Water Trucking in Northwest Syria

March 2024 | Syria

Introduction

Before 2011, most households in Syria received water from the piped network at a very low, heavily subsidised price.[1] Since then, destruction of infrastructure and the high burden of population displacement have led to a drastic drop in reliance on water networks. In 2023, less than half of households used piped networks as their primary source, with the majority of those also relying on a secondary source. Water trucking has emerged to fill the gap, and in 2023 was equally as widespread as piped networks.[2] Research in other low-income and developing countries has shown that water trucking tends to be substantially more expensive than network water and suffers from higher rates of contamination with faecal bacteria – making it unsafe to drink and a risk for the spread of diseases such as cholera.[3–5] Despite its risks and costs, water trucking plays an essential role in maintaining water access for households in hard-to-reach areas, during conflict, and during seasonal water shortages.[3,6–8]

Data on water trucking in Syria has been lacking since the outbreak of the conflict in 2011. This situation overview uses available secondary data sources as well as a primary data collection conducted in January 2024 to characterise water trucking systems in Northwest Syria (NWS), highlighting in particular their cost and safety. This assessment was conducted on request from the WASH cluster in NWS.

The first section goes over the methodology and essential limitations of the data collection. Section 2 introduces the main sources of water in NWS. Section 3 discusses water trucking operations, focusing on their costs and the quality of water provided. Section 4 considers how households are impacted by the high level of reliance on water trucking. Section 5 contains a summary and the main conclusions from this research.

For a non-technical summary, consider skipping to section 5 Summary & Conclusions on page 9.

KEY MESSAGES

- Water truckers depended on private and public groundwater sources, with the cost of water constituting the highest cost of the trucking operations.
- Water sold by truckers was not generally treated, and truckers did not provide chlorine to their customers. Given the prevalence of waterborne diseases such as cholera, this constitutes a public health risk.
- Households who depended on water trucking as their primary water source - almost half of households - reported lower levels of water sufficiency and higher expenditures. Nonetheless, water trucking is an essential source of water during crises, providing water to households who have no alternatives.

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1. METHODOLOGY OVERVIEW

The research presented here is based on primary data collected in October 2023 and January 2024. It was complemented by available secondary data sources, in particular the 2023 Multi-Sectoral Needs Assessment (MSNA),[2] a representative household-level data collection.

Two rounds of data were collected:

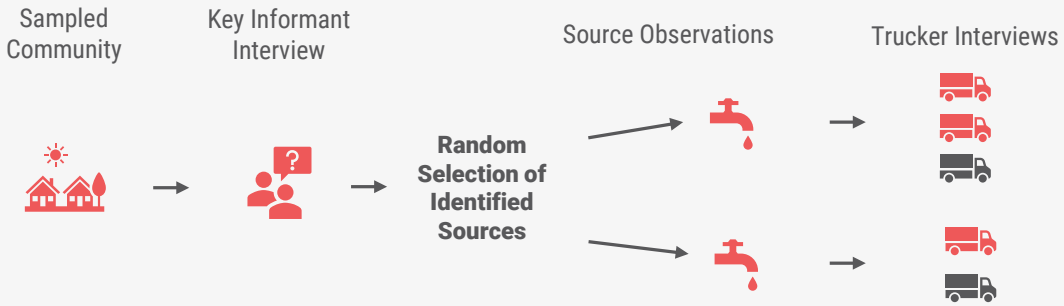
1. In order to identify communities with water sources used for trucking, data was collected between 24 and 31 October 2023. Overall, 965 locations - all accessible communities - in Northwest Syria (NWS) were assessed. Enumerators called one key informant in each location and asked a short set of questions about water sources in their location.
2. An extensive data collection was conducted between 15 and 25 January 2024. In this, information about water sources used by truckers was logged and 453 water truckers were interviewed, 269 in Aleppo and 184 in Greater Idleb.

   Truckers were identified as follows:

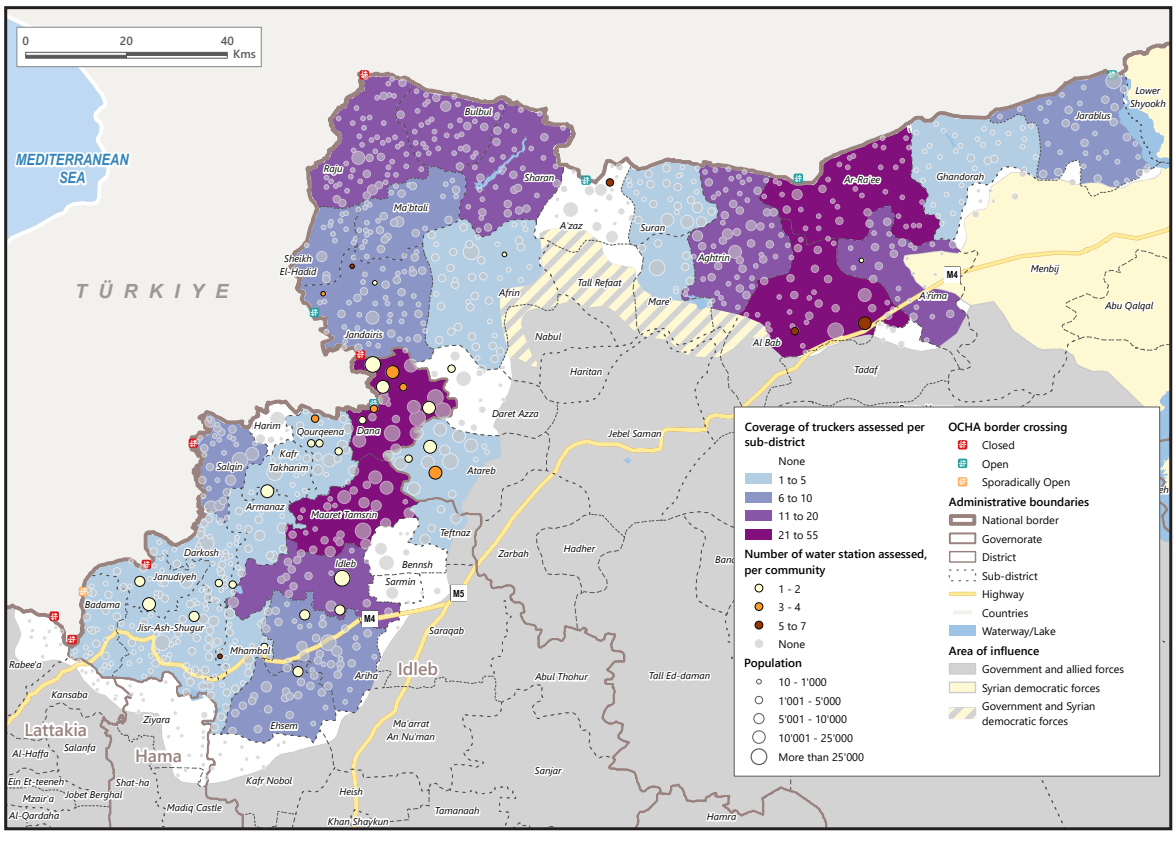
   - To identify truckers using private sources, eligible communities were randomly sampled. In the community, enumerators spoke to key informants to identify the location of the water sources. The survey tool then randomly selected water sources which the enumerator could access. Upon accessing the source, enumerators identified water truckers to interview. (see Figure 1 below)
   - To identify truckers using public water stations, data from the Assistance Coordination Unit (ACU) was used (see here). Public water stations were considered to be eligible if they were functional and used by water truckers. Enumerators accessed the water stations and identified water truckers to interview.

The reality of data collection meant that convenience sampling was applied. Hence, **the sample of truckers that was interviewed was not random and therefore is not representative of all truckers across all of NWS**. In particular, small water sources of limited importance were systematically excluded, meaning that truckers relying on larger water sources are overrepresented.

Figure 1 - Trucker Identification at Private Water Sources



Map 1: Locations of Water Trucker Interviews



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2. Water Sources in NWS

Northwest Syria is mountainous compared to the plains of central and eastern Syria. It sees higher levels of rainfall and more abundant, higher-quality groundwater than central and eastern Syria, though less so than the coastal governorates.[9] The key-informant level assessment conducted in October 2023 looked at the presence of various water sources across almost all communities in NWS. This assessment showed that the vast majority of water sources rely on groundwater, with less than 2% using surface water.[10] This reliance on groundwater is likely to have positive implications for water quality, as it is less easily contaminated by sewage, agricultural run-off, industrial waste, and other pollutants. However, years of intensive use of groundwater, primarily for agriculture, as well as changes in climate have led to a decrease in groundwater levels and declining water quality.[9] Localised assessments are needed to understand how much water can be sustainably extracted, and whether the quality of water is sufficient for drinking, agriculture, and other uses.

The greatest number of water sources was reported by key informants in the north of Idleb governorate (see map 2). This is a highly populated area, which may explain the large number of water sources observed here. Two thirds of the sources were reportedly privately owned, while over a quarter were owned by local authorities. These publicly owned sources tended to be more important, with over half of those that were functional serving all households in the community or even serving multiple communities. The majority of those sources was connected directly to a water network, while most sources used for water trucking were privately owned.

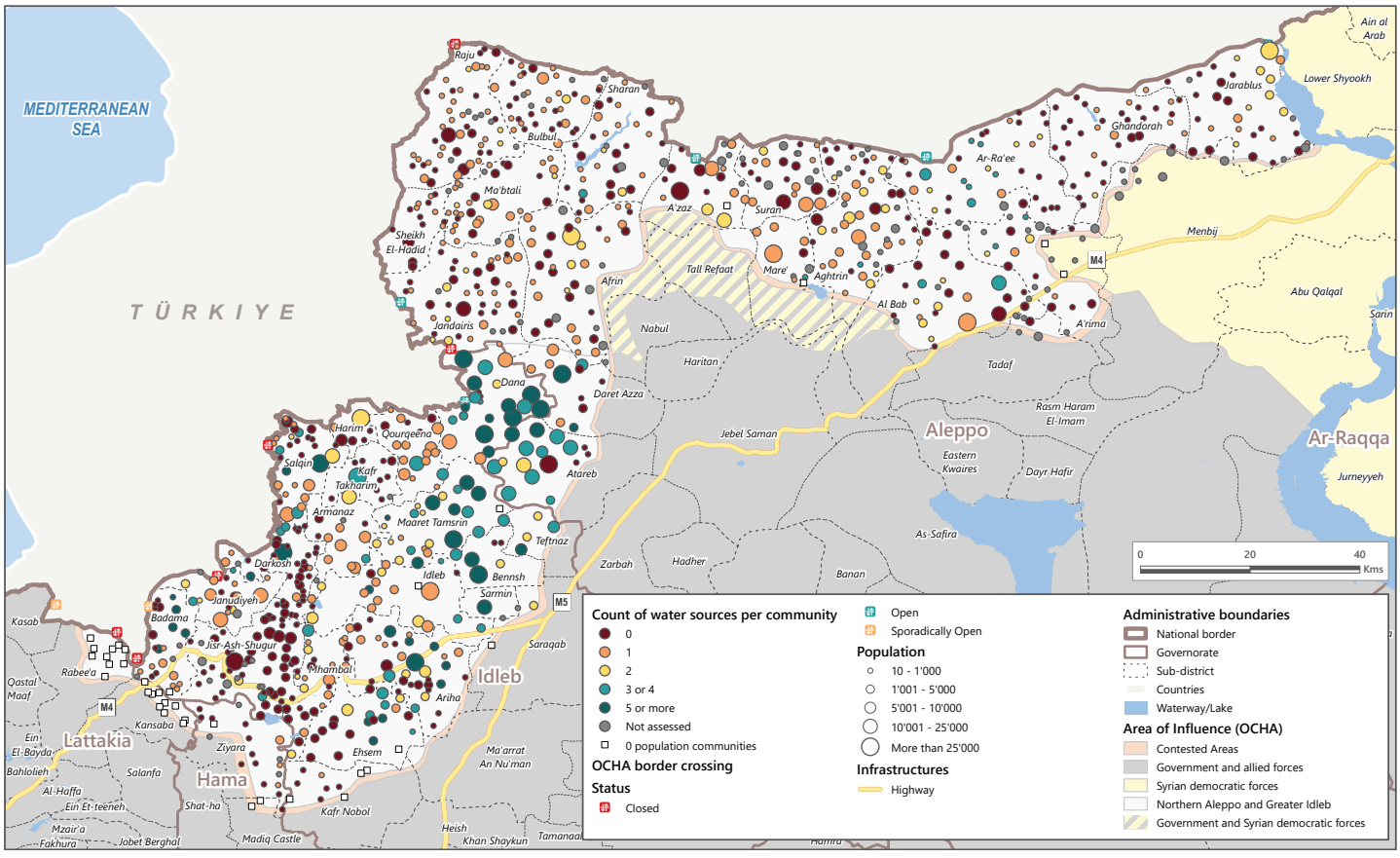
Prior to the outbreak of the Syrian conflict in 2011, Syrians widely used the piped water network. Water from the networks was heavily subsidised, so that household prices were lower than their operating costs.[1] However, by the end of 2021, 50% of water and sanitations systems were no longer functioning due to conflict-related damage, lack of maintenance, and other factors.[11] This is reflected in data collected for this report – 13% of sources owned by local authorities were not functional, and another 13% only partially functional.

3. Trucking Operations

The majority of interviewed truckers were self-employed and earned all of their incomes from trucking.

Water trucking operations are run by private vendors, non-governmental organisations (NGOs), or local authorities. While NGOs, as part of the humanitarian cluster system, regularly report on these activities, little to no information is available on private water trucking. In the October 2023 data collection, key informants in 95% of assessed communities reported that truckers did not have to register to *deliver* water, and in 97% they reportedly did not have to register to *collect* water,[10] which speaks to

Map 2: Number of Water Sources in Assessed Communities
as reported by key informants in October 2023



a general lack of oversight. Because of this, there is no information on how many private truckers operate across Northwest Syria.

To identify truckers for this data collection, REACH and partner enumerators accessed water sources used for trucking and interviewed truckers who were collecting water at the time of data collection. In this way, enumerators identified and interviewed over 450 water truckers. Of these, 420 (93%) were self-employed, with another 8 employed by for-profit organizations, and 25 working for NGOs or local authorities. This suggests that the majority of truckers are likely to be self-employed and thus operating without or with limited oversight. Note however that due to difficulties in identifying water truckers, this sample is not random and therefore does not represent the operations of all truckers across all of NWS.

These primarily self-employed truckers usually owned their own vehicles and earned all (71%) or most (20%) of their incomes through trucking. On average, they conducted over 3 deliveries per day and worked 5.5 days a week, to a total of almost 19 deliveries per week. However, the interviews were conducted in January, in the midst of the Syrian winter, and almost three quarters of truckers said that they completed much fewer deliveries than in summer. Some also noted that communities were able to rely on rainwater during the winter, reducing or eliminating the need for water trucking. To illustrate, a study conducted in Beirut, Lebanon, across multiple seasons found that while truckers conducted up to 50 deliveries a day in summer, this reduced to less than 20 deliveries in winter, with many truckers becoming inactive. Overall, supply of trucked water decreased by 78% in winter.[8] It is thus likely that there are many truckers who deliver water seasonally. These seasonal truckers might differ from those interviewed here. For instance, they might not own their own trucks, or might use their trucks to transport different types of goods in winter.

Trucked water was not chlorinated at the source or by truckers.

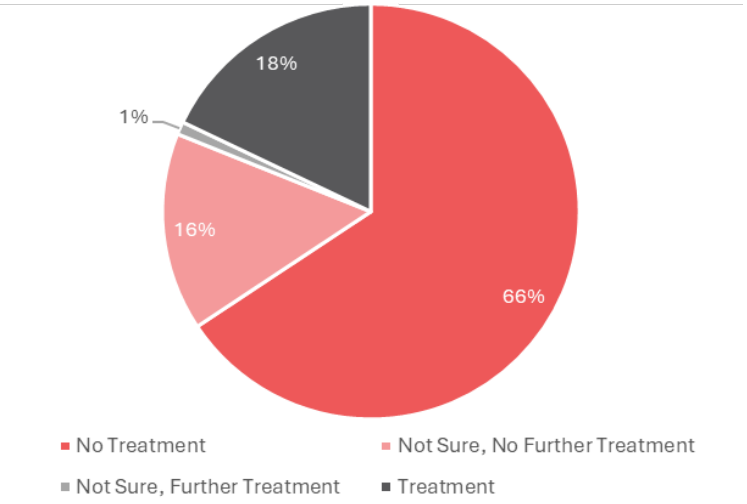
Most interviewed truckers only reported using one source for all of their trucking activities. Those using private water sources primarily used groundwater (93%), though some used reservoirs (5%). Reservoirs here are understood to be artificial basins or lakes into which groundwater is pumped and stored. Sources provided a mix of electric pumps (62%) and diesel pumps (55%). The pipes used were mostly standpipes, though a third of sources used loose pipes. These often did not have supports and so lay on the ground. This increases the risk of pipes becoming contaminated, particularly in case of damage. While not common, enumerators in two cases observed that the pipes lying on the ground were leaking, which means that dirt and bacteria can enter.

The trucks themselves lacked protective features. Guidelines from the WHO and WEDC state that trucks should have an access port large enough for a person to enter for cleaning, access points must be covered by a dust-proof lockable cover, and air vents (which are needed so air pressure can normalise while the truck is being filled and emptied) should have screens that prevent dust and insects from entering the water tank.[12] However, only a fifth of truckers reported having access ports, 71% reported having dust-proof lockable covers, and a fifth reported having screened air vents. Additionally, the guidelines state that water tanks and pumps should be cleaned at least every three months. 10% of the truckers interviewed reported never cleaning their water tanks and pumps, while 38% cleaned them less than every three months. Taking together the lack of protective features of trucks, inadequate cleaning, and the lack of water treatment (discussed below), this raises substantial public health concerns. In a study on trucking in Beirut, researchers found that trucks themselves were an important source of coliform bacteria contamination.[8] While coliform bacteria themselves are not likely to cause illness, their presence is an indicator that harmful diseases may be present in the water.[13]

In terms of water treatment, consider figure 2. 66% of truckers knew that the water was not treated at the source, and they did not chlorinate it themselves or deliver chlorine to the customers. In other words, they delivered untreated water to households and provided no means to disinfect it. Another 16% were not sure whether the water was previously treated. These truckers usually did not provided any further treatment. Of the remaining 18% who did report some form of water treatment, almost two thirds reported that the water had been chlorinated at the source, and half that they chlorinated it themselves. This was primarily reported by truckers who used public water sources, i.e. sources managed by NGOs or local authorities.

Figure 2: Proportion of Truckers Reporting Water Treatment

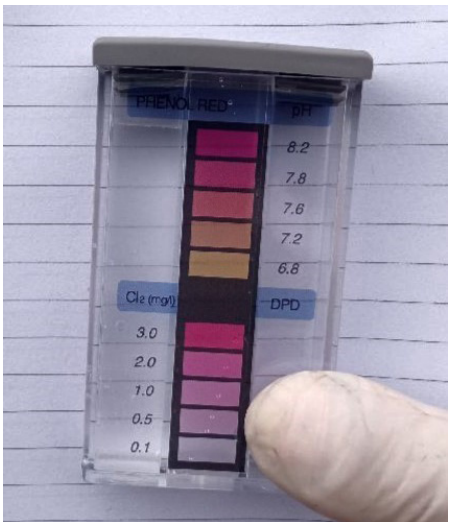
as reported by water truckers in January 2024



Comparing with available data on public stations,[14] truckers often reported that water was not treated although the stations did chlorinate the water. It may be that water was not being chlorinated at the time of data collection. Otherwise, truckers might not be aware of the treatment of the water.

Whenever water had reportedly been chlorinated by the time of data collection, enumerators conducted a test for Free Residual Chlorine (FRC). When chlorine is added to the water, it kills most organic matter. If enough chlorine is added, not all of it will be used up and some will remain as FRC. This is important because the remaining chlorine protects the water from future contamination.[15] The general guidance is that at least 0.5 mg of chlorine per litre of water should remain after chlorination.[12,16] In the tests conducted by our enumerators, two thirds of tests (38 out of 57) came back with 0.3 mg/l or less. In fact, many of the tests showed no noticeable signs of chlorine, see photo 1. Note that almost 80% (45 out of 57) of truckers that reported chlorination also reported that their water was being tested for FRC, usually by NGOs.

Photo 1: Photo of an FRC Test With No Noticeable Signs of Chlorine

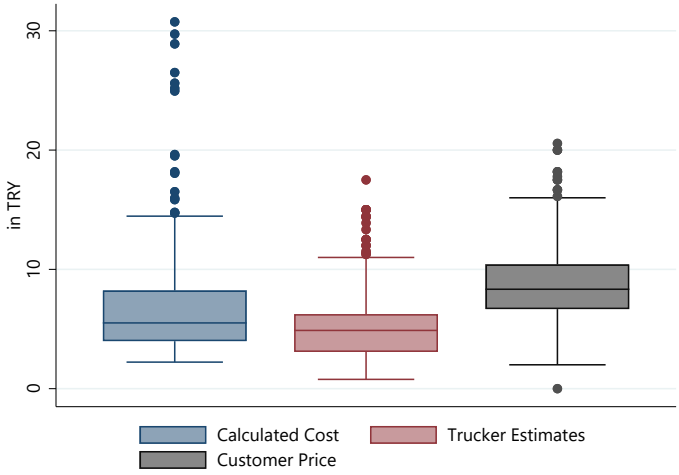


The cost of water and fuel were the main factors impacting overall costs of water trucking.

Truckers reported both on their overall costs and their different points of expenditure, such as fuel for transport or cost of pumping water. When reporting on overall costs, truckers tended to report somewhat lower values than when reporting on each expenditure point individually* (hereafter "calculated costs"). Overall, private water truckers reported a median cost per barrel (200l) of 4.9 TRY (see figure 3). Looking only at truckers who gave values for all expenditure points (280 out of 420 private truckers), their overall estimates for expenditures were 4.6 TRY per barrel while the calculated costs came out to 5.5 TRY. This excludes one-off registration costs, which were reported by 8% of truckers, and the cost of buying the truck and other equipment. It also excludes the cost of the truckers' labour.

Figure 3: Cost of Water Trucking Operations Per Barrel**

as reported by water truckers in January 2024



* Included costs are: water, chlorine and other water treatment, fuel, pumping, maintenance, and renting the truck.

For Private Truckers:

2.1 TRY per barrel The highest cost was the cost of purchasing water, at a median price of 2.1 TRY per barrel.

21 TRY per litre The second highest was the cost of fuel. Most truckers travelled 0.5 to 10 km from the source to the customer, with a median of 3 km. Truckers used a median of 0.7 litres of fuel per km at a cost of 21 TRY per litre.

1 TRY per barrel The third highest cost was pumping water, at a median of 1 TRY per barrel.

700 TRY per month And finally, only 300 truckers were able to estimate their maintenance costs, with a median of 700 TRY per month.

Only 26 of the 420 private truckers reported any costs for registration or permits; they were usually one-off costs, costing anywhere between 100 and 10,000 TRY.

The wage of the trucker is the difference between the price the customer pays and the costs the trucker faces. Calculated this way, the median income of a private water trucker was 70 TRY per delivery using trucker's self-reported costs, and 52 TRY using calculated costs. Looking at those private truckers whose only income came from trucking, they conducted a median of 20 deliveries per week at 50-70 TRY per delivery, which sums to 1,000-1,400 TRY or 33-46 USD per week, depending on the calculation method. This wage is equivalent to the survival minimum expenditure basket for a 6-person households for one month[17] and is substantially higher than key informant reports of wages for unskilled daily labour.[19] Considering this and the relatively high proportion of individuals working in trucking in some contexts,[22] water trucking may be a relevant source of livelihoods in NWS.

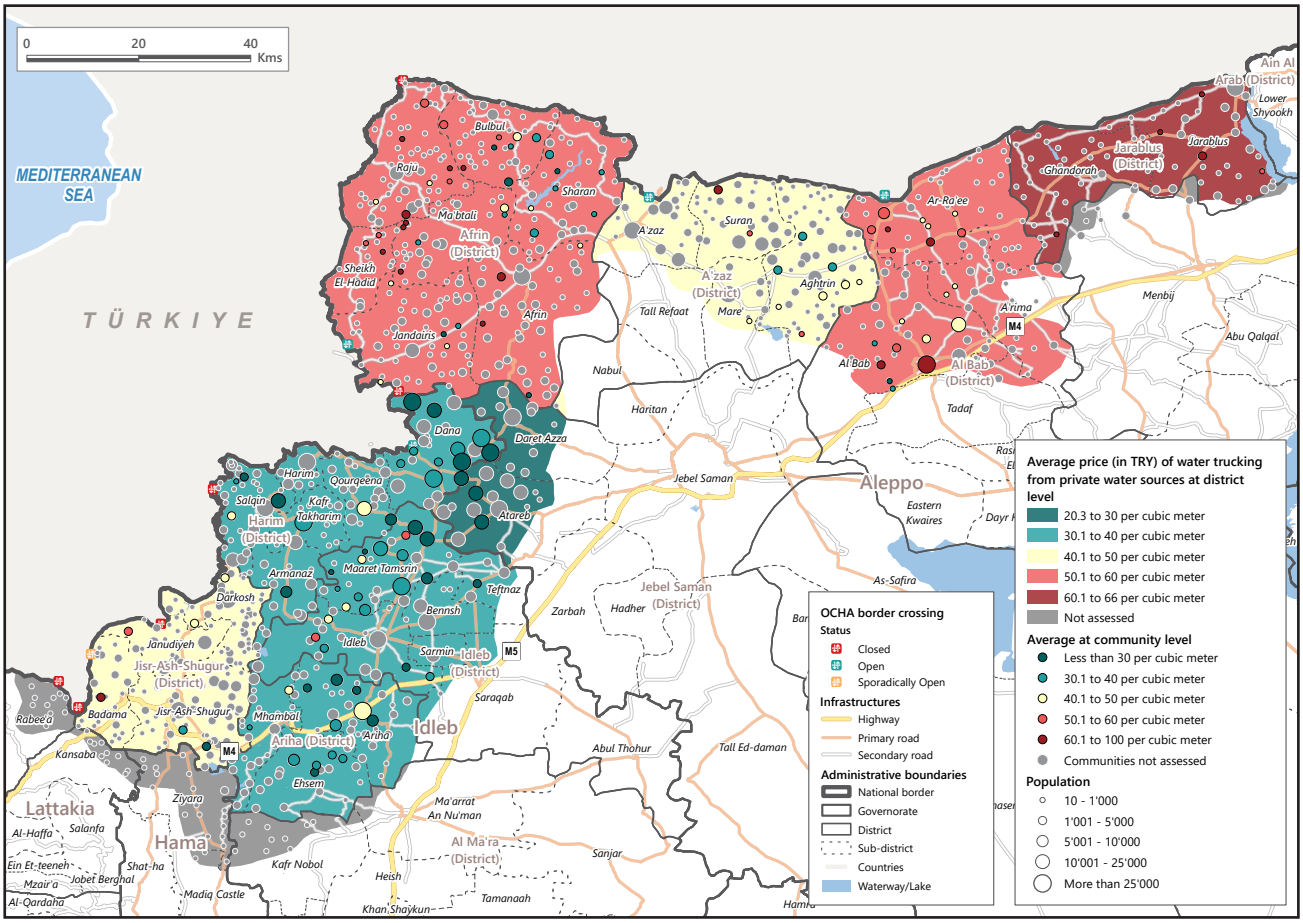
As shown in figure 3, prices for trucking vary strongly from delivery to delivery. A major factor in this is the time taken to deliver the water, with longer delivery times translating to higher prices. Truckers and enumerators noted that trucking operations were impacted by rugged and mountainous roads, with truckers at times having to drive longer distances to avoid unsuitable roads. This is

** Box Plot

The boxes show the range of expenditures of middle half of households, i.e. values between the 25th and 75th percentiles of expenditures. The horizontal lines inside the boxes show the median expenditures. The vertical lines represent the full range of values, except for those that are unusually far away from the median, i.e. outside the interquartile range, shown as dots.

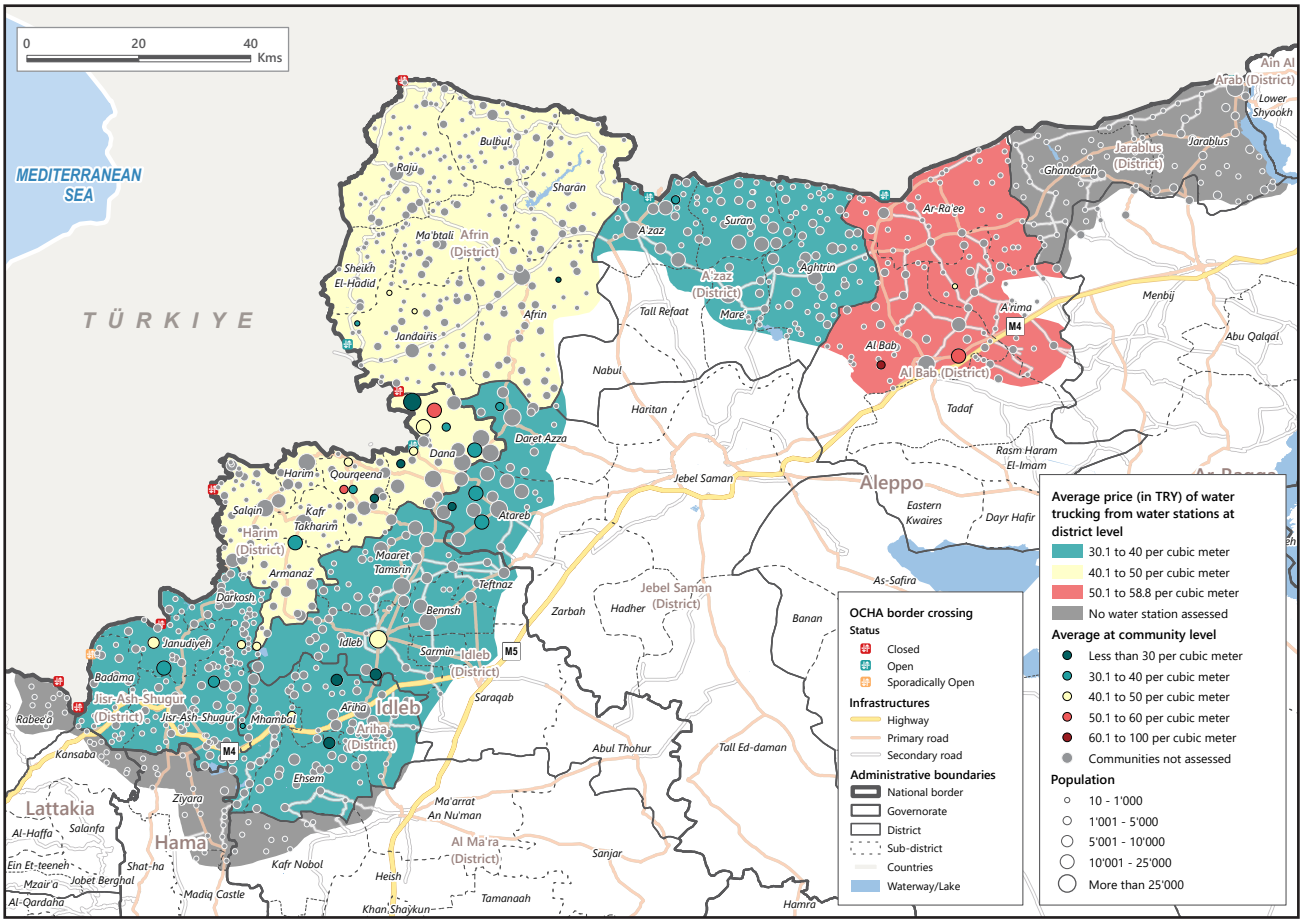
Map 3: Reported Prices of Trucked Water from Private Water Sources

as reported by water truckers for their current operations at the time of data collection



Map 4: Reported Prices of Trucked Water from Public Water Stations

as reported by water truckers for their current operations at the time of data collection

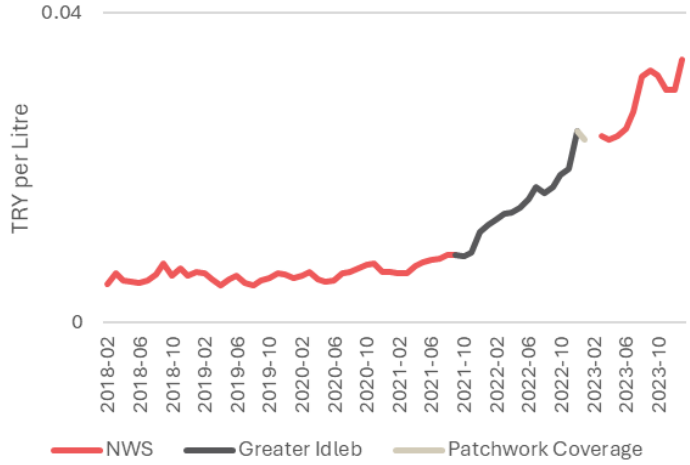


a two-way relationship, where bad road conditions can disrupt trucking activities and lead to truck damage, but conversely water trucks, being very heavy, can damage roads.[12]

While it might be assumed that seasonality would have a substantial impact on costs – higher demand in summer leading to higher prices – indicative data on water trucking prices over the past 6 years do not show strong signs of seasonality (see figure 4).[17] One possible explanation is that an increased number of truckers in summer increases supply sufficiently to offset the impact of increased demand. In line with this, a global review of small water vendors (including, but not exclusive to, water truckers) found that private water vending in most areas is a competitive business where prices are set to cover costs, rather than generating high profits.[3]

Other factors determining prices might include the depth of boreholes and the height of water tanks affecting pumping costs,[8] as well as additional services provided, such as delivering variable quantities of water.[3] These variables were not captured in this assessment.

Figure 4: Cost of Trucked Water per Litre[17]
as reported by water trucking key informants



4. Impacts on Households

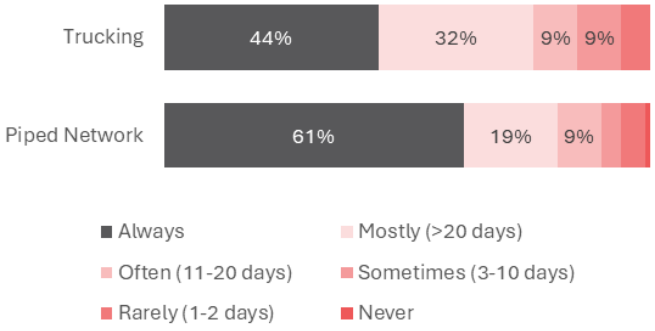
Almost half of the population depended on water trucking and the other half on piped networks.

In the 2023 household-level Multi-Sectoral Needs Assessment (MSNA), only 44% of households in NWS reported using the piped networks into their dwelling as their primary source of water, compared to 45% who primarily used water trucking. This differed strongly by population type. For host community populations, a third primarily relied on trucking. For in-camp populations, this was twice as high at two thirds of households.[2] NWS has some 1.9 million internally displaced persons (IDPs) who live in camps,[18] primarily in tents and concrete block shelters.[2] Given the transitory nature of displacement, IDPs depend on flexible, on-demand sources of water that do not require great investments in infrastructure. Availability of water networks also depended on the location of communities. Generally, households in larger communities were more likely to use water networks. Possibly as a result, households in Greater Idleb, in which communities are generally larger, were more likely to use networks, while those in Northern Aleppo more commonly relied on water trucking.[2,19]

Households that relied only on trucked water were less likely to report that they had enough water.

When asked how many days in the past month they had enough water, households relying on piped networks were more likely to say every day (61%) compared to those who relied on trucking (44%) (see figure 5). Since reliance on water trucking is not random, but rather may be linked to the location of the household, their economic means, and the type of shelter, this may affect their access to water. After statistically controlling for these factors, households relying exclusively on water trucking still had lower levels of water sufficiency than those relying only on piped networks.*

Figure 5: Household Water Sufficiency in the Past 30 days, by Source[2]
as reported by households in September 2023



Water sufficiency depended substantially on the combination of primary and secondary sources. For instance, households who primarily relied on networks but used water trucking as a secondary source were significantly worse off than those who relied only on networks. In fact, they were even worse off than those who reported trucking as their first source and networks as their second – the same two sources, but with different importance assigned to each.

One possible explanation for this is that networks in some areas function intermittently or provide insufficient water, forcing households to supplement with trucked water. In 11% of communities that relied on a combination of networks and trucking, key informants reported that access to water was limited by networks not pumping frequently enough.[19] In 2022, REACH and partners ran a

* In order to control for these factors, an ordered logit regression was run. The "days with sufficient water" indicator was converted into an ordinal variable. Independent variables included were primary and secondary water sources, as well as income per person, shelter type, community size, and subdistrict. The coefficient for water trucking with no secondary source was negative and statistically significantly different from zero compared to the baseline of network with no secondary source. However, omitting the secondary source left the source type indicator insignificant, suggesting that the secondary source used has a substantial impact on reported water sufficiency.

number of in-depth area-based assessments on water management systems in a few locations across northern Syria. One of the issues observed was that households at the end of water pipelines received too little water and had to supplement with water trucking.[20] On the other hand, households that relied primarily on trucked water and supplemented with networks may be better equipped to deal with network shortages, for instance if they have better social connections with water truckers, bigger storage tanks, more frequent water deliveries, or simply higher incomes. However, qualitative research would be needed to understand how households decide which water sources to use and how easily they are able to cope with supply disruptions.

Additionally, as described in the academic literature, water trucking and other forms of water vending provide water on demand in hard-to-reach areas, and thus play an essential role in providing water to households who would otherwise have no access.[3,6] Networks are expensive to establish in areas with low population density and rugged terrain, so that they are not necessarily the most effective solution in the short term.[3]

Despite facing lower levels of water sufficiency, households that primarily relied on water trucking had higher water expenditures.

Almost a third of households reported their water expenditures to be zero. This was largely driven by the in-camp IDP population, almost two thirds of whom reportedly did not pay for their water. Compare this to host community populations and out-of-camp IDPs, 84% of which paid for their water. For out-of-camp populations, those relying on water trucks were both significantly more likely to pay, and paid significantly more. The median out-of-camp household that relied only on the water network paid 10 TRY per person per month for water. Those who primarily used networks and supplemented with trucking paid 29 TRY per person per month. And those using only trucking paid 50 TRY per person per month, a 5-fold difference to water networks.* This is illustrated by the box plot in figure 6, which shows expenditures for specific combinations of primary and secondary sources. Note that while the median household relying on trucking did spend significantly more on water, the range of expenditures was large, and a number of households spent less on trucking than others did on network water.

Looking at the proportion of income the out-of-camp households spent on water, those that relied only on water trucking with no secondary source spent a median 10.5% of their incomes on water. This is more than twice the 5% upper limit suggested by the Sphere Standards, with almost three-quarters of households exceeding this limit.[21] Note that households generally reported very high expenditures that often exceeded total income. Looking instead at proportion of expenditures that went towards water, the median was around 5.6%, with over half exceeding the 5% mark. By contrast, those relying only on networks with no secondary source put 1% of their expenditures towards water.

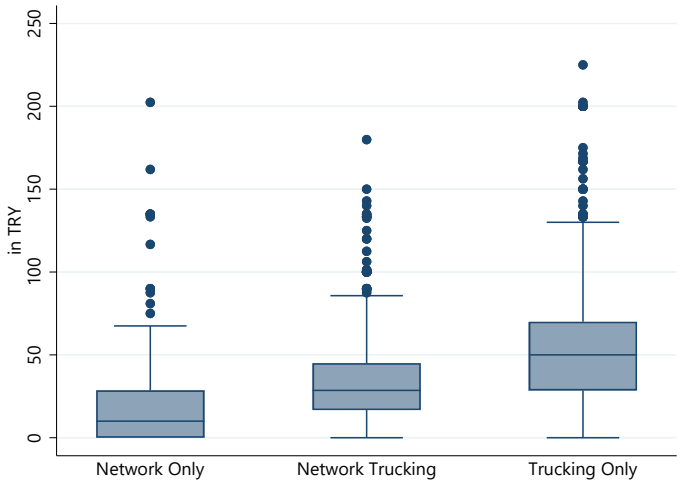
Given the poor livelihoods situation of many households in NWS, it may be that households are reducing their water consumption due to unaffordability. This is supported by the earlier finding that households relying on trucked water had lower levels of water sufficiency. This means that when looking at actual water expenditures, the higher price of trucked water may be partially offset by the lower quantities of water consumed by households relying on trucking due to their inability to afford sufficient water. The actual economic burden of water trucking may thus be higher than what is calculated here.

The finding of households paying more for water trucking is common in the literature. A 2015 paper looking at a network rehabilitation programme from a non-governmental organisation in NWS found that monthly operational and maintenance costs for network water supply equated to between USD 0.35 - 0.72 per m^3, depending on the location. This compared favourably to the USD 1.5 – 5 per m^3 that truckers were charging, depending on the location and season.[1] A global academic literature review looking at urban areas found that while trucking prices differ strongly by source, season, road conditions, and more, water trucking almost always cost more for consumers than water networks. Additionally, it generates negative externalities such as being more energy intensive, damaging roads, and others.[6] A global review by the World Bank found that water trucking was substantially more than 5 times as expensive as water networks.[22]

Data on the safety of trucked water is mixed; given the lack of water treatment by truckers, trucking may pose a public health risk.

It was previously discussed that truckers undertake insufficient measures to protect and treat water. However, evidence of water quality at the household level is mixed. When asked about problems with drinking water, community key informants tended to report no issues (51% of assessed communities) or that water was calcareous (i.e. high in minerals; 47%), regardless

Figure 6: Water Expenditures Per Person for Out-of-Camp Households, by Primary and Secondary Sources[2]
as reported by households in September 2023



* The values presented here are weighted medians.

of sources.[19] Calcareous water is not generally a health concern, and may even improve magnesium and calcium intake of consumers. It may be a nuisance in applications such as cleaning, as it increases the amount of soap needed and renders some detergents ineffective.[23] Key informants did not ordinarily report problems with smell, colour, or taste, (<2%) and key informants in only 2 out of 677 communities reported that water was perceived to be making people sick (0.3%).[19]

However, since the outbreak of cholera in September 2022, over a 190,000 suspected cases were reported in NWS.[24] Cholera is a severe diarrhoeal disease which spreads primarily when water and food are contaminated with faecal matter from infected persons.[25] The high rate of suspected cases might be linked with contamination of water used for drinking or washing fruits and vegetables, or of irrigation water, in addition to sanitation and hygiene problems.[26] Without concrete tests, it cannot be said which water sources are affected and there may be no link with water trucking. What rigorous studies have globally shown though is that unimproved water sources, including but not exclusive to water trucking, had significantly higher levels of faecal contamination, with storage of water at the household level further contributing to contamination.[4,5]

Chlorine does not destroy all pathogens, and it will not remove chemical contamination. Yet, it does effectively disinfect water and provides protection during transport and storage.[15] It also prevents the build-up of organic materials in the truck,[12] though some truckers prefer not to add chlorine in their tanks as it may be corrosive to metal. Providing households with chlorine can be an alternative to prevent truck damage.[16] Regardless of when it is added, chlorine helps to prevent severe and life-threatening diseases such as cholera,[27] though it does not replace investments into improved WASH infrastructure.[28]

5. Summary & Conclusions

The Syrian conflict has caused widespread damage and inhibited maintenance of water networks. In light of this damage, water trucking has become as common of a source of water as piped networks. The vast majority of water sources used by truckers relied on groundwater, which is a relatively safe source of water. These were most commonly owned by private persons, while sources that were managed by local authorities were more commonly connected to the network.

Purchasing water from these sources was the highest cost private truckers in this assessment faced, at around 2.1 TRY per barrel. The second highest expenditure was fuel despite the relatively short distances truckers travelled between the source and the customer (median 3 km). Households that the trucker required more time to reach tended to pay higher prices for trucked water. The median price per barrel charged by private truckers was 8.3 TRY. Delivering around 24 barrels per delivery, this left truckers earning around 52 or 70 TRY per delivery – depending on the method for calculating costs. For the majority of truckers, this was their only source of income, and they worked over 5 days a week delivering water even in winter.

Out-of-camp households who depended on trucked water usually paid much more than households who were able to rely exclusively or primarily on water networks. They were also more likely to report not having sufficient water. Given the on-demand nature of water trucking, the most likely explanation is that households cannot afford to purchase sufficient quantities of water from truckers. Even with households accessing insufficient quantities of water, the majority of out-of-camp households spent more than 5% of their incomes on water – above Sphere Standard guidance. From a supply-side perspective, global research suggests that water trucking operations are substantially more expensive than network water systems. Past work in rehabilitating water networks in NWS came to the same conclusions – operating and maintaining networks costs far less than trucking water.

Most trucked water was insufficiently protected from contamination. Trucks lacked basic safety features, and truckers cleaned their tanks infrequently. The water purchased at the source was usually untreated, and truckers neither chlorinated it themselves nor provided chlorine to households. Research in Beirut suggests that trucks themselves are a significant source of bacterial contamination, suggesting that trucking may contribute to public health risks. Global research also shows that unimproved sources of water, including water trucking, where much more likely to be contaminated with faecal bacteria. Chlorinating trucked water, particularly during disease outbreaks such as the September 2022 cholera outbreak, can mitigate risks.

However, in the words of the WHO:

"When there is a cholera outbreak, responders rush in soap and chlorine tablets, bring in safe water in trucks, and build temporary latrines to prevent the outbreak from spreading. While these actions are undoubtedly life-saving, longer-term investments in WASH infrastructure can prevent outbreaks in the first place. Wherever in the world cholera has been eliminated, it has been thanks to improvements in basic water, sanitation and hygiene – access to these is an internationally recognized human right."[28]

ABOUT REACH

REACH Initiative facilitates the development of information tools and products that enhance the capacity of aid actors to make evidence-based decisions in emergency, recovery and development contexts. The methodologies used by REACH include primary data collection and in-depth analysis, and all activities are conducted through inter-agency aid coordination mechanisms. REACH is a joint initiative of IMPACT Initiatives, ACTED and the United Nations Institute for Training and Research - Operational Satellite Applications Programme (UNITAR-UNOSAT).

ENDNOTES

[1] Boot NL, Chen Y, Cohen S, Khayat W, Steele A. Delivering sustainable water supply in fragile and conflict affected states: experiences from Syria. Published January 2015. Accessed February 12, 2024. https://repository.lboro.ac.uk/

[2] REACH Syria, OCHA. Multi-Sectoral Needs Assessment (MSNA) - Syria 2023. Published October 2023.

[3] Opryszko MC, Huang H, Soderlund K, Schwab KJ. Data gaps in evidence-based research on small water enterprises in developing countries. Journal of Water and Health. 2009;7(4):609-622. doi:10.2166/wh.2009.213

[4] Bain R, Cronk R, Wright J, Yang H, Slaymaker T, Bartram J. Fecal Contamination of Drinking-Water in Low- and Middle-Income Countries: A Systematic Review and Meta-Analysis. PLOS Medicine. 2014;11(5):e1001644. doi:10.1371/journal.pmed.1001644

[5] Shields KF, Bain RES, Cronk R, Wright JA, Bartram J. Association of Supply Type with Fecal Contamination of Source Water and Household Stored Drinking Water in Developing Countries: A Bivariate Meta-analysis. Environmental Health Perspectives. 2015;123(12):1222-1231. doi:10.1289/ehp.1409002

[6] Zozmann H, Morgan A, Klassert C, Klauer B, Gawel E. Can Tanker Water Services Contribute to Sustainable Access to Water? A Systematic Review of Case Studies in Urban Areas. Sustainability. 2022;14(17):11029. doi:10.3390/su141711029

[7] Aklan MM, de Fraiture C, Hayde LG. Which Water Sources Do People Revert to in Times of War? Evidence from the Sana'a Basin, Yemen. Int J Environ Res. 2019;13(4):623-638. doi:10.1007/s41742-019-00205-9

[8] Constantine K, Massoud M, Alameddine I, El-Fadel M. The role of the water tankers market in water stressed semi-arid urban areas: Implications on water quality and economic burden. Journal of Environmental Management. 2017;188:85-94. doi:10.1016/j.jenvman.2016.11.065

[9] Baba A, Karem RAL, Yazdani H. Groundwater resources and quality in Syria. Groundwater for Sustainable Development. 2021;14:100617. doi:10.1016/j.gsd.2021.100617

[10] REACH Syria. Water Source Mapping in Northwest Syria. Published October 2023.

[11] Daher J. Water Scarcity, Mismanagement and Pollution in Syria. European University Institute; 2022. Accessed February 8, 2024. https://south.euneighbours.eu/

[12] WHO, WEDC. Delivering safe water by tanker. Published July 2013. Accessed February 8, 2024. https://www.susana.org/

[13] Washington State Department of Health. Coliform Bacteria in Drinking Water. Accessed March 4, 2024. https://doh.wa.gov/

[14] Assistance Coordination Unit (ACU). Water Stations Database Weeks 47 & 48. Published November 2023.

[15] WHO, WEDC, eds. Measuring Chlorine Levels in Water Supplies. Hermann; 2013. https://cdn.who.int/

[16] Wildman T. Technical Guidelines On Water Trucking in Drought Emergencies. OXFAM Accessed February 8, 2024. https://www.oxfamwash.org/

[17] REACH Syria, Cash Working Group. Joint Market Monitoring Initiative (JMMI). Published January 2024. https://repository.impact-initiatives.org/

[18] Population Taskforce. Population Data July 2023. Published July 2023.

[19] REACH Syria. Humanitarian Situation Overview in Syria (HSOS). Published January 2024. https://www.reachresourcecentre.info/

[20] REACH Syria. Water Area-Based Assessments in Northern Syria. Published January 2023.

[21] Sphere. The Sphere Handbook 2018. Published 2018. Accessed March 4, 2024. https://spherestandards.org/

[22] Kariuki M, Schwartz J. Small-Scale Private Service Providers Of Water Supply And Electricity : A Review Of Incidence, Structure, Pricing, And Operating Characteristics. The World Bank; 2005. doi:10.1596/1813-9450-3727

[23] Skipton SO, Dvorak BI. Drinking Water: Hard Water. Nebraska Extensions. Published May 2016. Accessed March 5, 2024. https://extensionpubs.unl.edu/

[24] WHO, Health Cluster. Cholera Response Tracking Dashboard 2022-2023 Northwest Syria. Published December 2023. Accessed March 5, 2024. https://app.powerbi.com/

[25] WHO. Cholera. n.d. Accessed March 5, 2024. https://www.who.int/

[26] Daoudy M, Dureid M, Mayer-Rich E. Northwestern Syria in the Time of Cholera, Earthquakes, and Environmental Degradation. Carnegie Middle East Center. Published July 2023. Accessed February 4, 2024. https://carnegie-mec.org/

[27] MSF. 3.3 Supply of safe water | MSF Medical Guidelines. n.d. Accessed March 5, 2024. https://medicalguidelines.msf.org/

[28] The cholera emergency is avoidable. Accessed March 5, 2024. https://www.who.int/