisms of domination and legitimacy, transforming them into symbolic identity markers and sources of livelihood. Such practices were not solely limited to the regime but were also employed by non-state actors such as ISIS, further complicating the situation on the ground.

Moreover, water infrastructures themselves have been weaponized as military targets, whereby their destruction or disruption inflicts significant damage on populations. Battles throughout 2013 and 2014 between regime forces and opposition groups saw significant damage to water plants and sewage pipelines across several cities, including Aleppo, Deir-Ez-Zor, Homs, Hama, Idlib, and Raqqa. As a result, approximately 35% of Syria's water treatment plants had ceased functioning by July 2014 (Daoudy 2020).

The weaponization of water also extended to its use as a military tool, with actors using water assets within their control or upon their capture to coerce populations, extract concessions from adversaries, or support tactical goals. ISIS, for instance, used water as a weapon of war by depriving civilian populations of access to safe water in the areas under its control, and as a defensive tool to hinder and constrain the operational capabilities of opposing forces (Daoudy 2020).

Even cooperation over water, seemingly a positive step, can be weaponized to the detriment of civilian populations and advancement of military objectives. During the internationalized Syrian civil war, instances of water cooperation between ISIS and the Syrian government came at a direct cost to the American-sponsored Syrian Democratic Forces, showcasing yet another facet of the water crisis in NES (Daoudy 2020).

In summary, the strategic use and weaponization of water infrastructure by different actors have critically exacerbated the state of water supply systems in NES, leaving a legacy of destruction and instability in its wake (Daoudy 2020).

4.3. Direct Implications of Infrastructure Damage

The repercussions of infrastructure damage during conflicts, particularly focusing on water, electricity, and communication systems, are severe and multifaceted. The immediate aftermath of such damage profoundly disrupts the lives of the affected population, leading to health crises, displacements, and widespread societal disruption.

A major component of critical infrastructure that suffers in times of conflict is the water supply system. As noted by the International Committee of the Red Cross (ICRC 2021), the Syrian conflict has resulted in widespread destruction of water facilities, causing acute water shortages affecting millions of individuals. This infrastructure damage has caused a drastic reduction in the availability of safe drinking water. Prior to the conflict, about 98% of urban and 92% of rural communities had reliable access to safe water. However, a decade into the conflict, this situation has reversed dramatically, with only 50% of water and sanitation systems functioning properly across Syria (ICRC 2021).

In addition to immediate water shortages, this infrastructure damage has a profound impact on sanitation and health, leading to an increased risk of epidemics due to water pollution. The REACH (2023) report indicates that waterborne diseases (WBDs) are prevalent in northeast Syria, with frequent outbreaks of diarrheal diseases and typhoid. The research by Tabor et al. (2023) reinforces this observation, proposing a hypothesis that disruptions to water infrastructure could lead to increased incidences of WBDs.

The cascading impact of water infrastructure damage in Northeast Syria extends beyond immediate water shortages, also gravely affecting electricity generation. The region primarily relies on two sources for electricity: hydroelectric dams on the Euphrates River and fossil fuels,

mainly derived from the Sweidiyeh gas power plant (REACH 2023). However, the reduction in water availability has significant implications for the hydroelectric power sector.

In April 2023, households in two-thirds of the assessed communities reported receiving six or fewer hours of electricity per day on average, as shown on the map in Fig. 17, reflecting the stark state of electricity availability (REACH 2023). Moreover, approximately 80% of communities that relied on the electricity network reported this low level of access. These alarming figures underline the extensive impact of water infrastructure damage on NES's energy infrastructure.

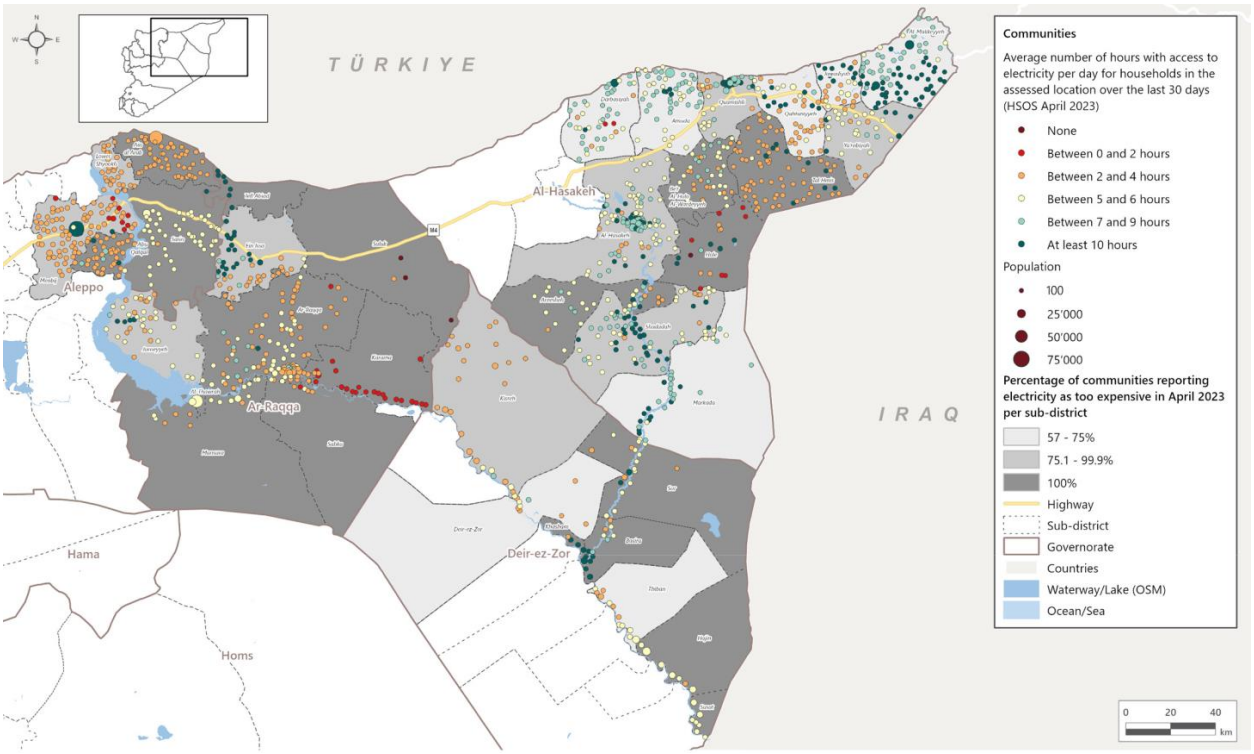

Fig. 17 Average hours of electricity access for households in communities, and percentage of communities reporting the high cost of electricity as a barrier to electricity access

Source: REACH. 2023.

Communities with relatively better electricity access predominantly relied on community generators. However, high electricity costs were frequently reported as a major barrier in these

communities and others relying on private generators (REACH 2023). Businesses in Ar-Raqqa and Al-Hasakeh cities also had to depend on multiple electricity sources due to the insufficiency of electricity from networks and community generators, further amplifying the economic burdens.

Interestingly, the reported expenditures on private generators were markedly higher than for community generators or public electricity sources. This highlights the economic disadvantage of private generators, even though electricity expenditures accounted for only a small proportion of businesses' operating costs (REACH 2023). Consequently, the lack of reliable and affordable electricity, driven largely by the degradation of water infrastructure, has emerged as a significant barrier to new job opportunities, particularly in energy-intensive sectors like manufacturing.

Communication infrastructure is also critical and suffers in times of conflict. Destruction to such systems hampers coordination efforts among humanitarian groups and disconnects families and communities, exacerbating the already dire situation. While the literature on communication infrastructure damage is lacking, it is well understood within the context of conflict and infrastructure damage that such effects are common and severe.

Residential and public buildings' destruction, another facet of infrastructure damage, has immediate and severe consequences for the inhabitants. Displacement, loss of livelihood, and increased vulnerability are some of the direct results. The ICRC (2021) report describes a situation of increased instability in conflict-heavy areas due to water scarcity and infrastructure damage. In northeast Syria, for example, daily water shortages affect at least 700,000 people, exacerbating an already dire situation for internally displaced persons (IDPs), refugees, and other vulnerable populations.

The ICRC (2021) further notes the intricate interplay between conflict, climate change, and infrastructure damage. Conflict-affected countries are disproportionately impacted by climate change, which further aggravates the availability and quality of water. This complicates efforts to rebuild and maintain critical infrastructure.

In conclusion, the direct implications of infrastructure damage in conflict zones like Syria, and particularly NES, are far-reaching and profound. They touch upon every aspect of daily life, from the availability of essential resources like water and electricity to public health, communication, and housing. The immediate impacts of such destruction are a stark reminder of the importance of preserving and protecting critical infrastructure during conflicts, in line with international humanitarian law. The comprehensive mitigation of these effects necessitates the engagement of various actors, including humanitarian organizations, development agencies, and the private sector, in reconstruction and response efforts (ICRC 2021).

4.4. Indirect and Long-term Impacts of Infrastructure Damage

While the direct impacts of infrastructure damage during conflicts are critical, the indirect and long-term effects can be equally, if not more, damaging. Such impacts often manifest over extended periods and influence a multitude of areas, from public health to socio-economic stability and environmental sustainability.

One of the most pervasive indirect effects of infrastructure damage is on public health. Beyond the immediate risks associated with waterborne diseases due to disrupted water supply (REACH 2023; Tabor et al. 2023), long-term public health implications can emerge. For instance, the inability to maintain personal hygiene due to limited water access can lead to skin diseases and other health complications (ICRC 2021). Similarly, the consistent lack of access to electricity can hamper

critical health services such as surgery, refrigeration of medications, and routine medical procedures (ICRC 2021).

In addition to public health, the damage to critical infrastructure during conflict can indirectly affect the socio-economic stability of a region. As outlined by the Humanitarian Practice Network (HPN 2021), the destruction of infrastructure and the subsequent challenges in reconstruction impede economic recovery post-conflict. The reduced availability of essential resources like water and electricity limits productive activities, affecting the local economy and livelihood opportunities. The disruption of communication networks also poses challenges for economic activities, affecting commerce and trade on both local and broader scales (HPN 2021).

The displacement of populations, a direct result of infrastructure damage, has long-lasting implications as well. A high percentage of displaced populations may struggle to reintegrate into society post-conflict due to the loss of homes and livelihoods. Displacement can also lead to overcrowded living conditions in undamaged areas, resulting in strained resources and increased social tensions (ICRC 2021).

Moreover, the environmental implications of infrastructure damage during conflict must not be overlooked. Damage to water infrastructure, such as wastewater treatment facilities, can lead to the contamination of groundwater resources (ICRC 2021). This could result in the degradation of ecosystems and negatively affect biodiversity in the long run. Additionally, the reduced ability to manage waste effectively due to damaged infrastructure contributes to pollution and environmental harm (HPN 2021).

Furthermore, infrastructure damage could have long-lasting impacts on education. The destruction of schools, for example, not only disrupts education in the short term but also hampers educational

outcomes in the long run. According to HPN (2021), destroyed or damaged schools can take many years to rebuild, and during that time, children are deprived of consistent education, affecting their development and future opportunities.

In conclusion, the indirect and long-term impacts of infrastructure damage in conflict zones are complex and extensive, affecting many aspects of life and the environment. These impacts underscore the importance of protecting infrastructure during conflicts and the need for comprehensive, long-term strategies for post-conflict reconstruction and recovery. Addressing these issues requires not only the efforts of humanitarian and development agencies but also the commitment of all parties involved in conflicts to adhere to international humanitarian law and protect critical infrastructure (ICRC 2021).

5. Impacts on Water Security in Northeast Syria

The complex interplay of conflict and water scarcity in Northeast Syria presents a significant challenge to water security in the region. This chapter delves into the multi-faceted impacts of the water crisis, brought on by the interrelated effects of infrastructure damage, shifting dynamics of water availability, and subsequent quality issues. Through an exploration of these impacts, we discern not only the immediate effects but also the long-term consequences that extend beyond physical water scarcity, touching upon socio-economic aspects and health implications. Additionally, this chapter contemplates the region's prospects for recovery, with a lens focused on sustainability and resilience.

5.1. Effects on Water Availability and Access

The conflict in Syria has profoundly altered the dynamics of water availability and access, especially in the Northeast region of the country. The violation of the infrastructure that supports water provision has resulted in a significant decline in water availability and created barriers to access for many communities (REACH 2023).

According to the International Committee of the Red Cross (ICRC 2021), numerous water supply systems in Northeast Syria have been damaged or entirely destroyed due to the conflict. Crucial infrastructural elements, such as pipelines, pumping stations, and water treatment facilities, have borne the brunt of military operations. This widespread infrastructural damage has interrupted water supplies, leading to severe water shortages in many areas (ICRC 2021). For example, the Allouk water station, a vital supply point for many communities, has repeatedly suffered damages, impacting its ability to provide consistent water services (REACH 2023).

The Alouk water station, a vital water source located in Al-Hasakeh Governorate, has been at the center of the region's worsening water crisis. This station, which used to provide clean drinking water to nearly a million people, has been mired in problems, with numerous disruptions affecting its operational capacity (OCHA 2021; UN 2021). The Alouk water station suffered directly and indirectly from the conflict. A culmination of issues, such as limited access for technical teams, electrical failures, and region-wide power shortages, have pushed the station to its limits, leading to complete cessation of operations on several occasions (OCHA 2021).

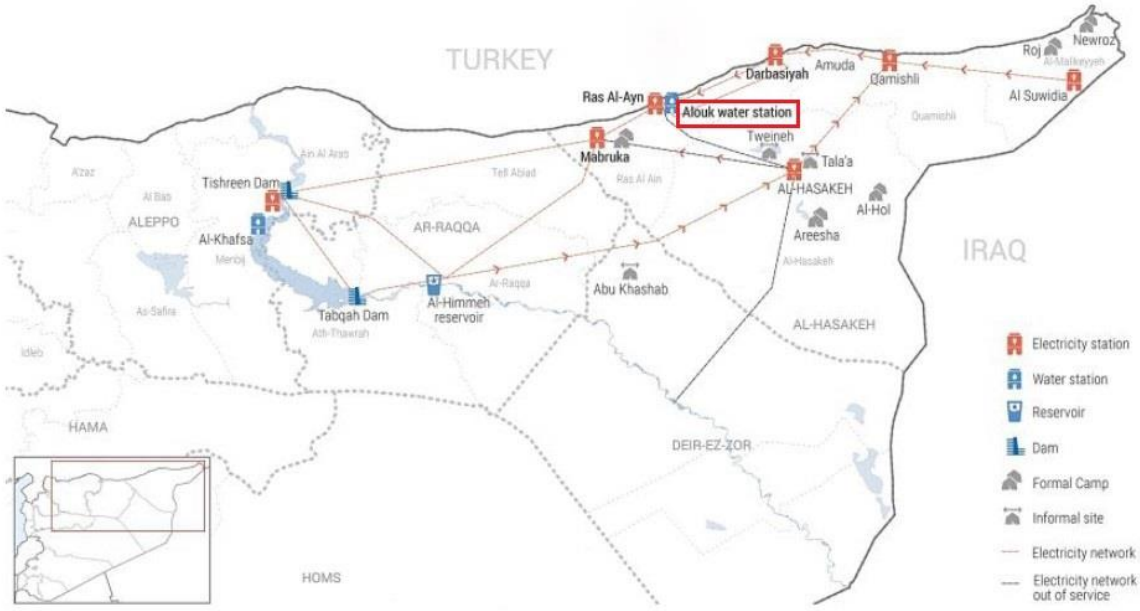

Fig. 18 Alouk water station location in Al-Hasakeh

Source: OCHA. 2023.

According to reports, the Alouk station's operational hiatus on June 23 was the 24th disruption recorded since November 2019 (OCHA 2021). This recurrent water supply interruption has grave implications for the region's populace, with an estimated 460,000 people directly dependent on Alouk for potable water. The station also fuels water trucking operations serving an additional 500,000 people, including those residing in six Internally Displaced Persons (IDP) camps (OCHA

2021). The situation has only got worse, and currently, the station functions at less than 50% capacity, affecting up to a million people, including 100,000 people in IDP camps and settlements (OCHA 2022).

The maps in Fig. 19 and Fig. 20 show the primary source of water for all purposes and for drinking, in communities and in informal settlements, respectively. It can be seen that the areas that previously relied on Alouk water station for their water supply now rely on water trucking — these are the communities in light blue around Al-Hasakeh city (REACH 2023). It was reported that households in these areas spend 7% of their monthly income on water in the second half of 2022, which exceeds the internationally accepted standards (REACH 2023).

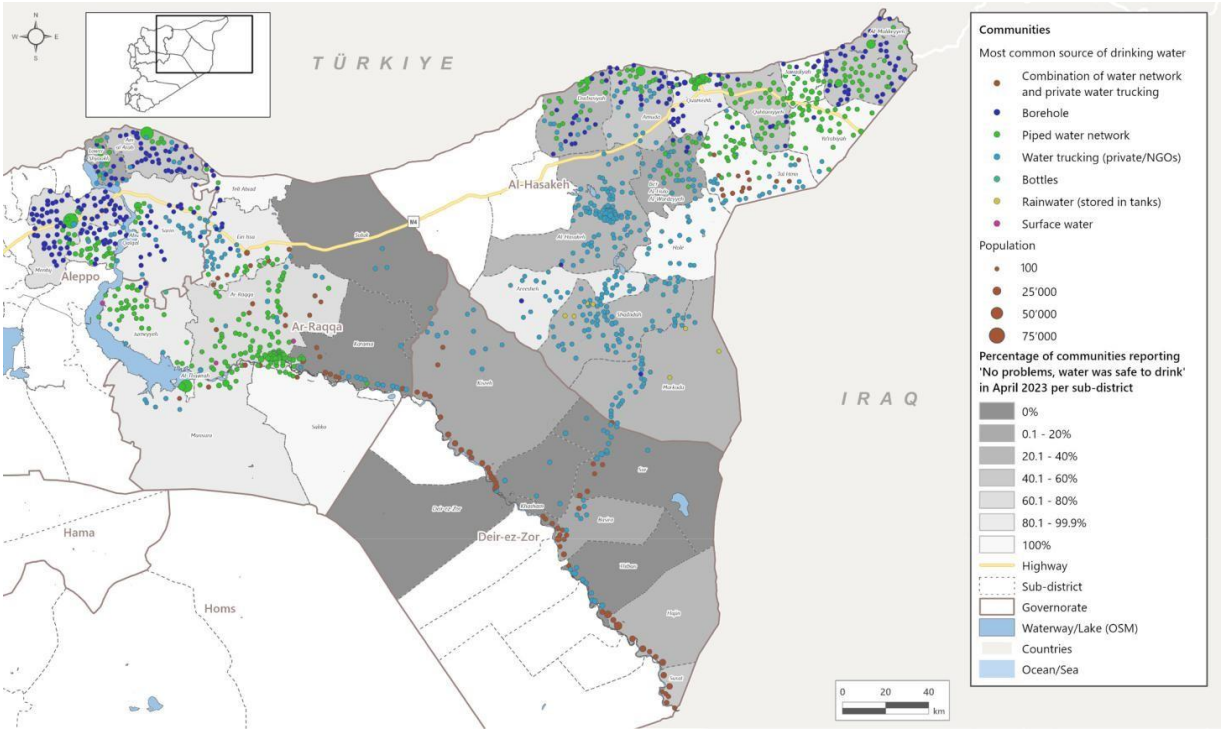

Fig. 19 Primary source of drinking water in communities, and percentage of communities in the sub-district

Source: REACH. 2023.

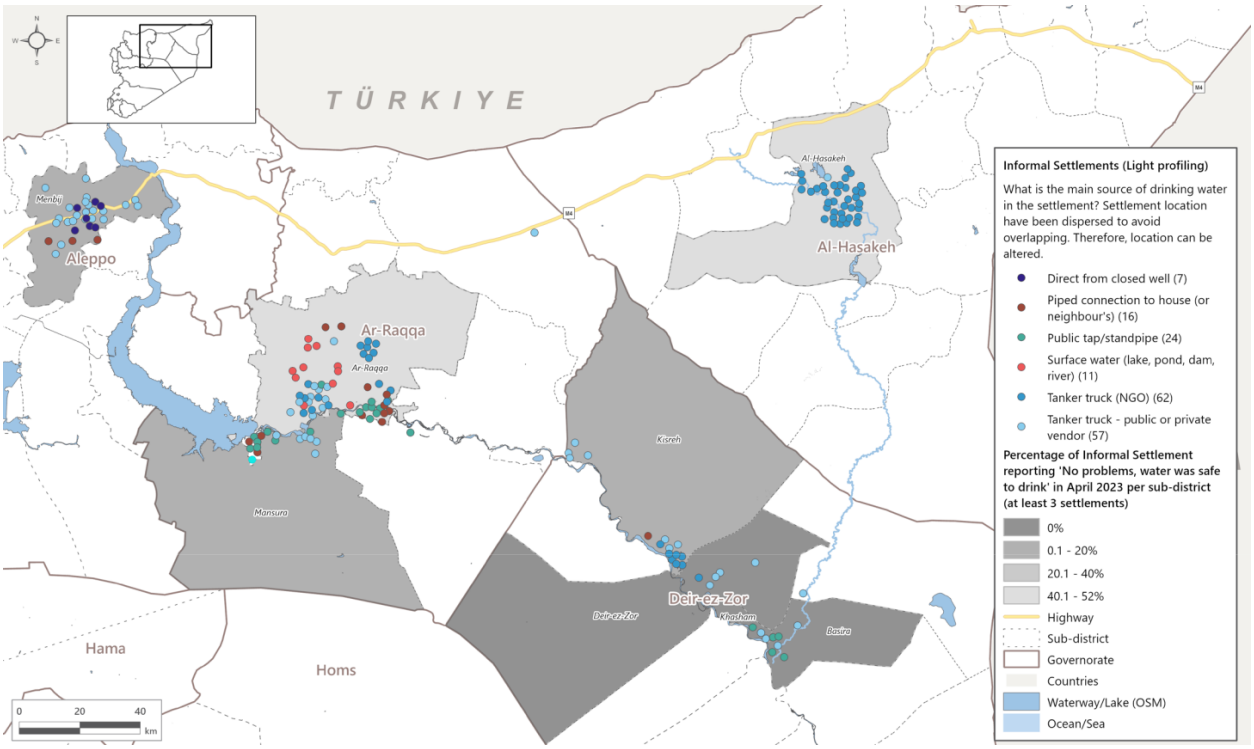

Fig. 20 Primary source of drinking water in informal settlements and collective centres, and percentage of informal sites in the sub-district

Source: REACH. 2023.

The consequences of conflict have also created barriers to water access, beyond the physical availability of water. Control over water points has emerged as a strategic tool in the conflict, resulting in further inequities in water access (HPN 2021). In some areas, communities have been denied access to water as a method of warfare, creating a scenario where water availability is controlled and manipulated to further political or military objectives (HPN 2021). Moreover, the volatility of the conflict situation has led to mass displacements, resulting in an influx of internally displaced persons (IDPs) in certain areas. This sudden surge in population places additional stress on the already strained water resources, exacerbating water scarcity and limiting access for both the host and displaced communities (REACH 2023).

Tabor et al. (2023) note that this decline in water availability and access is not evenly distributed. Some areas have been hit harder than others, resulting in pockets of severe water scarcity.

Inequities in water access, both within and between communities, have widened during the conflict, heightening social tensions and potentially sowing the seeds for future conflicts over resources.

The water crisis in NES has reached a critical point, with larger internally displaced persons (IDPs) camps being significantly affected. Despite the intervention of non-governmental organizations (NGOs), water access remains a major challenge in these camps, which are home to about 20% of the IDPs in Northeast Syria (REACH 2023). In some camps, such as Areesha, the situation escalated to the point where an estimated 25% of households went without water for two consecutive days in August 2022, a sharp rise from 11% in February of that year (see figure 21) (REACH 2023).

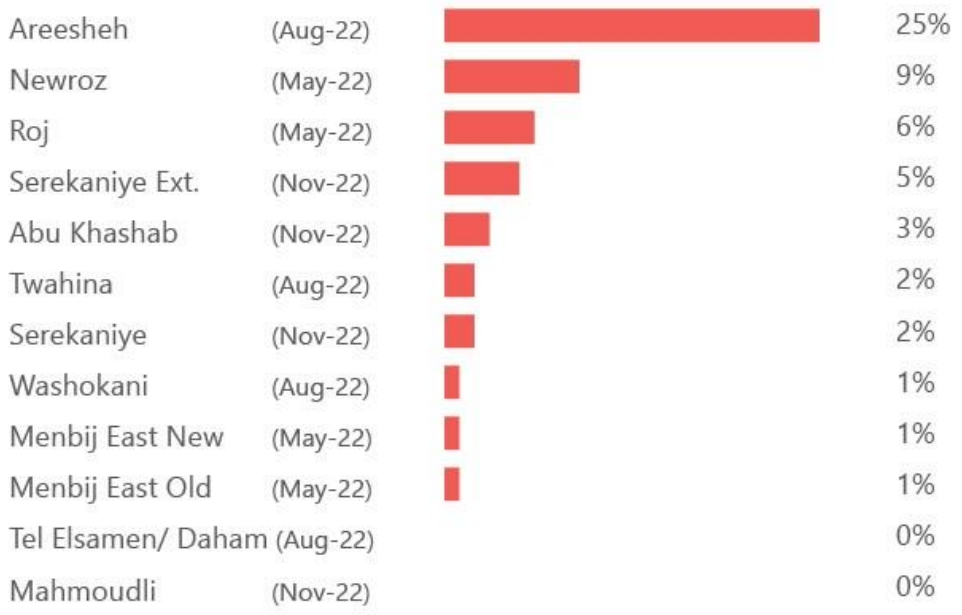

Fig. 21 Proportion of households that went 2 consecutive days without access to water in IDP camps

Source: REACH. 2023.

While public taps or standpipes were available in most camps, there were notable inconsistencies in water access from one camp to another. The report from REACH (2023) revealed that it was

uncommon for households in most camps to report a lack of water access for two consecutive days. Nonetheless, there were exceptions, underscoring the severity of the situation.

Furthermore, the data suggests that even when water was available, it was not necessarily sufficient for households to meet their needs. This led to the adoption of coping strategies, such as modifying hygiene practices and storing water. These measures indicate the extent to which the water crisis has forced households to compromise on their hygiene, exacerbating the health and sanitation issues in these communities (REACH 2023).

5.2. Effects on Water Quality and Health Implications

The conflict in NES has not only affected water availability and access but also significantly undermined water quality. This deterioration of water quality has critical implications for public health and exacerbates the vulnerabilities of affected communities (REACH 2023; Tabor et al. 2023).

Infrastructure damage from the conflict has had a major impact on water treatment processes, consequently affecting the quality of water available to the population (ICRC 2021). With the destruction of water treatment facilities, water purification processes have been disrupted, leading to an increased prevalence of untreated or poorly treated water in supply systems (ICRC 2021).

As noted by the Humanitarian Practice Network (HPN 2021), the conflict's destabilizing effects have also disrupted routine water quality monitoring and assessment activities. This lack of regular monitoring means that contamination incidents often go unnoticed until they result in observable health effects in the population.

Additionally, due to the unavailability of clean water sources, many communities have been forced to rely on alternative water sources such as untreated surface water or groundwater from unprotected wells. These sources are often contaminated with pathogens or chemicals, leading to a higher risk of waterborne diseases (REACH 2023). The risk of waterborne diseases spreading is high due to the lack of appropriate sewage management and households' reliance on untreated water sources (REACH 2023).

According ro the report by REACH (2023) the persistent gaps in households' access to Water, Sanitation, and Hygiene (WASH) services facilitated the spread of cholera. Despite there being no obviously recognizable trend in waterborne diseases over the past two years, the outbreak of cholera in September 2022 indicates the severity of the WASH situation and the high risk of waterborne disease spread (REACH 2023). As of April 2023, the whole of Syria has seen over 100,000 suspected cases and 100 suspected cholera deaths. In NES specifically, almost 22,000 suspected cases have been reported, among these, there were 23 fatalities (REACH 2023). The correlation between the source of drinking water and the presence of waterborne diseases in NES has proven to be quite interesting. Communities, as well as internally displaced people (IDP), that rely on water trucking as their primary source of drinking water have reported the highest number of cases where water was perceived to be making people sick (Fig. 22). The reason is that the water provided by private trucking is not actually monitored and might be unsafe to drink (REACH 2023).

The Euphrates, which is the main source of surface water in Northeast Syria, is having raw sewage discharged into it (EPC 2022; REACH 2023). This has not only environmental consequences but also a significant impact on public health in NES. Many communities rely on the Euphrates not just for irrigation, but as a source of drinking water. A few IDP sites, particularly in Ar-Raqqa

governorate, where surface water is the main source of drinking water have reported cases of perceiving water to be making people sick (see Fig. 23) (REACH 2023). This problem is probably made worse due to the declining levels of water in the Euphrates, making the concentration of the cholera bacteria higher which subsequently leads to a higher risk of being infected with the disease (REACH 2023).

Moreover, the damaged sanitation infrastructure and insufficient waste disposal have led to increased contamination of water sources (Tabor et al. 2023). The breakdown of sanitation systems has resulted in sewage seepage into water bodies and groundwater sources, elevating the risk of waterborne diseases and other health issues related to poor water quality.

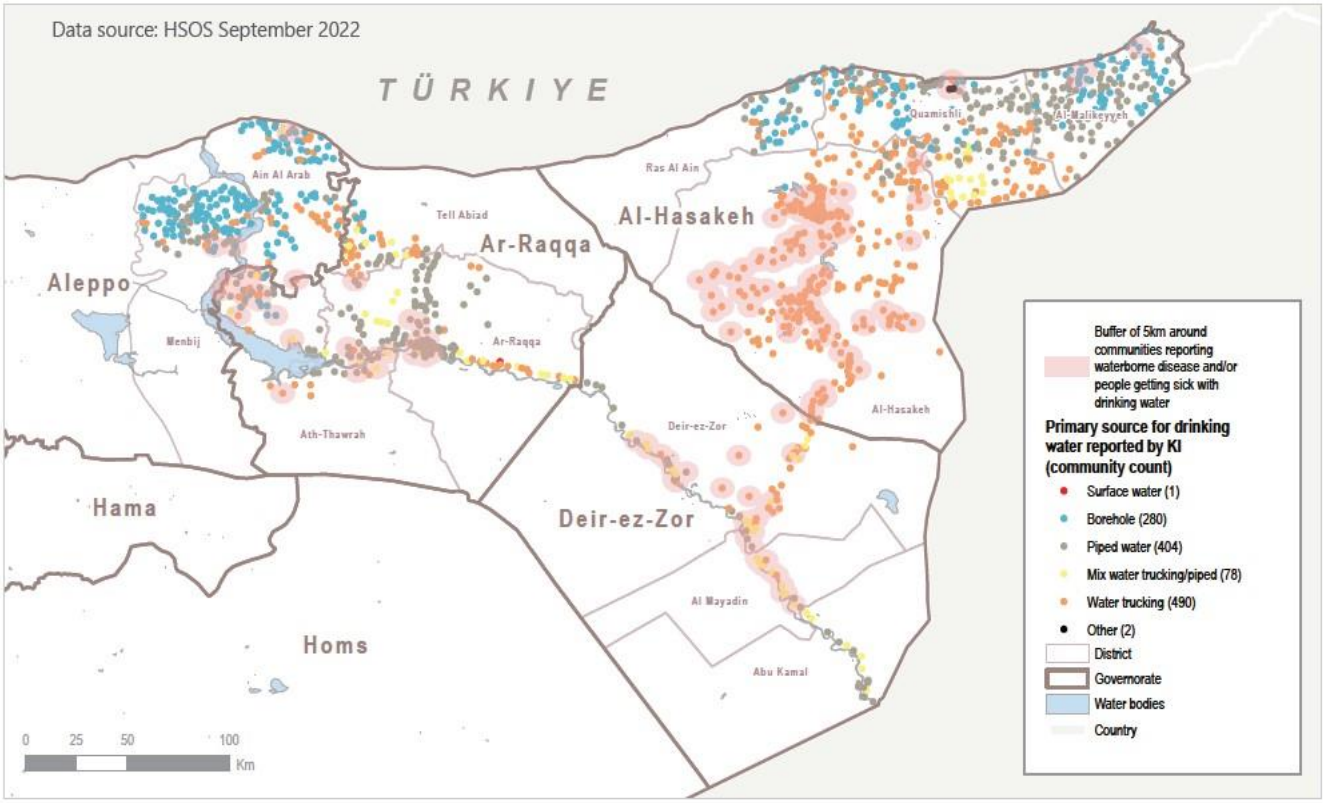

Fig. 22 Main source of drinking water in communities and presence of waterborne disease
Source: REACH. 2022.

These factors collectively contribute to a significant deterioration of water quality in NES leading to an increased public health risk. These effects highlight the need for immediate actions to repair and rehabilitate water and sanitation infrastructure, improve monitoring of water quality, and enhance community awareness and resilience to water-related health risks in the post-conflict phase.

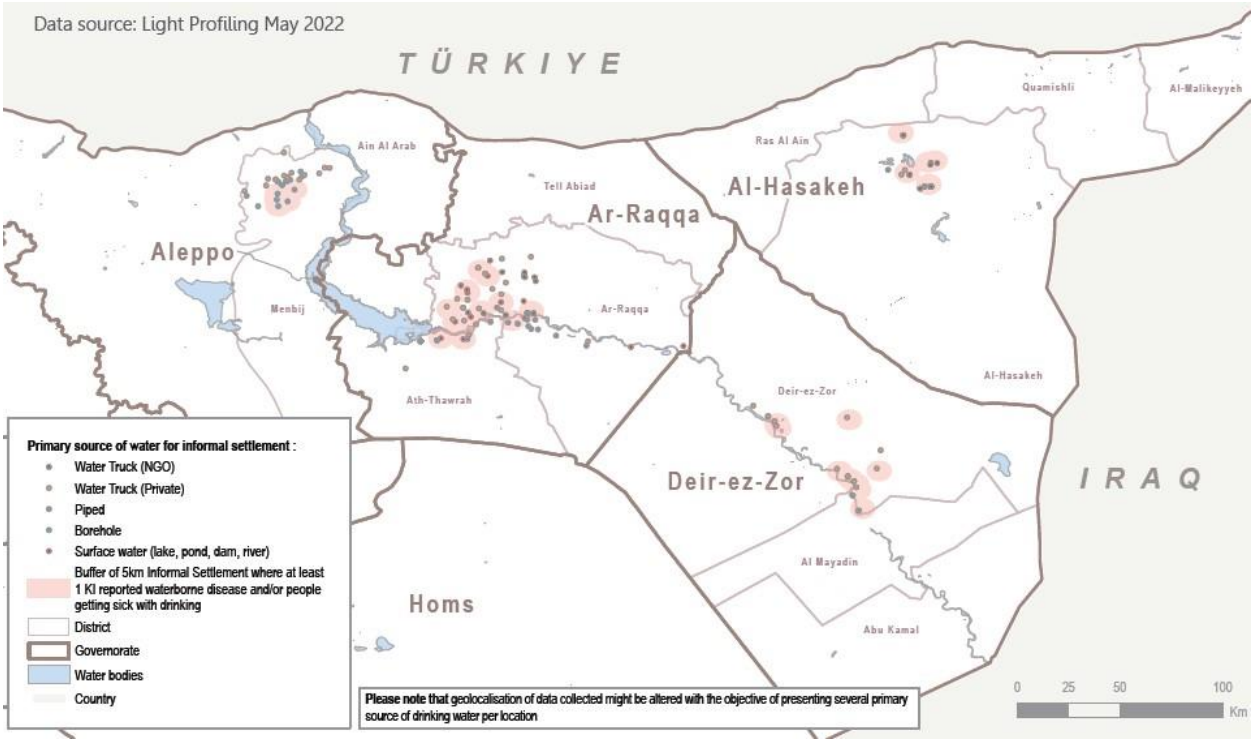

Fig. 23 Main source of drinking water in IDP sites and presence of waterborne disease

Source: REACH. 2022.

5.3. Broader Socio-economic Implications

The ramifications of the conflict-induced water crisis in Northeast Syria extend well beyond the immediate water availability and quality issues, triggering a cascade of socio-economic and health implications that affect the lives of individuals and the functioning of communities in profound ways.

The water crisis has exacerbated the food insecurity situation in Northeast Syria. Insufficient water for irrigation has resulted in reduced agricultural productivity, leading to higher food prices and decreased access to nutritious food (HPN 2021). This lack of water has long-term consequences on local economies, particularly for agrarian communities for whom crop and livestock farming are primary sources of income (Tabor et al. 2023).

This situation affects food security and the production of food, especially when put in context with the frequent droughts and extreme weather events attributed to climate change. The limited availability of water has had a detrimental effect on crop growth and agricultural livelihoods, further compromising food accessibility and contributing to the inflation of food and commodity prices (OCHA 2022).

While food continues to be available in NES, it is widely unaffordable. High production costs, low yields, and high import costs mean that despite food being generally available in NES, it is widely unaffordable (REACH 2023). By May 2022, the median household was consuming around 75 USD worth of food each month while the median monthly household income was 153 USD, meaning that around half of households' money was going towards paying for food (REACH 2023). This is particularly concerning as a quarter of households were skipping meals, and a quarter prioritizing the feeding of vulnerable household members (REACH 2023).

The economic implications of this are far-reaching. The economy of NES is built up around the primary sector, specifically around fuels and agriculture. The production losses in the agricultural sector severely affect the estimated 18% of the employed population working in the agricultural sector (REACH 2023). This is particularly the case as the majority are self-employed. High

operational costs are the key barrier to agricultural livelihoods, limiting farmers' abilities to generate incomes (REACH 2023).

Additionally, water scarcity and contamination issues have resulted in an increased burden on women and children, who in many societies are responsible for water collection (REACH 2023). As water sources become more scarce or distant due to the conflict, these individuals spend more time and energy on water collection, contributing to their physical exhaustion and limiting their opportunities for education and economic participation (REACH 2023).

Furthermore, the lack of adequate water for sanitation and hygiene has led to unhygienic living conditions, further amplifying the risk of communicable diseases (ICRC 2021). It has also heightened the vulnerabilities of certain groups, including the disabled, elderly, and internally displaced persons, who face additional challenges in accessing sanitation facilities and maintaining personal hygiene (REACH 2023).

The impacts of the water crisis on socio-economic conditions are multi-faceted and reinforce the complexities and challenges faced by communities in NES. It underscores the necessity of integrated and holistic approaches in addressing water security issues in the region, focusing on not just the direct but also the indirect and far-reaching effects of the crisis.

5.4. Long-term Consequences and Prospects for Recovery

The prolonged water crisis in Northeast Syria, exacerbated by conflict-related infrastructure damage, will likely have enduring implications on the region's water security. While the immediate effects are indeed severe, it is the long-term consequences that threaten the region's potential for recovery and future stability.

One of the primary long-term implications of this crisis is the degradation of the region's water resources. Excessive reliance on groundwater due to the destruction of surface water infrastructure, coupled with the lack of regulation and management, has led to the over-extraction of groundwater reserves (Tabor et al. 2023). This over-extraction can result in land subsidence and the salinization of groundwater, causing irreversible damage to the resource base and posing severe risks to future water availability (HPN 2021).

Furthermore, the disruption of education, specifically in relation to water and sanitation hygiene practices, presents a significant long-term concern. The knowledge and practice of proper hygiene are essential in preventing disease outbreaks and ensuring the health of communities. With the education system disrupted due to the conflict, generations may grow without this vital knowledge, resulting in the persistence of unhygienic practices that can impact community health and disease prevalence (REACH 2023).

The water crisis also has far-reaching economic consequences. As noted in section 5.3., the agricultural sector, heavily reliant on water availability, is one of the most affected. In the long run, the decline in agricultural productivity could precipitate significant changes in the region's economy and employment patterns, leading to increased poverty and economic instability (Tabor et al. 2023).

Despite these challenges, prospects for recovery exist. The post-conflict recovery phase will require robust and coordinated efforts from local, national, and international actors to rebuild the region's water infrastructure. Emphasis must be placed on sustainable practices and the development of resilient systems capable of withstanding future shocks (ICRC 2021).

Solutions also lie in the promotion of water conservation practices, the regulation of groundwater extraction, and the use of alternative water sources such as rainwater harvesting (HPN 2021). Concurrently, investment in education can ensure that future generations are equipped with the knowledge to manage water resources sustainably and maintain good hygiene practices (REACH 2023).

While the long-term consequences of the water crisis in Northeast Syria are formidable, with targeted and well-coordinated efforts, recovery and a future of water security in the region is achievable.

6. Response and Mitigation Strategies

6.1. Local Response Mechanisms

The battle for survival against the twin problems of water scarcity and infrastructure damage in Northeast Syria has led to a multifaceted local response characterized by resilience, innovation, and dependence on external aid. One of the major factors in the survival of local communities has been the relative success of humanitarian interventions in providing access to water. However, these efforts have not been sufficient to overcome severe gaps in the WASH (Water, Sanitation, and Hygiene) systems (REACH 2023)..

Despite these efforts, there are distinct variations in the challenges faced across different areas in the region. In the Rweished area in Deir-ez-Zor governorate, the local water station, which sources water from groundwater and the Euphrates, is non-operational due to a lack of funding and capacity. This has led to households incurring high water expenditures and has resulted in poor water quality that has caused health issues such as diarrhea and skin diseases (REACH 2023).

Meanwhile, in the Tal Brak area of Al-Hasakeh governorate, the primary source of water is groundwater from a nearby water station. Here, the problem lies not in the source but in the distribution, as the insufficient availability of electricity prevents adequate water pressure to pump water to households at the end of the pipelines. These households rely instead on regular water trucking (REACH 2023). The lack of electricity also contributes to frequent equipment failures at the water station (REACH 2023).

Urban areas such as Al-Hasakeh and Ar-Raqqa cities face unique challenges due to significantly different water supply systems that impact households' access to sufficient amounts of safe water

(REACH 2023). NGOs have been instrumental in these areas, supporting water stations by retrofitting them to reach lower water tables and providing essential water to residents when the water network is offline (REACH 2023).

One area of focus for these NGOs has been reducing water consumption in agriculture, the single largest consumer of fresh water (REACH 2023). They have worked towards this through various initiatives, such as establishing greenhouses, implementing efficient irrigation systems, and providing solar panels to power irrigation pumps (REACH 2023). But, they have also recognized that more is needed, including raising awareness among residents about water conservation and how to respond to water crises, and helping farmers reduce their water usage (REACH 2023).

Local organizations such as the Syrian Arab Red Crescent (SARC) have also been a cornerstone of the response effort. Providing life-saving and life-sustaining health services across a network of 150 health facilities to over one million patients, SARC has been able to reach 80% of the Syrian population, including NES, with safe water through the treatment and maintenance of damaged water infrastructure (IFRC 2021). In 2020, SARC implemented 41 different water and rehabilitation projects, which accounted for 15% of all water projects across the country (IFRC 2021).

The local response mechanisms in Northeast Syria have exhibited a resilient and innovative combination of strategies to cope with the water scarcity and infrastructure damage. These strategies are not without their challenges, but they serve as a testament to the strength of these communities and their commitment to overcoming adversity. However, the urgent need for more sustainable and long-term solutions to the water crisis in the region remains.

6.2. National and International Intervention

The national and international response to the water crisis in Northeast Syria has been multifaceted, involving various modalities and coordinated efforts.

- **Overview of National and International Response**

In response to the escalating water crisis in northern and Northeast Syria, an area predominantly under the control of the Autonomous Administration of North and East Syria (AANES), also known as Rojava, a cooperative and strategic approach is paramount. The AANES, a de facto autonomous region with limited control by the Syrian regime, plays a pivotal role in managing the crisis locally (Abdulqader 2021; Allsopp and Van Wilgenburg 2019). However, the scale of the problem necessitates international intervention.

In September 2021, acknowledging the severity of the situation, the United Nations and its partners unveiled a comprehensive response plan, which took into account the unique geopolitical context (OCHA 2022). The plan, requesting US$200 million, aimed to assist up to 3.4 million people out of the over five million estimated to be affected within the AANES jurisdiction (OCHA 2022).

Building upon this, a revised water response plan was included within the Syria Humanitarian Response Plan for 2022-2023. This plan ambitiously targets to assist 5 million people by December 2022, necessitating a budget of $226.2 million. The plan is holistic, taking into account needs across all sectors of response within Syria, testifying to the complex and interrelated nature of the crisis (OCHA 2022).

The response strategy has been divided across various sectors, each with distinct activities, targets, and financial requirements. For instance, the strategy includes the creation of both long and short-

term work opportunities during the rehabilitation of public and private infrastructure. Providing market-based modalities of assistance to vulnerable households also forms part of the strategy. Funding requirements for these and other initiatives for the second half of 2022 amount to $20,661,912, leaving a funding gap of $11,024,358 that must be bridged to ensure the success of these vital operations (OCHA 2022).

In response to the WASH risks, significant efforts have been undertaken to ensure the health and safety of the population. For instance, in an attempt to forestall a second wave of cholera during the summer, UNICEF and partners have distributed more than 683 tons of sodium hypochlorite as a cholera prevention measure across the country. This action has helped to increase the free residual chlorine dosage and concentration, providing 13.5 million people nationwide, including in NES, access to safe and clean water since the beginning of September 2022 (UNICEF 2022).

In addition to these measures, clean water is being trucked to locations where access to water remains a significant concern, such as Al-Hasakah. At the same time, organizations like UNICEF are assessing the additional need for sodium hypochlorite or other relevant chemicals to ensure the water provided through these trucks is safe for consumption (UNICEF 2022).

The necessity for international and local collaboration in mitigating the water crisis was underscored by the inaugural International Water Forum held in Al-Hasakeh, Northeast Syria, in September 2021 (Schwartzstein and Zwijnenburg 2022). The forum became a critical dialogue platform for international organizations, local scholars, community leaders, and civil society groups. During the forum, discussions centered around the root causes and potential solutions to pressing issues such as water insecurity, agricultural decline, and pollution (Schwartzstein and Zwijnenburg 2022). The forum's conclusion led to a call for international pressure on Turkey to

reverse its policies and breaches of laws related to water resources. It also appealed to the Autonomous Administration to engage in dialogue and cooperation with relevant authorities, including those in Iraq, Syria, and international organizations (Schwartzstein and Zwijnenburg 2022; Abdulqader 2021).

Simultaneously, grassroots initiatives have been gaining momentum in the region. Several communities across the northeast have taken proactive measures, such as initiating or expanding tree planting projects, in response to the water crisis. Furthermore, local activists have shown a growing interest in conducting environmental and climate change research, hinting at a potential grassroots shift towards environmental conservation and water and food security, provided they receive sufficient support (Schwartzstein and Zwijnenburg 2022).

The Syrian Water Resource Platform exemplifies the spirit of cooperation and resource optimization necessary in the face of the crisis. This platform brings together a wide array of stakeholders interested in the water resources sector in North Syria, including Northeast Syria. These include humanitarian organizations, government and non-government entities, universities, research centers, experts, and consultants. The platform's mission is to enhance response strategies, optimize resource utilization, and maximize impact through effective coordination, information integration, and management. By fostering a shared space for dialogue and action, the platform is well-positioned to address the pressing water-related challenges in the region (Syrian Water Resource Platform 2023).

- **Challenges and Impact**

The water crisis in Syria has been exacerbated by climatic-induced and human-caused shocks affecting natural resources, particularly water. Insufficient and poorly distributed rainfall, severe

drought conditions combined with low water levels in the Euphrates River, and damaged water infrastructure have not only reduced access to water for drinking and domestic use for millions of Syrians, but also triggered substantial harvest and income losses, an increase in water-borne diseases and malnutrition rates, and additional protection risks, especially for women and girls (OCHA 2022).

More than eleven years into the crisis in Syria, water systems suffer collapse and damage affecting communities' access to safe drinking water and water for irrigation. According to a June 2022 water mapping assessment, a critical 3% of all populated communities did not have sufficient access to their primary water source in the last 30 days. A further 24% of populated communities reported that they rarely had sufficient access to their primary water source, meaning that an estimated 6.9 million people only had access to their primary water source between 2-7 days per month (OCHA 2022).

The response strategies have been met with various challenges, including the severe and long-term drought affecting Syria, unusually dry conditions during the rainy season, and abnormally high temperatures caused by climate change. These conditions have exacerbated water deficits, increasing evaporation from soils, water reservoirs, and rivers, as well as transpiration and water demand from plants (OCHA 2022).

- **Future Directions**

Given the severity of the water crisis and the challenges faced in implementing response strategies, further interventions are needed. The updated water response plan aims to assist 5 million people until December 2022, indicating the ongoing commitment of national and international bodies to

address the crisis. However, the substantial funding gap underscores the need for increased resources to effectively implement these interventions (OCHA 2022).

The national and international interventions have played a crucial role in mitigating the water crisis in Northeast Syria. However, the severity of the crisis, exacerbated by climatic changes and ongoing conflict, necessitates continued and increased efforts to ensure access to safe and sufficient water for all affected communities.

6.3. Analysis of the Effectiveness of Response Strategies

The effectiveness of response strategies in Northeast Syria can be evaluated based on their impact on the water crisis and the overall humanitarian situation.

The local response mechanisms have been instrumental in providing immediate relief to affected communities (IFRC 2021). However, these mechanisms are often short-term and may not be sustainable in the long run. For instance, the digging of informal wells, while providing immediate access to water, can lead to over-extraction and further depletion of groundwater resources (IFRC 2021). Similarly, water rationing and the use of water trucks are temporary measures that do not address the root causes of water scarcity.

On the other hand, national and international interventions have had mixed results. According to OCHA (2022), governmental and international bodies have made significant efforts to provide direct aid and implement policy changes. However, these interventions have faced numerous challenges, including conflict, logistical issues, and funding constraints (OCHA 2022).

In terms of effectiveness, the UN and its partners' plan to mitigate the impact of the water crisis in Northern and Northeast Syria aims to assist 5 million people until December 2022 (UNICEF 2022). However, the effectiveness of these interventions is undermined by the severe and long-

term drought affecting Syria, exacerbated by climate change and high temperatures. The large-scale destruction of water and sanitation infrastructure due to conflict and economic crisis has also contributed to the water crisis, with 47% of the population relying on alternative and often unsafe water sources (UNICEF 2022).

In terms of cholera outbreak response, UNICEF and partners have implemented a rapid response at scale to curb the spread of the disease and limit its negative impacts (UNICEF 2022). This includes the establishment of cholera treatment centres, distribution of sodium hypochlorite to provide safe and clean water, and risk communication and community engagement interventions (UNICEF 2022). However, UNICEF urgently needs an additional US$11.6 million to fund an emergency cholera response for three months (UNICEF 2022).

While the response strategies have had some positive impacts, they have not been sufficient to fully address the scope of the water crisis in Northeast Syria. The effectiveness of these strategies has been undermined by various challenges, including conflict, logistical issues, funding constraints, and climate change. Further interventions and investments are needed to restore the country's water and sanitation system and prevent repeated outbreaks in the future.

7. Prospects for Post-conflict Rehabilitation and Policy Recommendations

The escalating water crisis in Northeast Syria underscores the urgency of effective post-conflict rehabilitation measures aimed at restoring the water security of the region. This section of the thesis examines the potential pathways and strategies for post-conflict rehabilitation within the context of the unique difficulties and complexities of the Syrian landscape. It is crucial to bear in mind that these viewpoints are inherently speculative due to the unpredictable nature of the conflict and future climate scenarios.

The rehabilitation and recovery of water resources and infrastructure in Northeast Syria face a myriad of challenges. The intricate nature of the situation is influenced by a blend of conflict-triggered damage, environmental stress, institutional frailties, and limitations in resources.

- Infrastructure Damage and Degradation: Years of conflict and neglect have left a substantial proportion of the region's water infrastructure severely damaged or destroyed. This includes critical water supply networks, pumping stations, treatment plants, and irrigation systems. In addition to physical infrastructure, the region also grapples with severe electricity shortages that hamper the operation of water facilities. Restoration of this infrastructure would necessitate substantial financial investment, technical expertise, and time.

- Environmental Stress and Climate Change: The impacts of climate change, as evidenced by recurring droughts, declining water levels of the Euphrates, and increasing temperatures, pose significant challenges to the restoration of water security. The

anticipated climatic variations could further strain the already scarce water resources, complicating rehabilitation efforts.

- Resource and Labor Limitations: The recovery and rehabilitation process will require significant financial resources and skilled labor, both of which are currently lacking. The economic impact of the conflict, combined with international sanctions and regional economic challenges, has severely constrained Syria's capacity to fund the necessary rehabilitation works. Meanwhile, the exodus of professionals and laborers due to the conflict has further exacerbated the situation.

- Institutional and Governance Challenges: Effective water management requires robust institutional mechanisms. However, the conflict has resulted in fragmentation and weakening of governance structures. The establishment of a unified, accountable, and efficient water management system presents a considerable challenge. This includes the need for collaboration and dialogue between the Autonomous Administration of North and East Syria (AANES) and the Syrian regime for coordinated water resource management.

- Security, Stability Risks, and Political Unrest: Ongoing security issues, political unrest, and instability could hinder rehabilitation efforts. The potential for future conflicts and continued political uncertainty could deter investment and delay or disrupt recovery projects.

- Socio-economic and Psychological Challenges: The conflict has exacerbated poverty and unemployment, reducing the capacity of communities to contribute to and benefit from rehabilitation efforts. The psychological toll of the conflict has also affected the population's resilience and ability to engage in recovery initiatives. Addressing these socio-

economic and psychological issues is vital to ensure the long-term sustainability of post-conflict rehabilitation.

In the quest for water security in Northeast Syria, the recovery and rehabilitation of water infrastructure take center stage. The region's current water crisis calls for multifaceted strategies aimed at the restoration of damaged facilities, integration of sustainable and resilient design principles, and diversification of water sources.

- Infrastructure Repair and Upgrading: It is paramount that immediate measures are taken toward the repair and enhancement of water infrastructure. This requires local, regional, and international actors to be involved. Essential components such as wells, water treatment plants, and pipeline networks have been significantly damaged during the conflict and are in dire need of restoration. The upgrading process should not only focus on bringing these facilities back to their pre-conflict conditions but also consider implementing more resilient designs and materials to withstand future shocks.

- Climate-Resilient and Sustainable Infrastructure: Future water infrastructure projects should not only factor in climate change predictions but also integrate principles of sustainability. The projects should include features that enhance resilience to future climate-related stresses, such as more frequent and severe droughts and higher temperatures. Furthermore, sustainability considerations would ensure efficient use of resources, reduced environmental impact, and long-term viability of the infrastructure. Sustainable water management practices could include energy-efficient treatment processes, use of renewable energy sources, and waste minimization and recycling.

- Alternative Water Sources: While improving the existing infrastructure is critical, there is a pressing need to diversify water sources to increase the resilience of water supply systems. This could involve the development of rainwater harvesting systems and the safe reuse of treated wastewater, providing a sustainable source of water for non-potable uses such as irrigation and industrial processes.

- Investing in Agricultural Best Practices: Generally, the agricultural sector in Syria is a significant water user, and hence, promoting sustainable farming practices is a critical strategy for water conservation. Practices such as drip irrigation can significantly reduce water usage by delivering water directly to the plant roots, thereby minimizing evaporation and runoff. Crop rotation can enhance soil fertility and health, reducing the need for irrigation and contributing to more efficient water use. These changes, however, would require providing farmers with the necessary support in terms of knowledge transfer and possibly financial assistance to adopt these best practices.

- Improved Solid-Waste Collection and Management Practices: Many parts of Northeast Syria suffer from groundwater pollution due to improper waste disposal. Upgraded practices in solid-waste collection and management, including the construction of safe landfill sites outside urban areas, can help temper some of the damage (Schwartzstein and Zwijnenburg 2022).

It is critical to remember that the successful implementation of these strategies requires a supportive political environment, sufficient funding, public acceptance, and the participation of all relevant stakeholders. To implement these strategies, the following policy recommendations are made:

- Increase Investment in Water Infrastructure:

  Increase Investment in Water Infrastructure: It is essential that international donors, national governments, and private sector entities amplify their efforts to invest in the restoration and upgrading of water infrastructure in Northeast Syria. This involves not only substantial financial support but also technical assistance, knowledge sharing, and capacity building.

  Particular emphasis should be placed on comprehensive projects that serve multiple purposes concurrently. For instance, developing modern water supply and treatment facilities would not only enhance access to clean and safe water but also improve public health through better sanitation. Furthermore, these projects could stimulate the local economy by creating job opportunities, both during the construction phase and in the longer-term operation and maintenance of the facilities.

  It is crucial that the design and execution of these projects are tailored to be inclusive, reflecting the specific needs and circumstances of the local communities in Northeast Syria.

- Promote a Policy Shift Towards Less Water-Intensive Agriculture:

  Agricultural sector is of extreme prominence in NES. To ensure a sustainable water future, it is recommended that policies be formulated and enforced to encourage a shift in the agriculture sector towards less water-intensive farming. This could involve promoting the cultivation of grains and other staple foods, which typically require less water compared to certain non-edible and water-intensive crops such as cotton (Schwartzstein and Zwijnenburg 2022). Also providing subsidies or financial incentives for water-saving methods and technologies could help motivate farmers to follow methods that reduce water

use. These policies can help strike a balance between food security and water conservation, making the sector more sustainable in the face of limited water resources.

- Promote Water Conservation and Efficiency:

  There is a need to implement policies that encourage the efficient use of water and discourage waste. Public awareness campaigns can educate people about the importance of water conservation and provide practical tips for reducing water use in homes, businesses, and agricultural practices (as mentioned before).

  It is important to engage the communities in water management: Local communities should be actively involved in water management decisions, and that could be achieved through community-based water management programs, which can enhance local ownership, promote conservation behaviors, and improve the sustainability of water systems.

- Implement a Robust Water Quality Monitoring and Regulation Policy:

  Sources of surface water in NES, and mainly the Euphrates river, suffer from pollution due to raw sewage being discharged into them (EPC, 2022; REACH, 2023). In addition to that, water procured via private trucking have been perceived to make people sick in NES (REACH 2023). In light of the potential health risks posed by compromised water quality, it is imperative for the Autonomous Administration of North and East Syria (AANES) and present NGOs, in collaboration with international agencies, to introduce and enforce a comprehensive water quality monitoring and regulation framework. Such a policy should mandate regular testing of both surface water sources, like the Euphrates River, and decentralized distribution systems, such as private water trucking. It should also ensure strict adherence to internationally recognized water quality standards, with penalties for

entities that compromise water safety. And finally, this policy should establish a transparent reporting mechanism, allowing residents to access timely updates on water quality, thereby building trust and fostering a sense of accountability among water suppliers.

- Prioritize WASH (Water, Sanitation, and Hygiene) Programs in Policy Frameworks:

  To guarantee the well-being of the populace, it is not sufficient to merely ensure water availability; the broader WASH conditions are equally pivotal. Policymakers should:

  - Allocate significant resources towards the establishment and maintenance of advanced sanitation infrastructure, ranging from basic facilities to advanced sewage treatment plants.
  - Initiate widespread community awareness campaigns, stressing the significance of personal hygiene, safe sanitation practices, and the risks associated with non-compliance.
  - Collaborate with NGOs, local communities, and international bodies to streamline the WASH interventions, ensuring that they are tailored to the unique needs and challenges of Northeast Syria.

- Assess the Status of International Sanctions Regimes:

  Given the pressing need for resources and humanitarian assistance in NES, the international community is urged to reconsider the impact of current international sanctions regimes. Access to essential services such as clean water, food, and healthcare services, particularly in rural communities, should be examined in relation to these sanctions (Schwartzstein and Zwijnenburg 2022).

Specific attention should be directed toward assessing the effectiveness of the current exemptions in place for humanitarian, agricultural, and water-related aid. It is critical to ensure these exemptions facilitate, rather than hinder, the delivery of necessary services by international aid organizations and local authorities, especially in relation to water and sanitation infrastructure.

Given the severity of Northeast Syria's water crisis, this reassessment could identify areas for potential adjustments to the sanctions that would better enable rehabilitation and restoration of water infrastructure, consequently fostering more effective post-conflict recovery (Schwartzstein and Zwijnenburg 2022).

- Regional Diplomatic Initiative:

  Taking inspiration from the International Water Forum held in Hasakah in 2021, it is essential for global actors to spearhead a regional diplomatic initiative (Schwartzstein and Zwijnenburg 2022). The goal would be to mitigate and preemptively address potential disputes arising from the utilization of shared water resources, such as the Euphrates River and other significant water bodies in the region.

The road to water infrastructure recovery in Northeast Syria is a challenging journey that requires concerted efforts from local, regional, and international actors. These policy recommendations provide a roadmap to a sustainable water future in Northeast Syria. Emphasizing investment in infrastructure, the promotion of less water-intensive agriculture, water conservation, and international cooperation, these policies embody a holistic and forward-thinking approach to the water crisis. The successful implementation of these recommendations would necessitate collective efforts, cross-sectoral collaboration, and a persistent commitment to ensuring access to

clean and safe water for all residents of Northeast Syria. Ultimately, the path to resolution lies not only in overcoming the present crisis but also in preparing for future water security challenges in an increasingly uncertain climate future.

8. Conclusion and Discussion

The intricate relationship between conflict and infrastructure is vividly illustrated in the case of Northeast Syria (NES). This research has endeavored to shed light on the profound ramifications of war on the region's water infrastructure, offering insights that transcend the immediate context of NES.

- Infrastructure Damage: The conflict has not only physically damaged the water infrastructure but has also disrupted the socio-cultural fabric of NES. The direct targeting of water systems, coupled with collateral damages, has led to a significant alteration in human settlements, forcing communities to adapt to new patterns of water demand and access.

  The Tabqa Dam, along with the Tishrin Dam, are significant components of the Northeast Syrian water supply and electricity infrastructure. Both dams, particularly the Tabqa, suffered extensive damage during the conflict due to their strategic locations and roles. For instance, in March 2017, the Tabqa dam was at the center of a battle between ISIS and the SDF — backed by the U.S., resulting in significant damage to the dam's control room, halting its operations and rendering it out of service.

  Water stations are integral to Northeast Syria, transferring and providing drinking water for millions of residents in the region. Their damage during the conflict has not only disrupted water supply but also heightened health risks. As of July 2023, there were 63, 31, and 15 suspended water stations in Al-Hasakeh, Ar-raqqa, and Aleppo (NES districts), respectively. However, all of Deir-ez-Zor's 61 existing water stations are functional. Though it is worth mentioning that some water stations in Deir-ez-Zor have been

completely destroyed during the conflict. In total, around 17% of Northeast Syria's water stations are suspended leaving millions to rely on other sources of water such as private trucking and surface water sources.

The conflict has also significantly damaged and disrupted pipelines and water distribution networks across the region, which are crucial for delivering water from sources like dams and water stations to households, industries, and agricultural lands. However, the extent of the damage to these pipelines and networks is not thoroughly documented.

- Water Insecurity: The conflict in NES has had profound implications on the region's water infrastructure, leading to severe water insecurity. The intricate relationship between the conflict and infrastructure degradation has disrupted not only the physical aspects of water delivery but also the socio-cultural dynamics of the region. As a result, communities have been forced to adapt to new patterns of water demand and access, such as private trucking and surface water which can be compromised.

  The pre-existing water scarcity in NES was further intensified by the conflict. The destruction of surface water infrastructure, such as dams and water stations, has led to an over-reliance on groundwater sources. This over-extraction poses significant risks, including potential land subsidence and groundwater salinization. Such challenges highlight the fragility of the region's water resources and emphasize the need for sustainable management strategies.

  The direct targeting of water systems, combined with collateral damages from the conflict, has significantly altered human settlements. For instance, the destruction of water supply networks, pumping stations, and treatment plants has made it challenging for residents to

access clean water. A great example of that is the Alouk water station in Al-Hasakeh, which is currently operating at below half its capacity, impacting nearly a million individuals, of which 100,000 are in IDP camps and settlements. This has had cascading effects on public health, with disruptions in water access and sanitation heightening the risk of waterborne diseases. Moreover, the conflict's impact on education, especially concerning water and sanitation hygiene practices, poses long-term threats to the health and well-being of communities.

- Public Health Implications: The water crisis in NES, exacerbated by the ongoing conflict, has had profound implications for public health. The destruction and degradation of water infrastructure, including treatment facilities, have led to a significant decline in water quality. This deterioration has critical repercussions, especially when considering the health and vulnerabilities of affected communities.

  One of the most pressing concerns arising from the compromised water quality is the heightened risk of waterborne diseases. Due to the unavailability of clean water sources, many communities have resorted to using alternative sources such as untreated surface water or groundwater from unprotected wells. These sources are often contaminated with pathogens or chemicals, increasing the risk of waterborne diseases. A report by REACH in 2023 highlighted that the persistent gaps in households' access to Water, Sanitation, and Hygiene (WASH) services facilitated the spread of diseases, including cholera.

  The outbreak of cholera in September 2022 stands as a testament to the severity of the WASH situation and the high risk of waterborne disease spread in the region. As of April 2023, Syria as a whole reported over 100,000 suspected cases of cholera, with 100

suspected deaths. Specifically, in Northeast Syria, almost 22,000 suspected cases were reported, resulting in 23 fatalities. The correlation between the source of drinking water and the presence of waterborne diseases in Northeast Syria is particularly alarming. Communities and internally displaced people (IDP) that rely on water trucking as their primary source of drinking water reported the highest number of cases where water was perceived to be making people sick. This is attributed to the fact that water provided by private trucking is often not monitored and might be unsafe to drink.

- Socio-economic Repercussions: The conflict-induced water crisis in Northeast Syria has triggered a cascade of socio-economic repercussions that extend beyond immediate water availability and quality concerns. These implications have deeply affected the lives of individuals and the overall functioning of communities.

  The water crisis has notably exacerbated food insecurity in the region. With insufficient water for irrigation, agricultural productivity has seen a decline, leading to increased food prices and reduced access to nutritious food. This lack of water has long-term consequences on local economies, especially for agrarian communities where crop and livestock farming are primary income sources. The limited water availability has detrimentally affected crop growth and agricultural livelihoods, further compromising food accessibility and contributing to the inflation of food and commodity prices. By May 2022, the median household in NES was spending around 75 USD monthly on food, which was approximately half of the median monthly household income of 153 USD. This economic strain was evident as a quarter of households reported skipping meals or prioritizing feeding vulnerable members.

The economy of Northeast Syria, primarily built around agriculture, has been severely impacted by the water crisis. Production losses in the agricultural sector have affected the estimated 18% of the employed population working in this sector, most of whom are self-employed.

Furthermore, the deepening water crisis has disproportionately affected women and children, traditionally tasked with water collection. As reliable water sources diminish or move farther away due to conflict-related disruptions, these groups face longer, often perilous journeys to fetch water. This increased burden not only leads to physical strain but also robs children of valuable school hours and women of potential economic opportunities, further exacerbating the region's socio-economic challenges.

Additionally, the reduced access to clean water in NES has compromised sanitation and hygiene standards, resulting in unsanitary living environments and an increased risk of disease transmission. This situation is especially challenging for vulnerable groups like the elderly, disabled, and those displaced by conflict, who face even greater obstacles in accessing proper sanitation and maintaining personal hygiene.

- Lessons, Diplomacy, and Shared Water Resources: The situation in NES highlights the critical need for resilience, collaboration, and a forward-thinking approach when addressing water crises. It is not merely about reconstructing physical infrastructure but also about rejuvenating communities, re-establishing trust, and plotting a sustainable future. The international community, policymakers, and researchers should unite, drawing from Northeast Syria’'s experiences, to ensure water remains a life-sustaining resource rather than a source of conflict. Furthermore, the shared water resources in the region

underscore the significance of diplomatic efforts. The challenges posed by the water crisis in NES illuminate the potential for regional cooperation to alleviate conflicts over shared water resources, emphasizing that collaborative endeavors can lead to sustainable water management benefiting all involved parties.

Recommendations for Future Research:

- On-Site Field Research and Local-Level Data Collection: Future studies should prioritize direct fieldwork in Northeast Syria to capture the intricate details and lived experiences that might be missed in desk-based research. Engaging directly with affected communities and observing the damaged infrastructure firsthand can lead to a richer understanding of the water crisis and its implications. This immersive approach ensures that the data collected is both granular and specific, reflecting the true ground realities and fostering trust and collaboration with local communities.

- Impact of Sanctions: International sanctions, while intended as political tools, have profound implications on Northeast Syria's socio-economic and humanitarian landscape. These restrictions can hinder the flow of essential goods, services, and financial resources, complicating efforts to repair water infrastructure. Moreover, they can pose significant challenges for aid organizations, from funding constraints to difficulties in importing relief materials. Local industries and livelihoods are also affected, with sanctions potentially exacerbating economic challenges in a region already grappling with conflict aftermath and a water crisis. Furthermore, strained diplomatic relations due to sanctions might reduce international support for Northeast Syria, emphasizing the need for a nuanced understanding of sanctions when formulating international policy decisions.

- Holistic Health and Psychosocial Impacts: Beyond the immediate health concerns arising from the water crisis, there's a pressing need to investigate the long-term health and psychosocial effects on the residents of Northeast Syria. Prolonged exposure to contaminated water can lead to chronic health conditions, and when combined with the stresses of conflict and water scarcity, the psychological and emotional toll on individuals becomes significant. Future research should aim to provide a comprehensive understanding of both the physical and mental health implications of the crisis, offering insights into holistic interventions and support mechanisms.

- Economic Impacts: The water crisis in Northeast Syria, exacerbated by significant infrastructure damage, has had ripple effects on the region's economy. Future research should delve deeper into understanding the direct and indirect economic consequences of this infrastructure degradation. This includes assessing the loss of livelihoods, especially in sectors heavily reliant on water, evaluating the costs associated with rebuilding and rehabilitating damaged infrastructure, and understanding the broader economic implications for trade, industry, and regional development. Such a focused study can provide insights into the economic resilience of the region and offer strategies for sustainable economic recovery and growth.

- Regional Diplomatic Initiatives: Given the centrality of shared water resources like the Euphrates and Tigris rivers in regional geopolitics, future research should delve deeper into the potential of diplomatic efforts in Northeast Syria and its neighboring regions. Investigating historical water-related agreements and disputes can provide a foundation for understanding current challenges. There's a significant research gap in exploring how joint water management, data-sharing, and collaborative projects can foster regional trust and

cooperation. Additionally, as water scarcity becomes a pressing concern, understanding the dynamics of water as a potential conflict driver is crucial. Research could also evaluate the role of international entities in mediating and facilitating water-focused discussions, providing insights into how water can be a catalyst for regional peace and collaboration.

The water crisis in NES serves as a stark reminder of the multifaceted challenges that arise in conflict zones. As the region embarks on the arduous journey of recovery and reconstruction, the lessons from NES underscore the importance of resilience, collaboration, and forward thinking. Addressing the water crisis is not just about infrastructure; it's about restoring communities, rebuilding trust, and charting a sustainable path forward. The international community, policymakers, and researchers must come together, drawing inspiration from the lessons of NES, to ensure that water remains a source of life, not conflict.

Bibliography

Abbara, Aula, et al. "Weaponizing water as an instrument of war in Syria: Impact on diarrhoeal disease in Idlib and Aleppo governorates, 2011–2019." International Journal of Infectious Diseases 108 (2021): 202-208.

Abdulqader, Jindar. "Water Forum in Syria's Hasakah Concludes with a Set of Recommendations." North Press Agency, 28 Sept. 2021, www.npasyria.com/en/65321/.

Adamo, Nasrat, Nadhir Al-Ansari, and Varoujan K. Sissakian. "Global climate change impacts on Tigris-Euphrates Rivers basins." Journal of Earth Sciences and Geotechnical Engineering 10.1 (2020): 49-98.

Ali, Massoud. "Years of drought: A report on the effects of drought on the Syrian peninsula." Heinrich-Böll-Stiftung-Middle East Office (2010).

Al-Khalidi, Suleiman. "قوة سورية معارضة تدعمها أمريكا تصد هجوما للدولة الإسلامية قرب سد الطبقة." Reuters, 2 Apr. 2017,www.reuters.com/article/syria-isil-sdf-mh2-idARAKBN1740M4.

Allsopp, Harriet, and Wladimir Van Wilgenburg. The Kurds of Northern Syria: governance, diversity and conflicts. Vol. 2. Bloomsbury Publishing, 2019.

"Yemen: 'Our Kids Are Bombed': Schools under Attack in Yemen." Amnesty International, 11 Dec. 2015, www.amnesty.org/en/documents/mde31/3026/2015/en/.

"Alouk Water Station Location in Al-Hasakeh." Syria: Alouk Water Station - Flash Update: Disruption to Alouk Water Stationt, Reliefweb, 1 July 2021, https://reliefweb.int/report/syrian-arab-republic/syria-alouk-water-station-flash-update-disruption-alouk-water-station. Accessed 26 July 2023.

Al-Quraishi, Ali K., and David A. Kaplan. "Connecting changes in Euphrates River flow to hydropattern of the Western Mesopotamian Marshes." Science of The Total Environment 768 (2021): 144445.

Altinbilek, Dogan. "Development and management of the Euphrates–Tigris basin." International Journal of Water Resources Development 20.1 (2004): 15-33.

Al-Warfalli A, Elumani A (2018) Rolling summer blackouts weigh on Libya's struggling traders. Reuters https://www.reuters.com/article/uk-libya-economy-power-idUKKBN1L214C. Accessed on 29 June 2023.

Ashraf, Tamanna, Shlomi Dinar, and Jennifer Veilleux. "Dams, Terrorism, and Water Nationalism's Response to Globalization and Development: The Case of South Asia." Terrorism and political violence 34.5 (2022): 958-978.

Autesserre, Séverine. Peaceland: Conflict resolution and the everyday politics of international intervention. Cambridge University Press, 2014.

Aydin-Kandemir, Fulya, and Dursun YILDIZ. "Assessment of growing water and food security crises in Afghanistan." International Journal of Water Management and Diplomacy 1.6 (2023): 5-28.

Banks, David. "Water Assessment Mission to Afghanistan January-February 2002." Part F: Urban water supply systems in Afghanistan. Oslo: Norwegian Church Aid (2002).

Barnes, Jessica. "Managing the waters of baʿth country: the politics of water scarcity in Syria." Geopolitics 14.3 (2009): 510-530.

"Causes and Consequences of the Cholera Outbreak in Northeast Syria." EPC (Emirates Policy Center), 18 Nov. 2022, epc.ae/en/details/featured/causes-and-consequences-of-the-cholera-outbreak-in-northeast-syria.

Clark-Kazak, Christina. "Ethical considerations: Research with people in situations of forced migration." Refuge 33.2 (2017): 11-17.

Collelo, Thomas (1987), Syria: A Country Study, Washington: GPO for the Library of Congress, OCLC 44250830

Cook, Christina, and Karen Bakker. "Water security: Debating an emerging paradigm." Global environmental change 22.1 (2012): 94-102.

Creswell, John W., and J. David Creswell. Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications, 2017.

Daoudy, Marwa. "Water weaponization in the Syrian conflict: strategies of domination and cooperation." International Affairs 96.5 (2020): 1347-1366.

Dureab, Fekri, et al. "Risk factors associated with the recent cholera outbreak in Yemen: a case-control study." Epidemiology and Health 41 (2019).

FAO. (2021). Near East: Yemen. Food and Agriculture Organization of the United Nations.

FAO. (2016). AQUASTAT Main Country Database - FAO's Information System on Water and Agriculture. Food and Agriculture Organization of the United Nations.

"A fighter from the Islamic State group poses next to Tishrin Dam." Middle East Eye, 31 December 2015, https://www.middleeasteye.net/news/fears-syrias-tishrin-dam-may-collapse-amid-rising-water-levels. Accessed July 22, 2023.

Flick, Uwe. "An introduction to qualitative research." An introduction to qualitative research (2022): 1-100.

"Functionality status of water stations in Al-Hasakeh governorate." Syrian Water Resources Platform, 2-15 July 2023, https://app.powerbi.com/view?r=eyJrIjoiZDQzMDZiNTktMzlkNy00YmQ5LWE0NDctZjg0ODM5ZDllNDc2IiwidCI6ImZiMTU5MTQzLTlhNTYtNDRlYS04MWMzLTNiM2NkNGJkMmQ2NyIsImMiOjl9. Accessed 28 July 2023.

"Functionality status of water stations in Ar-Raqqa governorate." Syrian Water Resources Platform, 2-15 July 2023, https://app.powerbi.com/view?r=eyJrIjoiZDQzMDZiNTktMzlkNy00YmQ5LWE0NDctZjg0ODM5ZDllNDc2IiwidCI6ImZiMTU5MTQzLTlhNTYtNDRlYS04MWMzLTNiM2NkNGJkMmQ2NyIsImMiOjl9. Accessed 28 July 2023.

"Functionality status of water stations in Aleppo governorate (Northeast Syria subdistricts)." Syrian Water Resources Platform, 2-15 July 2023, https://app.powerbi.com/view?r=eyJrIjoiZDQzMDZiNTktMzlkNy00YmQ5LWE0NDctZjg0ODM5ZDllNDc2IiwidCI6ImZiMTU5MTQzLTlhNTYtNDRlYS04MWMzLTNiM2NkNGJkMmQ2NyIsImMiOjl9. Accessed 28 July 2023.

"Functionality status of water stations in Deir-ez-Zor governorate." Syrian Water Resources Platform, 2-15 July 2023, https://app.powerbi.com/view?r=eyJrIjoiZDQzMDZiNTktMzlkNy00YmQ5LWE0NDctZjg0ODM5ZDllNDc2IiwidCI6ImZiMTU5MTQzLTlhNTYtNDRlYS04MWMzLTNiM2NkNGJkMmQ2NyIsImMiOjl9. Accessed 28 July 2023.

Garrity, A. "Conflict Rubble: A Ubiquitous and Under-Studied Toxic Remnant of War." Toxic Remnants of War Project (2014).

Giovanis, Eleftherios, and Oznur Ozdamar. "The transboundary effects of climate change and global adaptation: The case of the Euphrates-Tigris water basin in Turkey and Iraq." Available at SSRN 4320746 (2021).

Glass, Samantha. "Twisting the tap: water scarcity and conflict in the Euphrates-Tigris River basin." (2017).

Gleick, Peter H. "Water and terrorism." Water policy 8.6 (2006): 481-503.

Gleick, Peter H. "Water, drought, climate change, and conflict in Syria." Weather, climate, and society 6.3 (2014): 331-340.

Gleick, Peter, and Charles Iceland. "Water, security and conflict." (2018).

Grey, D. and Sadoff, C.W. (2007) Sink or Swim? Water Security for Growth and Development. Water Policy, 9, 545-571. https://doi.org/10.2166/wp.2007.021

Grigg, Neil S. "Global water infrastructure: State of the art review." International Journal of Water Resources Development 35.2 (2019): 181-205.

Habib, Habibullah. "Water related problems in Afghanistan." International Journal of Educational Studies 1.3 (2014): 137-144.

Habib, Leila., and W. Ibrahim. "Status of soil resource in Syria." Proceedings of the Assessment of Existing Soil Information System, Damascus (2007).

Haddad, George, Ivett Szeles, and J. Sandor Zsarnoczai. Water management development and agriculture in Syria. No. 1401-2016-117273. 2008.

Hanoush, Feras. "Raqqa's Water War." Atlantic Council, 11 Aug. 2017, www.atlanticcouncil.org/blogs/syriasource/raqqa-s-water-war/.

Hinnebusch, Raymond, et al. "Agriculture and reform in Syria." Syria Studies 3.1 (2011): 1-79.

Hole, Frank, and B. F. Zaitchik. "Policies, plans, practice, and prospects: irrigation in northeastern Syria." Land Degradation & Development 18.2 (2007): 133-152.

"Water Weaponisation and Displacement in Northeast Syria." HPN Humanitarian Practice Network, 16 July 2021, www.odihpn.org/publication/water-weaponisation-and-displacement-in-northeast-syria/.

ICRC. "The Water Situation in Yemen." International Committee of the Red Cross, 8 June 2022, www.icrc.org/en/document/water-situation-yemen#:~:text=It%20is%20estimated%20that%2017.8,30%25%20of%20the%20Yemeni%20population.

ICRC. "Syria Water Crisis: Up to 40% Less Drinking Water after 10 Years of War." International Committee of the Red Cross, 1 October 2021, https://www.icrc.org/en/document/syria-water-crisis-after-10-years-war.

ICRC. "Covid-19: Millions Dealing with Sporadic Water Shortages, Crippled Health Services in North-East Syria." International Committee of the Red Cross, 21 May 2020, www.icrc.org/en/document/north-east-syria-millions-dealing-sporadic-water-shortages-crippled-health-services.

ICRC. "Bled Dry - How war in the Middle East is bringing the region's water supplies to breaking point." International Committee of the Red Cross, 25 March 2015, https://www.icrc.org/en/download/file/5508/full_report-water-middle-east-icrc.pdf.

IFRC. Syria: Droughts - Emergency Plan of Action (EPoA) DREF Operation N° MDRSY006 (2021), www.reliefweb.int/attachments/8bd73601-c90a-3070-b23a-ef42a1d7c7d3/MDRSY006do.pdf.

IFRC. Emergency Plan of Action Syria: Droughts. International Federation of Red Cross and Red Crescent Societies (2021). https://reliefweb.int/sites/reliefweb.int/files/resources/MDRSY006do.pdf

"An image published by the Islamic State's news agency on the day of the bombing in 2017." The New York Times, Jan 20, 2022, https://www.nytimes.com/2022/01/20/us/airstrike-us-isis-dam.html. Accessed July 21, 2023.

"An image published by the Islamic State's news agency the day of the bombing." The New York Times, Jan 20, 2022, https://www.nytimes.com/2022/01/20/us/airstrike-us-isis-dam.html. Accessed July 21, 2023.

Kaisi, A., M. Yasser, and Y. Mahrouseh. "Syrian Arab Republic Country Report." El Gamal F.(ed.), Lamaddalena N.(ed.), Bogliotti C.(ed.), Guelloubi R.(ed.). Non-conventional water use: WASAMED project. Bari: CIHEAM/EU DG Research (2005): 251-264.

Kamizoulis, G., et al. "Wastewater recycling and reuse practices in Mediterranean region: Recommended Guidelines." Arab Water World Mag 34 (2003).

Khan, Azmat. "A coalition missile penetrated five stories of the dam's north tower. Two missiles on the southern tower penetrated three floors down." The New York Times, Jan 20, 2022, https://www.nytimes.com/2022/01/20/us/airstrike-us-isis-dam.html. Accessed July 21, 2023.

Kibaroglu, Aysegul, and Waltina Scheumann. "Evolution of Transboundary Politics in the Euphrates-Tigris River System: New Perspectives and Political Challenges." Global Governance, vol. 19, no. 2, 2013, pp. 279–305. JSTOR, http://www.jstor.org/stable/24526371.

Lund, Aron. "Cholera in the Time of Assad: How Syria's Water Crisis Caused an Avoidable Outbreak." The Century Foundation, 24 Jan. 2023, www.tcf.org/content/report/cholera-in-the-time-of-assad-how-syrias-water-crisis-caused-an-avoidable-outbreak/#:~:text=In%20the%20first%20few%20decades,%2C%20sanitation%2C%20and%20health%20infrastructure. Accessed 13 June 2023.

Mahaqi, Ali, et al. "Environmental hydrogeochemistry characteristics, controlling factors and groundwater quality assessment in Herat City, West Afghanistan." Water Resources 47.2 (2020): 325-335.

"Main source of drinking water in communities and presence of waterborne disease." REACH, 21 September 2022, https://reliefweb.int/attachments/095410fb-891f-43a1-82e9-0b0973df41b5/REACH_SYR_Cholera-Outbreak-NES_Brief_September-2022.pdf. Accessed 2 August 2023.

"Main source of drinking water in IDP sites and presence of waterborne disease." REACH, 21 September 2022, https://reliefweb.int/attachments/095410fb-891f-43a1-82e9-0b0973df41b5/REACH_SYR_Cholera-Outbreak-NES_Brief_September-2022.pdf. Accessed 2 August 2023.

Major dams on the Euphrates River in Syria. The Arab Weekly, September 4, 22021, https://thearabweekly.com/plummeting-euphrates-water-level-threatens-syrias-breadbasket. Accessed July 14, 2023.

"Map of Syria". Fanfak Water, March 22 2019, https://water.fanack.com/syria. Accessed July 14, 2023.

Miles, Matthew B., and A. Michael Huberman. Qualitative data analysis: An expanded sourcebook. sage, 1994.

Mourad, Khaldoon A., and Ronny Berndtsson. "Syrian water resources between the present and the future." Air, Soil and Water Research 4 (2011): ASWR-S8076.

O'Brien, Mandeep. "A Reality Check Which Ignites #foreverychild - Striving for Universal Access to Water in Sudan." UNICEF, 21 Mar. 2023, www.unicef.org/sudan/press-releases/reality-check-which-ignites-foreverychild-striving-universal-access-water-sudan#:~:text=Nationally%2C%20water%20supply%20coverage%20is,limited%20or%20unsafe%20drinking%20water. Accessed 29 June 2023.

OCHA (2022) Critical Response and Funding Requirements - Response to the Water Crisis in Syria (August 2022) https://reliefweb.int/report/syrian-arab-republic/critical-response-and-funding-requirements-response-water-crisis-syria-august-2022

OCHA (2021) Syrian Arab Republic. Euphrates Water Crisis and Drought Outlook https://reliefweb.int/sites/reliefweb.int/files/resources/Syrian%20Arab%20Republic%20-%20Euphrates%20water%20crisis%20and%20drought%20outlook%2C%20as%20of%2017%20June%202021.pdf

OCHA (2021) Water Crisis in Northern and Northeast Syria: Immediate Response and Funding Requirements (9 September 2021) https://reliefweb.int/report/syrian-arab-republic/water-crisis-northern-and-northeast-syria-immediate-response-and-funding

OCHA (2021) Syria: Alouk Water Station - Flash Update: Disruption to Alouk Water Station, www.reliefweb.int/report/syrian-arab-republic/syria-alouk-water-station-flash-update-disruption-alouk-water-station. Accessed 26 July 2023.

OCHA (2020). "Libya Humanitarian Needs Overview 2020."www.reliefweb.int/report/libya/libya-humanitarian-needs-overview-2020-january-2020. Accessed on 29 June 2023

OCHA (2020). "Libya: Covid-19. Situation Report No. 2." https://reliefweb.int/report/libya/libya-covid-19-situation-report-no-2-21-april-2020. Accessed on 29 June 2023

Oweis, T. Y, H. J Farahani, and A. Y. Hachum. "Evapotranspiration and water use of full and deficit irrigated cotton in the Mediterranean environment in northern Syria." Agricultural water management 98.8 (2011): 1239-1248.

Philipps, Dave, et al. "A Dam in Syria Was on a 'no-Strike' List. the U.S. Bombed It Anyway." The New York Times, 20 Jan. 2022, www.nytimes.com/2022/01/20/us/airstrike-us-isis-dam.html.

"Primary source of drinking water in communities, and percentage of communities in the sub-district." REACH, July 2023, https://reliefweb.int/attachments/a30e2ec7-107d-46ca-a671-6507b8eb3a3d/REACH-SYR_Water-Crisis-in-NES_July2023.pdf. Accessed 1 August 2023.

"Primary source of drinking water in informal settlements and collective centres, and percentage of informal sites in the sub-district." REACH, July 2023, https://reliefweb.int/attachments/a30e2ec7-107d-46ca-a671-6507b8eb3a3d/REACH-SYR_Water-Crisis-in-NES_July2023.pdf. Accessed 1 August 2023.

"Proportion of households that went 2 consecutive days without access to water in IDP camps." REACH, July 2023, https://reliefweb.int/attachments/a30e2ec7-107d-46ca-a671-6507b8eb3a3d/REACH-SYR_Water-Crisis-in-NES_July2023.pdf. Accessed 1 August 2023.

REACH, 2023, Current Situation of the Water Crisis in Northeast Syria and Its Humanitarian Impacts, https://reliefweb.int/attachments/a30e2ec7-107d-46ca-a671-6507b8eb3a3d/REACH-SYR_Water-Crisis-in-NES_July2023.pdf

REACH (2016). "Libya Multi-Sector Needs Assessment III". REACH Humanitarian Response. https://www.humanitarianresponse.info/ru/operations/libya/assessment/reach-multi-sector-needs-assessment-iii. Accessed 29 June 2023.

Roberts, Neil. "Geopolitics and the Euphrates' water resources." Geography 76.2 (1991): 157-159.

Rosvold, Elisabeth Lio, et al. "Climate, Peace and Security Fact Sheet: Afghanistan." (2021).

Sakran, Abdel Jawad. "The Euphrates Dam Is at Risk in the SDF Operation to Capture It from ISIS." Atlantic Council, 27 Jan. 2017, www.atlanticcouncil.org/blogs/syriasource/the-euphrates-dam-is-at-risk-in-the-sdf-operation-to-capture-it-from-isis/.

Salman, Maher, and Wael Mualla. "Water demand management in Syria: Centralized and decentralized views." Water Policy 10.6 (2008): 549-562.

Salman, Maher, and Wael Mualla. "The utilization of water resources for agriculture in Syria: Analysis of current situation and future challenges." Erice International Seminars on Planetary Emergencies. 2003.

Schwartzstein, Peter and Zwijnenburg, Wim. "We fear more war. We fear more drought: How climate and conflict are fragmenting rural Syria." PAX, January 2022, https://paxforpeace.nl/media/download/PAX_report-Pastoralist_Syria.pdf

Selby, Jan, and Clemens Hoffmann. "Beyond scarcity: rethinking water, climate change and conflict in the Sudans." Global Environmental Change 29 (2014): 360-370.

Shumilova, Oleksandra, et al. "Impact of the Russia–Ukraine armed conflict on water resources and water infrastructure." Nature Sustainability 6.5 (2023): 578-586.

Skaf, Michael, and Shifa Mathbout. "Drought changes over last five decades in Syria." Economics of drought and drought preparedness in a climate change context (2010): 107-112.

Sottimano, Aurora, and Nabil Samman. “Syria Has a Water Crisis. and It's Not Going Away.” Atlantic Council, 24 Feb. 2022, www.atlanticcouncil.org/blogs/menasource/syria-has-a-water-crisis-and-its-not-going-away/.

Souleima, Delil. “Critical equipment was in ruins and the dam stopped functioning entirely.” The New York Times, Jan 20, 2022, https://www.nytimes.com/2022/01/20/us/airstrike-us-isis-dam.html. Accessed July 21, 2023.

Sowers, Jeannie, and Erika Weinthal. "Humanitarian challenges and the targeting of civilian infrastructure in the Yemen war." International Affairs 97.1 (2021): 157-177.

Staff, ToI. “Risking Thousands, US Targeted Massive Syria Dam It Claimed Was on ‘no Strike’ List.” The Times of Israel, 21 Jan. 2022, www.timesofisrael.com/risking-thousands-us-targeted-massive-syria-dam-it-claimed-was-on-no-strike-list/.

Standard, Business. “79% Households in Afghanistan Suffer Water Shortage, Shows Survey.” Business Standard, 12 Dec. 2022, www.business-standard.com/article/international/79-households-in-afghanistan-suffer-water-shortage-shows-survey-122121200188_1.html.

Sümer, Vakur. “War over Tishreen Dam: Growing Significance of Hydraulic Structures in the Middle East.” ORSAM, Centre for Middle Eastern Studies (ORSAM), 12 Jan. 2016, www.orsam.org.tr/en/war-over-tishreen-dam-growing-signficance-of-hydraulic-structures-in-the-middle-east/.

Syrian Water Resources Platform. “Water Stations Database 2023 W27-28”, 2023, www.wrp-sy.org/. Accessed 26 July 2023.

“The SRTF Successfully Completes the Rehabilitation Activities for Two Water Pumping Stations in Deir Ez-Zor.” Syria Recovery Trust Fund, 2022, www.srtfund.org/news/651-the-srtf-successfully-completes-the-rehabilitation-activities-for-two-water-pumping-stations-in-deir-ez-zor.

Tabor, Ruby, et al. "Disruption to water supply and waterborne communicable diseases in northeast Syria: a spatiotemporal analysis." Conflict and Health 17.1 (2023): 1-15.

Tashakkori, Abbas, and Charles Teddlie. Mixed methodology: Combining qualitative and quantitative approaches. Vol. 46. sage, 1998.

Timakova, Olga A. "Targeting Environmental Infrastructure: Libya Conflict Case Study." 2023. 1-18.

Triebert, Christiaan. “Syria’s Bombed Water Infrastructure: An OSINT Inquiry.” Bellingcat, 11 Dec. 2015, www.bellingcat.com/news/mena/2015/12/11/syrias-bombed-water-infrastructure/.

UN-ESCWA and BGR (United Nations Economic and Social Commission for Western Asia; Bundesanstalt für Geowissenschaften und Rohstoffe). 2013. Inventory of Shared Water Resources in Western Asia. Beirut.

UNICEF (2023). Whole of Syria Humanitarian Situation Report, January-December 2022, https://reliefweb.int/report/syrian-arab-republic/unicef-whole-syria-humanitarian-situation-report-january-december-2022. Accessed 26 July 2023.

UNICEF (2022). "Syria Cholera Response Situation Report for 04 October 2022." https://reliefweb.int/attachments/7dd7ed96-4966-46c5-8e50-e21a9abe26d6/UNICEF%20Syria%20Cholera%20Response%20Situation%20Report%20-%2004%20October%202022.pdf. Accessed 3 August 2023.

UNICEF (2022). "Humanitarian Action for Children: Syrian Arab Republic." https://www.unicef.org/media/112346/file/2022-HAC-Syrian-Arab-Republic.pdf. Accessed 3 August 2023.

UNICEF (2021). "New UNICEF Report Highlights Scale and Impact of Attacks on Water and Sanitation Facilities on Children in Conflict-Affected Countries." www.unicef.org/press-releases/new-unicef-report-highlights-scale-and-impact-attacks-water-and-sanitation.

UNICEF (2019). "Water station in northeast Syria out of service, impacting 400,000 people as violence continues". https://www.unicef.org/mena/press-releases/water-station-northeast-syria-out-service-impacting-400000-people-violence-continues. Accessed July 18, 2023,

UN-OCHA. World humanitarian data and trends 2018. United Nations Office for the Coordination of Humanitarian Affairs; 2018.

UN Water, 2013. Water Security & the Global Water Agenda: A UN-Water Analytical Brief. United Nations University, Hamilton, Canada.

Van Loon, A. F., et al., 2015. Drought in a human-modified world: reframing drought definitions, understanding, and analysis approaches. Hydrology and Earth System Sciences, 19(8), pp.3635-365

Veilleux , Jennifer, and Shlomi Dinar. "New Global Analysis Finds Water-Related Terrorism Is on the Rise." New Security Beat, 8 May 2018, www.newsecuritybeat.org/2018/05/global-analysis-finds-water-related-terrorism-rise/.

Weir, Doug. "Civilian protection, environmental pollution and conflict–a role for the public health community." Medicine, Conflict and Survival 31.1 (2015): 4-12. https://doi.org/10.1080/13623699.2015.1020103

Wendle, John. "Syria's climate refugees." Scientific American 314.3 (2016): 50-55.

Wood, Elisabeth Jean. "The ethical challenges of field research in conflict zones." Qualitative sociology 29 (2006): 373-386.

Zaynab, Mayladan. “A Harsh Reality: Millions in Northern Syria Lack Access to Clean Water.” People in Need, 21 Mar. 2023, www.peopleinneed.net/a-harsh-reality-millions-in-northern-syria-lack-access-to-clean-water-10161gp.

Zwijnenburg, Wim, and te Pas, Kristine. "Amidst the Debris... A Desktop Study on the Environmental and Public Health Impact of Syria’s Conflict." PAX, October 2015, https://paxforpeace.nl/media/download/pax-report-amidst-the-debris-syria-web.pdf.

Appendix

The distribution of functioning and suspended water stations across the governerates of Northeast Syria as of July 2023.

In the tables, the following abbreviations are used: WTS (Water Treatment Station), WS (Well Station), BS (Boosting Station), and SS (Spring Station).

Table 1. The distribution of functioning and suspended water stations across the subdistricts of Al-Hasakeh governorate as of July 2023

District	Station Name	Station Type	Functionality Status	Suspension Cause
ALHASAKEH	Tasfiat Alhemah	WTS	Suspended	Temporary suspension
	Dakh Alhemah	BS	Suspended	Temporary suspension
	Al-Azizieh	BS	Suspended	Temporary suspension
	Ain Altina	WS	Functioning	
	Nurak	WS	Functioning	
	Wadi al Ahmer	WS	Suspended	Temporary suspension
	Hilaliyeh Wa Al-Rahmaniyah	WS	Functioning	
	Umm al-Masamir	WS	Functioning	
	Tahlit Makhrum	WTS	Functioning	
	Mashrue Nafasha	WS	Functioning	
	Tal Tamer	WS	Suspended	Temporary suspension
	Ain Al Abed	WS	Suspended	Temporary suspension
	Kon Attar	WS	Functioning	
	Western Gherban	WS	Functioning	
	Kherbet Elsweifat	WS	Functioning	
	Atshana	WS	Functioning	
	Hulwa Sumayhan	WS	Functioning	
	Ger Missyn	WS	Functioning	
	Syha mibrd	WS	Functioning	
	Sekr Simahan	WS	Functioning	
	Tal Hesen	WS	Functioning	
	Girezyl	WS	Suspended	Under maintenance

	Um Khef Alsbekh	WS	Functioning	
	Al rofa	WS	Functioning	
	Al Regm	WS	Functioning	
	Tal Azan	WS	Functioning	
	Tal Azan Alqaria	WS	Functioning	
	Bweir Bir Helo	WS	Functioning	
	Lzzaka	WS	Functioning	
	Kharab Abdel Sayed	WS	Functioning	
	A'Kar	WS	Suspended	Under maintenance
	Little Hayahi	WS	Functioning	
	Tafla	WS	Functioning	
	Tel Azzam	WS	Functioning	
	Um Qser	WS	Functioning	
	Tall Hamidiya	WS	Functioning	
	Khbirat	WS	Functioning	
	Tasfit Markada	WTS	Suspended	Temporary suspension
	Tasfit Shamasani	WTS	Suspended	The station is destroyed
	Elweh Al-Gharbiyah	BS*	Suspended	Temporary suspension
	Tasfit Shaddadah	WTS	Suspended	Temporary suspension
	Forty Seven	BS	Suspended	Temporary suspension
	Tasfit Areesheh	WTS	Suspended	Military issues
	Tahlit Twaymiyn	WTS	Suspended	The station is destroyed
A L M A L I K E Y Y E H	Mustafawiyeh	WS	Functioning	
	Mustafawiyeh Alghamur	WS	Functioning	
	Tal Elawar	WS	Functioning	
	Tal Elawar (Alghamur)	WS	Functioning	
	Taleeah	WS	Functioning	
	Murtafiah	WS	Functioning	
	Lower Arar	WS	Functioning	
	Kharab Abu Ghaleb	WS	Functioning	
	Marja	WS	Functioning	
	Kharab Bonyan	WS	Functioning	
	Yusefiyeh Alshamali	WS	Functioning	
	Yusefiyeh Aljanubi	WS	Functioning	
	Yusefiyeh Alsharqi	WS	Functioning	
	Lower Rmeilan (Rmilan Albasha)	WS	Functioning	
	Upper Rmeilan (Rmilan Alsheekh)	WS	Functioning	
	Bostan	WS	Functioning	
	Hamra	WS	Functioning	
	Abu Obaida	WS	Functioning	
	Tlin	WS	Functioning	

	Tal Jmal	WS	Functioning	
	Salhiyeh Al-Malikeyyeh	WS	Functioning	
	Tal Elfukhar	WS	Functioning	
	Kharab Alskeer	WS	Functioning	
	Maabada Bir 1	WS	Functioning	
	Maabada Bir 2	WS	Functioning	
	Maabada Bir 3	WS	Functioning	
	Maabada Bir 4,8	WS	Functioning	
	Maabada Bir 5	WS	Functioning	
	Maabada Bir 6	WS	Functioning	
	Maabada Bir 7	WS	Functioning	
	Maabada Bir 9	WS	Functioning	
	Maabada Bir 10	WS	Functioning	
	Maabada Bir 11	WS	Functioning	
	Maabada Bir 12	WS	Functioning	
	Maabada Bir 13	WS	Functioning	
	Tabaqa	WS	Functioning	
	Upper Tal Khanzir	WS	Functioning	
	Khan Eljabal	WS	Functioning	
	Um Tlul	WS	Functioning	
	Besta Sus	WS	Functioning	
	Tal Zyara	WS	Functioning	
	Sabe Jfar	WS	Functioning	
	Tal Adas	WS	Functioning	
	Tal Eldiq	WS	Functioning	
	Tal Elthahab	WS	Functioning	
	Beit Hannun	WS	Functioning	
	Jawadiyah - Bir 1 Alsinaea	WS	Functioning	
	Jawadiyah - Bir 2 (Jawadiyah Alghamur Janubi)	WS	Functioning	
	Jawadiyah - Bir 3 Almustawda'at	WS	Functioning	
	Jawadiyah - Bir 4 Almakhafar Alqadim	WS	Functioning	
	Jawadiyah - Bir 5 Alrasafa	WS	Functioning	
	Jawadiyah - Bir 6 Albaladia	WS	Functioning	
	Jawadiyah - Bir 7 Ghassan Kanfani	WS	Functioning	
	Jawadiyah - Bir 8 Hadiqat Almasrif	WS	Suspended	Needs total-scale maintenance
	Hamra Aljadida	WS	Functioning	
	Bab Elhadid	WS	Functioning	
	Baqla	WS	Functioning	

	Qneitra Jawadiyah	WS	Functioning	
	Tubiyeh	WS	Functioning	
	Raheiba	WS	Functioning	
	Abu Qeir	WS	Functioning	
	Tal Elsedeq Aljadida	WS	Functioning	
	Sueda	WS	Functioning	
	Tal Elhawa	WS	Functioning	
	Qasr Eldib	WS	Functioning	
	Sharm El Sheikh	WS	Functioning	
	Ein Diwar	WS	Functioning	
	Zheiriyeh	WS	Functioning	
	Tal Elomara	WS	Functioning	
	Kisweh	WS	Functioning	
	Hab Hawa	WS	Functioning	
	Yanbue	WS	Functioning	
	Mansura Al-Malikeyyeh	WS	Functioning	
	Hassaniyeh	WS	Functioning	
	Ein Elkhadra	WS	Functioning	
	Ein Elkhadra Aljadida	WS	Functioning	
	Al-Malikeyyeh - Alkhazzan Algharbi	WS	Functioning	
	Al-Malikeyyeh - Khazzan Albaladia	WS	Functioning	
	Al-Malikeyyeh - Khazzan Alsinaea	WS	Functioning	
	Al-Malikeyyeh - Bir Balaqu	WS	Functioning	
	Al-Malikeyyeh - Masakin Almuealimin	WS	Functioning	
	Al-Malikeyyeh - Bir Almalaab	WS	Functioning	
	Al-Malikeyyeh - Bir 10 (Hadiqat Amn Aldawla)	WS	Functioning	
	Al-Malikeyyeh - Madrasat Zuhair Bin Abi Aulama	WS	Functioning	
	Al-Malikeyyeh - Bir 12 (Hadiqat Alaskaria Aljadida)	WS	Functioning	
	Al-Malikeyyeh - Bir Althakana	WS	Functioning	
	Al-Malikeyyeh - Bir Alnahr	WS	Functioning	
	Al-Malikeyyeh - Alhadiqa Aljanubia	WS	Functioning	
	Al-Malikeyyeh - Almashfaa Alwatani Aljadid	WS	Functioning	
	Al-Malikeyyeh - Mahatat Narmu	WS	Functioning	
	Al-Malikeyyeh - Hadiqat Alzuhwr	WS	Functioning	

	Al-Malikeyyeh - Hadiqat Tishrin	WS	Functioning	
	Al-Malikeyyeh - Hadiqat Alkawakibi (Alfunun)	WS	Functioning	
	Al-Malikeyyeh - Albawilia (Hadiqat Alyarmuk)	WS	Functioning	
	Alsaffan	WTS	Functioning	
	Tawakol	WS	Functioning	
	Jaberiyeh Jawadiyeh	WS	Functioning	
	Hafethiyeh	WS	Functioning	
	Thaheriya Bir 1	WS	Functioning	
	Thaheriya Bir 2	WS	Functioning	
	Thaheriya Bir 3	WS	Functioning	
	Abbasiyeh	WS	Functioning	
	Msheirfet Jawadiyeh	WS	Functioning	
	Tal Elatshan Bir 1	WS	Functioning	
	Tal Elatshan Bir 2	WS	Functioning	
	Tal Khalil Jawadiyeh	WS	Functioning	
	Deir Elghosn - Alkhazzan Alismanti	WS	Functioning	
	Deir Elghosn - Khazzan Alhadid	WS	Functioning	
	Deir Ayub	WS	Functioning	
	Dayr Hafir	WS	Functioning	
	Shabak	WS	Functioning	
	Shabak Aljadida (Alghamur)	WS	Functioning	
	Abra Bir 1	WS	Functioning	
	Abra Bir 2	WS	Functioning	
	Qasemiyeh	WS	Functioning	
	Mashuq	WS	Functioning	
	Mashuq Aljadida (Alghamur)	WS	Functioning	
	Saberiyeh - Alkhazzan Alismanti	WS	Functioning	
	Saberiyeh - Khazzan Alhadid	WS	Functioning	
	Ya'robiyah - Bir Alhudud	WS	Functioning	
	Ya'robiyah - Bir Hadiqat Alshahid Zakariaa Almuhimid	WS	Functioning	
	Ya'robiyah - Bir Almuhalaq	WS	Functioning	
	Ya'robiyah - Bir Hadiqat ibn Ala'amid	WS	Functioning	
	Ya'robiyah - Bir Tal Aqil	WS	Functioning	
	Ya'robiyah - Almahmudiyeh	WS	Functioning	
	Ya'robiyah - Bir Hadiqat Alshadiaq	WS	Functioning	
	Ya'robiyah - Bir Hai Althawra	WS	Functioning	
	Sleiman Sari	WS	Functioning	

	Eastern Fattumeh	WS	Functioning	
	Tal Mashan	WS	Functioning	
	Tal Dweim	WS	Functioning	
	Hurriyeh	WS	Functioning	
QAMISHLI	Bsheiriyeh Qahtaniya	WS	Functioning	
	Tanuriyeh	WS	Functioning	
	Alharamoon	WS	Functioning	
	Qahtaniyyeh - Hai Althawra	WS	Functioning	
	Qahtaniyyeh - Hai Aljhad	WS	Functioning	
	Qahtaniyyeh - Hai Aljawlan	WS	Functioning	
	Qahtaniyyeh - Hai Alqadisia	WS	Functioning	
	Qahtaniyyeh - Hai Tishrin	WS	Functioning	
	Karimeh	WS	Functioning	
	Manathra	WS	Functioning	
	Bayandur	WS	Functioning	
	Krie Brie	WS	Functioning	
	Tal Khatun	WS	Functioning	
	Khweitleh Eljawaleh	WS	Functioning	
	Sofiyeh	WS	Suspended	Lack of operational costs
	Mahrakan	WS	Functioning	
	Tal Ziwan	WS	Functioning	
	Digire	WS	Functioning	
	Qahtaniyyeh - Tariq Alshalhumia	WS	Functioning	
	Suqiyeh	WS	Suspended	Needs simple-scale maintenance
	Abu Ghadir	WS	Functioning	
	Hilweh (Hilweh Alshaikh)	WS	Functioning	
	Hulwah Ghammr	WS	Functioning	
	Big Bayaza	WS	Functioning	
	Kherbet Elthibeh	WS	Functioning	
	Big Lilan	WS	Functioning	
	Zorfafa	WS	Suspended	Needs simple-scale maintenance
	Upper Siha	WS	Functioning	
	Lower New Siha	WS	Functioning	
	Ath-Thawrah Quamishli	WS	Functioning	
	Al-Bajariyah	WS	Functioning	
	Big Jneidiyeh	WS	Functioning	
	Thabanah	WS	Functioning	
	Al-Qusayr	WS	Functioning	
	Abu Rasin	WS	Functioning	
	Um Elfursan	WS	Functioning	
	Upper Big Um Jfar	WS	Functioning	

	Takht Elshmasiyeh	WS	Functioning	
	Tal Eid	WS	Suspended	Lack of operational costs
	Tal Fares	WS	Functioning	
	Hamu	WS	Functioning	
	Khajoka	WS	Functioning	
	Kharbit Dalali	WS	Functioning	
	Dudan	WS	Functioning	
	Rehiyeh	WS	Functioning	
	Big Sweidiyeh Quamishli	WS	Functioning	
	Akula	WS	Functioning	
	Himo	WS	Functioning	
	Quamishli (Elhilaiya)	WS	Functioning	
	Oweija	WS	Functioning	
	Quamishli (Jaghjigh)	WS	Functioning	
	Salhiyeh	WS	Functioning	
	Hayahi	WS	Functioning	
	Mluk Sray	WS	Functioning	
	Alsafieh	WS	Functioning	
	Abu Thweil	WS	Functioning	
	Tanuriyeh Aljadideh	WS	Functioning	
	Tal Steeh	WS	Functioning	
	Kherbet Amu	WS	Functioning	
	Dalawiya	WS	Functioning	
	Hatemiyeh	WS	Functioning	
	Bweir Bu Aasy	WS	Functioning	
	Big Dankhiyeh	WS	Functioning	
	Alkhalil (Kharab Krad)	WS	Functioning	
	Harm Rash	WS	Functioning	
	Tal Ehmeir	WS	Functioning	
	Hseiniyeh	WS	Functioning	
	Sadiyeh - Alakrad	WS	Functioning	
	Sadiyeh - Alarab	WS	Functioning	
	Lower Haswiyeh	WS	Functioning	
	Om alkher barkia (Sakkar)	WS	Functioning	
	Tal Hmis - Almasjid	WS	Functioning	
	Tal Hmis - Hai Aljabal	WS	Functioning	
	Tal Hmis - Hai Aljisr	WS	Functioning	
	Tal Hmis - Hai Aljala	WS	Functioning	
	Tal Hmis - Hai Alzakia	WS	Functioning	
	Tal Hmis - Hai Almihnia	WS	Functioning	
	Upper Haswiyeh	WS	Functioning	

	Mjerinat Mahal	WS	Functioning	
	Yathreb	WS	Functioning	
	Tal Maaruf	WS	Functioning	
	Hdeibiyeh	WS	Functioning	
	Rehiyeh Madineh	WS	Functioning	
	Tal Anbar	WS	Functioning	
	Rehiyeh Sawda	WS	Functioning	
	Tal Ghazal	WS	Functioning	
	Big Hanuah	WS	Functioning	
	Kharab Askar	WS	Functioning	
	Big Hajiyeh	WS	Functioning	
	Little Hajiyeh	WS	Functioning	
	Farfara Tal Hmis	WS	Functioning	
	Tawarij Elghaanah	WS	Functioning	
	Abu Khazaf	WS	Suspended	Needs simple-scale maintenance
	Little Tal Bustan	WS	Functioning	
	Tall Bustan Khabir	WS	Functioning	
	Nasibeh Elmazeniyeh	WS	Functioning	
	Abu Tweineh	WS	Suspended	Needs simple-scale maintenance
	Western Harset Elrad	WS	Functioning	
	Rasm Eldrue	WS	Suspended	Lack of operational costs
	Naem Al-Jallad	WS	Functioning	
	Naem Elhyar	WS	Functioning	
	Amuda - Alkhazzan Alraisi	WS	Functioning	
	Amuda - Alhai Algharbi	WS	Functioning	
	Jaberiyeh	WS	Functioning	
	Um Rabee	WS	Functioning	
	Bardeh - Beriva Amuda	WS	Functioning	
	Bahira	WS	Functioning	
	Tal Ahmar Amuda	WS	Functioning	
	Tal Habash	WS	Functioning	
	Fokhar	WS	Suspended	Needs simple-scale maintenance
	Jamila Joly	WS	Functioning	
	Jorhariyeh	WS	Functioning	
	Hasda	WS	Functioning	
	Hettin	WS	Functioning	
	Topz	WS	Functioning	
	Dikiyeh	WS	Functioning	
	Western Raya - Raya Sadoon	WS	Functioning	
	Qleiah (Qajleh)	WS	Functioning	
	Muhayrikah	WS	Functioning	

	Nif	WS	Suspended	Needs simple-scale maintenance
	Mla Sobat	WS	Functioning	
	Sfira Amuda	WS	Functioning	
	Abo Zaid	WS	Functioning	
	Girke Daquriyah (Karki Daquriyah)	WS	Functioning	
	Baleh Zozan (Tal Almasiaf)	WS	Functioning	
	Tobo	WS	Functioning	
	Zenar	WS	Functioning	
RAS AL AIN	Tall Seker (Siker Fokani)	WS	Functioning	
	Sharifa (Sharfyah)	WS	Functioning	
	Shafaqa	WS	Functioning	
	Tall al-Shur al-Gharbi	WS	Functioning	
	Safawi	WS	Functioning	
	Safira Darbasiyah	WS	Functioning	
	Sorsork	WS	Functioning	
	Thahr El Arab	WS	Functioning	
	Western Alia - Alia Darbasiyah	WS	Functioning	
	Farfara Derbasiyeh	WS	Functioning	
	Korrat kawi	WS	Functioning	
	Qarmaniyeh	WS	Functioning	
	Kerbetili	WS	Functioning	
	Kerpeshek	WS	Functioning	
	kar Kend	WS	Functioning	
	Southern Torate	WS	Functioning	
	Motasallem	WS	Functioning	
	Musherfeh Darbasiyah	WS	Functioning	
	Malak	WS	Functioning	
	Tall Kadish	WS	Functioning	
	Al Ennabiya	WS	Functioning	
	Metheak	WS	Functioning	
	Noflyah Kikan	WS	Functioning	
	Abu Rasin - Alhai Alsharqi	WS	Suspended	Military issues
	Abu Rasin - Alhai Algharbi	WS	Suspended	Military issues
	Zaydiyeh	WS	Suspended	Military issues
	Assadiya	WS	Suspended	Military issues
	AlKhadrawi	WS	Suspended	Military issues
	Um Harmala	WS	Suspended	Needs total-scale maintenance
	Dawoodiyeh	WS	Suspended	Military issues
	Big Arada	WS	Suspended	Military issues
	Mishirfah Ras al ayn	WS	Suspended	Military issues
	Tal Thiab Wa Alkisreh	WS	Suspended	Military issues

	Dahmaa	WS	Functioning	
	Rawya	BS	Functioning	
	Shara	WS	Functioning	
	Siwan (Abo Alson)	WS	Functioning	
	Om Oshbeh	WS	Suspended	Temporary suspension
	Um Ezam Ras Al Ain	WS	Functioning	
	Umirt	WS	Suspended	Temporary suspension
	Bir Shamu	WS	Functioning	
	Tal Arqam	WS	Functioning	
	Tal Elamir	WS	Suspended	Military issues
	Western Tal Elward	WS	Suspended	Military issues
	Tal Baydar Ras El Ein	WS	Functioning	
	Tell Mohammed Kabir	WS	Functioning	
	Khrbit Al-Banat	WS	Functioning	
	Kherbet Hamid	WS	Functioning	
	Ras Al Ain - Alkhazzan Alshamali	WS	Functioning	
	Ras Al Ain - Aljanubia	WS	Functioning	
	Ras Al Ain - Almadinat Alsinaia	WS	Functioning	
	Ras Al Ain - Hadiqat Alfaruj	WS	Functioning	
	Ras Al Ain - Hadiqat Tishrin (Alhawarna)	WS	Functioning	
	Ras Al Ain - Mushrafa	WS	Functioning	
	Ras Al Ain - Maqaru Alwahda	WS	Functioning	
	Western Rabiat	WS	Suspended	Military issues
	Reema	WS	Suspended	Lack of operational costs
	Aonik Hawa	WS	Functioning	
	Farhia	WS	Suspended	Military issues
	Lothee (Umm Sulaybah)	WS	Functioning	
	Mbarkiyeh	WS	Functioning	
	Mjeibreh	WS	Suspended	Temporary suspension
	Mazraet Abd Hai (Oum Orbatah)	WS	Suspended	Military issues
	Mezri	WS	Suspended	Military issues
	Madpaa (Tall Qarttal)	WS	Functioning	
	Al tweem	WS	Suspended	Lack of operational costs
	Tal-Khanzir	WS	Functioning	
	Mekhtla (Sewanah)	WS	Functioning	
	Faresa	WS	Functioning	
	Tal Blal (Tal Al-Bougha)	WS	Functioning	
	Tal Halaf (Tal Hadara)	WS	Functioning	
	Alnasrea	WS	Functioning	
	Asfar Najjar	WS	Suspended	Needs moderate-scale maintenance

	Western Alouk	WS	Functioning	
	Merekez Shamali	WS	Suspended	Temporary suspension
	Dwerah	WS	Functioning	
	Alnokra (Kidkan)	WS	Suspended	Needs simple-scale maintenance
	Manajir	WTS	Suspended	Needs total-scale maintenance
	Rajm Okab (Thamud)	WS	Suspended	Needs total-scale maintenance
	Jahafa Alouk (Al-Jaffah)	WS	Functioning	
	Arnan Shamali	WS	Functioning	
	Seha	WS	Suspended	Military issues
	Modan	WS	Suspended	Lack of operational costs
	Al-Azizieh (Almthana)	WS	Functioning	
	Jan Tamer (Almutlah)	WS	Suspended	Temporary suspension
	Helewa	WS	Suspended	Military issues
	Om Shoaifa	WS	Suspended	Military issues
	Qotniyeh (Alhardana)	WS	Functioning	
	Al Qasb (Bab Elkheir)	WS	Suspended	Military issues
	Busays Tahtani	WS	Suspended	Military issues
	Al-Nofalieh (Nofalieh Alhilu)	WS	Suspended	Needs simple-scale maintenance
	Southeren Merekez	WS	Suspended	Temporary suspension
	Beses Fokani	WS	Suspended	Military issues
	Nadass	WS	Suspended	Temporary suspension
	Ain Hisan	WS	Functioning	
	Eastern Alouk Alqaria	WS	Suspended	Needs total-scale maintenance
	Ras Al Ain - Albawaba	WS	Functioning	
	Ras Al Ain - Alkaraj	WS	Functioning	
	Ras Al Ain - Kshto	WS	Functioning	
	Darbasiyah - Alhadiqa Ala'amma	WS	Functioning	
	Darbasiyah - Alsawamie	WS	Functioning	
	Darbasiyah - Alfuran Alali	WS	Functioning	
	Darbasiyah - Tal Aylul	WS	Functioning	
	Darbasiyah - Mahatat Alkahraba	WS	Functioning	
	Ghanamiyah	WS	Functioning	
	Quneitra Darbasiyah	WS	Functioning	
	Qayrawan	WS	Functioning	
	Mahmudiyeh	WS	Functioning	
	Abu Kala	WS	Functioning	
	BerKafri	WS	Functioning	
	Briva	WS	Functioning	
	Bsheiriyeh	WS	Functioning	
	Birkiniz	WS	Functioning	

	Tal Tishrine	WS	Functioning	
	Tal Abbud	WS	Functioning	
	Upper Tal Ghazal	WS	Functioning	
	Southern Khas - Khas Kikiyeh	WS	Functioning	
	Kharbet Balk (Aldammam)	WS	Functioning	
	Dabash	WS	Functioning	
	Rashidiyeh Derbasiyeh	WS	Functioning	
	Rihaniya	WS	Functioning	
	Salam	WS	Functioning	
	Sybriyka	WS	Functioning	

Table 2. The distribution of functioning and suspended water stations across the subdistricts of Ar-Raqqa governorate as of July 2023

District	Station Name	Station Type	Functionality Status	Suspension Cause
A R R A Q Q A	Widyan	WTS	Functioning	
	Kalta	WTS	Functioning	
	Zahera	WTS	Functioning	
	Tal Elsamen Dahham	WTS	Functioning	
	Ayuj (Abu Jedi)	WTS	Functioning	
	Hawi Elhawa	WTS	Functioning	
	Hilo Abed	WTS	Functioning	
	Ar-Raqqa	WTS	Functioning	
	Ar-Raqqa - Bir Alhashm	WTS	Functioning	
	Ar-Raqqa - Almaslakh	WTS	Functioning	
	Big Sweidiyeh	WTS	Functioning	
	Adnaniyeh Ar-Raqqa	WTS	Functioning	
	Hweijet Faraj	WTS	Functioning	
	Akeirshi	WTS	Functioning	
	Sahlabiyeh (Kilo Sifr)	WTS	Functioning	
	Bir Said	BS	Functioning	
	Wihdeh (Alhukumia)	WTS	Functioning	
	Abu Suseh	BS	Functioning	
	Ar-Raqqa - Almurab Alshamali	BS	Suspended	Temporary suspension
	Yamama	WTS	Functioning	

	Sahlabiyeh Alsharqia	WTS	Functioning	
	Baladiya Jadida	WTS	Functioning	
	Abu Touta	BS	Functioning	
	Karama	WTS	Functioning	
	Shaher	WTS	Functioning	
	Hamrat Balasim (Hamrat Boytieyeh)	BS	Functioning	
	Matab Elburashed	WTS	Functioning	
	Abu Wahil	WTS	Functioning	
	Assahamiat	WTS	Functioning	
	Assadiya 1	WTS	Functioning	
	Assadiya 2	WTS	Suspended	Needs simple-scale maintenance
	Assadiya 3	WTS	Functioning	
	Mehran	BS	Functioning	
	Kahlan	BS	Functioning	
	Qadessiyeh	WTS	Functioning	
ATH THAWRA	Al-Thawrah	WTS	Functioning	
	Ayed Saghir	WTS	Functioning	
	Abu Assi	WTS	Functioning	
	Abu Horaira	WTS	Functioning	
	Hora	WTS	Functioning	
	Sefsafa	WTS	Functioning	
	Abbad (Mazraet Sefsafa)	WTS	Functioning	
	Abu Kbee Algharbi	WTS	Functioning	
	Mansura	WTS	Functioning	
	Al Barouda	WTS	Functioning	
	Jurneyyeh	BS	Functioning	
	Ramleh	WS	Functioning	
	Tawi	WTS	Functioning	
	Western Jaabar	WTS	Functioning	
	Bir Shallal	WS	Suspended	Needs moderate-scale maintenance
	Shams Eldin (Tanirah)	WTS	Functioning	
	Mahmudli	BS	Functioning	
	Tal Othman	BS	Functioning	
	Al-Thawrah - Alkhazzan Shamali	BS	Functioning	
	Al-Thawrah - Alkhazzan Aljanubi	BS	Functioning	
	Jeidine (Qsair)	BS	Functioning	
	Aljarrafat	WTS	Functioning	
	Alseleib (Thamin AL-Adhar)	WS	Suspended	Military issues
	Tal Elkibir	WS	Suspended	Military issues
	Kinana (Bandr Khan)	WS	Functioning	

TELL ABIAD	Abu Haye	WS	Functioning	
	Ein Issa	BS	Functioning	
	Baghdic	WS	Functioning	
	Banat Ali	WS	Suspended	Military issues
	Khaldiya	WS	Suspended	Military issues
	Alflaiheea	WS	Functioning	
	Maghar	WS	Functioning	
	Elbeida	WS	Functioning	
	Hisheh	WTS	Functioning	
	Hisheh Rafia	BS	Functioning	
	Fatsa	WTS	Suspended	Military issues
	Big Yamama	WS	Suspended	Needs moderate-scale maintenance
	Tell Abiad Almarkaz	WS	Functioning	
	Tell Abiad Almahatah	WS	Functioning	
	Tell Abiad Aliskan	WS	Functioning	
	Tell Abiad Sharqi	WS	Functioning	
	Qaysoum	WS	Suspended	Needs total-scale maintenance
	Ein Al-Arus Shamali	WS	Functioning	
	Ein Al-Arus Janubi	WS	Functioning	
	Tal Fandar	WS	Functioning	
	Tal Akhdar - Aljamis	WS	Functioning	
	Upper Tal Ahmar	WS	Suspended	Needs moderate-scale maintenance
	Alnadhera	WS	Suspended	Military issues
	Kherbet Fares	WS	Suspended	Military issues
	Tiba	WS	Functioning	
	Hanano (Kurmazat)	WS	Functioning	
	Badi	WS	Suspended	Lack of operational costs
	Amin	WS	Suspended	Needs moderate-scale maintenance
	Kherbet Elroz	WS	Suspended	Needs total-scale maintenance
	Ber Issa	WS	Suspended	Military issues
	Sharkrak	WS	Suspended	Temporary suspension
	Hweijet Abdi	WS	Suspended	Lack of operational costs
	Khabura	WS	Suspended	Needs simple-scale maintenance
	Alhawi	WS	Suspended	Lack of operational costs
	Saideh	WS	Suspended	Lack of operational costs
	Alsard (Al Isawi)	WS	Suspended	Lack of operational costs
	Mashrafat Al Alazzo	WS	Functioning	
	Ber shmalee	WS	Functioning	

	Rajm Onwah	WS	Suspended	Needs moderate-scale maintenance
	Arbid	WS	Functioning	
	Alghobin	WS	Functioning	
	Hammam At-Turkman	WS	Functioning	
	Doghaniyeh	WS	Functioning	
	Suluk Sharqi	WS	Functioning	
	Ali Alnada	WS	Functioning	
	Kattar	BS	Suspended	Needs total-scale maintenance
	Ghweilan (Fuylan)	WS	Suspended	Needs moderate-scale maintenance
	Sakhret Erbeed	WS	Functioning	
	Alsalheea Ein Issa	WS	Functioning	
	Khafiyeh (Althawra)	WS	Suspended	Needs simple-scale maintenance
	Quneitra	WS	Suspended	Needs total-scale maintenance
	Hashisha	WS	Suspended	Lack of operational costs
	Munbatih	WS	Functioning	
	Hadiqat Muhamad Aldurra	WS	Functioning	
	Almukhtalta	WS	Suspended	Needs simple-scale maintenance
	Malotya	WS	Functioning	
	Abu Khorzeh	WS	Suspended	Military issues
	Suluk Janubi	WS	Functioning	
	Zehia	WS	Functioning	
	At-Turkman Shamali	WS	Functioning	
	Suluk Albalad	WS	Functioning	
	Ein Al-Arus (al saha)	WS	Functioning	

Table 3. The distribution of functioning and suspended water stations across the Northeast Syria subdistricts of Aleppo governorate as of July 2023

District	Station Name	Station Type	Functionality Status	Suspension Cause
	Upper Jbeileh - Qorrat Quri	BS	Functioning	
	Ghassaniyeh - Qorret Halanj	WS	Functioning	
	Juma' Ali	WS	Functioning	
	Elishar	WS	Suspended	Needs moderate-scale maintenance

AIN AL ARAB	Firazdaq - Arsalan Tash	WS	Functioning	
	Kas Kaskan	WS	Suspended	Needs total-scale maintenance
	Shoruq - Holaqi	WS	Suspended	The station is destroyed
	Sharan Ain Al Arab	WS	Suspended	Needs total-scale maintenance
	Marj Ismail	WS	Suspended	Needs total-scale maintenance
	Qantarra - Qantaret Kikan	WS	Suspended	Needs total-scale maintenance
	Upper Shyookh	WS	Suspended	Military issues
	Shamaliyeh - Boraz Ogli	WS	Functioning	
	Tal Elebar	WS	Functioning	
	Upper Mawa - Upper Khanik	WS	Functioning	
	Jalabiyeh	WS	Functioning	
	Kerak	WS	Suspended	Needs moderate-scale maintenance
	Kufyan	WS	Suspended	Needs total-scale maintenance
	Hadid Castle	WS	Suspended	Needs moderate-scale maintenance
	Milheh	WS	Functioning	
	Magharbatin	WS	Suspended	Needs total-scale maintenance
	Ras El Ein Qabli	WS	Suspended	Needs total-scale maintenance
	Elzarqa	WS	Suspended	Needs moderate-scale maintenance
JARABLUS	Jarablus	WTS	Functioning	
	Hjeileh - Jrables	BS	Functioning	
	Ghandorah	SS	Functioning	
	Sweida - Qorret Tashli	WS	Functioning	
	Forsan - Sabahiler	SS	Functioning	
	Marma Elhajar - Tishtan	SS	Suspended	Temporary suspension
	Zoghra	BS	Functioning	
	Rif Jarablus	WTS	Functioning	
MENBIJ	Um Edam	WS	Functioning	
	Dadat	WS	Functioning	
	Qeshlet Yusef Basha	WTS	Functioning	
	Abu Kahf	BS	Functioning	
	Little Maqtaa Elhajar	BS	Suspended	Needs total-scale maintenance

Table 4. The distribution of functioning and suspended water stations across the subdistricts of Deir-ez-Zor governorate as of July 2023

District	Station Name	Station Type	Functionality Status
ALMAYADIN	Hawayej Alrghaib	WTS	Functioning
	Thiban	WTS	Functioning
	Haqil Alomar	WTS	Functioning
	Tayyana	WTS	Functioning
	Darnaj	WTS	Functioning
	Sweidan Jazira	WTS	Functioning
	Karama Thiban	WTS	Functioning
	Eastern Jarda	WTS	Functioning
	Abu Hardoub	WTS	Functioning
ABU KAMAL	Abu Hamam Algharbia	WTS	Functioning
	Abu Hamam Alsharqia	WTS	Functioning
	Kishkiyeh	WTS	Functioning
	Kishkiyeh Alththania	WTS	Functioning
	Gharanij Algharbia	WTS	Functioning
	Gharanij Alsharqia	WTS	Functioning
	Gharanij Maadan	WTS	Functioning
	Bahra	WTS	Functioning
	Hajin Hauama	WTS	Functioning
	Hajin Wasat	WTS	Functioning
	Hajin Sharq	WTS	Functioning
	Shafa Algharbia	WTS	Functioning
	Shafa Wosta	WTS	Functioning
	Bubadran	WTS	Functioning
	Sosa Algharbia	WTS	Functioning
	Alsafafnah	WTS	Functioning
	Jisr AlBaguz	WTS	Functioning
	Upper Baguz Sharq	WTS	Functioning
DEIR	Kobar	WTS	Functioning
	Ali	WTS	Functioning
	Lower Safira	WTS	Functioning
	Jazaret Elbuhmeid	WTS	Functioning
	Jazaret Milaj	WTS	Functioning
	Hawayej Thyab Jazira	WTS	Functioning
	Hawayej Bumasaa	WTS	Functioning
	Mhemideh	WTS	Functioning

E Z Z O R	Breiha	WTS	Functioning
	Basira	WTS	Functioning
	Zir	WTS	Functioning
	Shiheil Alsharqia	WTS	Functioning
	Shiheil Algharbia	WTS	Functioning
	Sabha	WTS	Functioning
	Sur Janub	WTS	Functioning
	Sur Shamal	WTS	Functioning
	Sur Gharb	WTS	Functioning
	Sur Sharq	WTS	Functioning
	Zghir Jazireh	WTS	Functioning
	Dahleh	WTS	Functioning
	Jdidet Bikara	WTS	Functioning
	Jdid Ekeidat	WTS	Functioning
	Shaqra	WTS	Functioning
	Hreiji	WTS	Functioning
	Hreijiyeh	WTS	Functioning
	Abu Khashab	WTS	Functioning
	Hejneh	WTS	Functioning
	Kobar Rafe	BS	Functioning
	Jazaret Milaj Rafe	BS	Functioning
	Abu Khashab Rafe	BS	Functioning
	Kasra	WTS	Functioning
	Kasra Rafe	BS	Functioning
	Sawa	WTS	Functioning
	Sawa Rafe	BS	Functioning