Unreliable Water Sources in the West Bank

Revealing the challenges in Al-Walaja Village

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WSSS
WATER: SYSTEMS, SCIENCE & SOCIETY

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Source: Colleen O'Brien

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Executive Summary

Since 2012, graduate students from the Water: Systems, Science and Society (WSSS) program at Tufts University have been working in Bethlehem to develop and maintain water quality monitoring programs in Palestinian communities. In the summer of 2016, together with two nonprofits, the Lajee Center (a Palestinian NGO in Aida refugee camp) and 1for3 (an American NGO that addresses environmental health and quality of life issues in Palestinian communities), we started a water quality monitoring and education program in Al-Walaja village. The following report present a summary of our findings.

Managing water resources in the West Bank is a complex issue, due to the ongoing political conflict between Israel and Palestine. There are four main sources of water in the West Bank: the Jordan River and the North-Eastern, Western, and Eastern Aquifers. These were once shared sources but since the Six Day War, in 1967, the West Bank no longer has access to water in the Jordan River and control of the remaining water resources, as well as the development of wells across the West Bank, has fallen under Israeli administration (World Bank 2009).

Article 40 of the Oslo Accords, signed in 1995, initiated the recognition of Palestinian water rights and called for a coordinated effort for water management between the two parties. Although the accords were intended to be a 5-year interim agreement until permanent negotiations were concluded, no further negotiations or agreements have been made since their drafting and the interim agreement still governs the use of water in this region today (Israel Ministry of Foreign Affairs 1995).

Water quantity and quality in the region have been rapidly decreasing due to the overdrawing of groundwater and pollution from aged and deteriorated cesspits and septic tanks.

Situated northwest of Bethlehem city, Al-Walaja village sits on 4.328 square kilometers of land between the 1948 Green Line, Beit Jala town, Battir and Husan village, and the Har Gilo Israeli settlements (ARIJ 2010). In 2007, the village had a population of 2,041 with 390 households (ARIJ 2010). Al-Walaja is located mostly in Area C, which is under full Israeli civil and military control.

There are three main sources of water in Al-Walaja: piped water from the Palestinian Water Authority (PWA), rainwater collected in underground cisterns and bottled water or tankered water, water delivered in large quantities by water trucks.

Data gathering consisted of household surveys, water sample collection and testing to assess water quality and availability in Al-Walaja village. The team surveyed three different neighborhoods in Al-Walaja village over five days: Al Khala, Al Thahar and Ain Jawaizeh. The households were randomly selected for survey and sample collection. A total of 58 water samples were collected and 52 households were surveyed in Arabic with local translators and in accordance with a Tufts IRB approved protocol.

The samples were collected in each home from either a kitchen or bathroom water faucet. In addition, samples were collected from three cisterns and four point-of-use filters. Out of the 50 kitchen or bathroom water samples collected 15 were contaminated with total coliforms and two with *Escherichia coli* (*E. coli*). All three cistern samples tested positive for total coliforms and one tested positive for *E. coli*. Out of the four filter samples tested three contained total coliforms but none contained *E. coli*.

The information gathered during our research helps to characterize the water situation in the village, and also illuminates next steps and priorities for future work. Based on survey answers, both water quantity and quality issues are more prevalent in the dry season when households suffer the greatest water shortages. During this time, some families often rely on cistern water as a secondary water source. Because cistern samples and three out of four filters samples returned positive, follow-up with the community should be conducted to determine if households who depend on cistern or filter water take appropriate measures to clean their water or change their filter. In addition, further studies would help explain why parts of the village, such as Ain Jawaizeh, suffer from water shortages in the dry season.

The team provided the newly-established Environment Unit at the Ansar Center with the necessary equipment and resources for future water testing and community education. Additional resources will be needed to maintain the Environment Unit.

Part 1: Introduction

According to the United Nations, safe drinking water and adequate sanitation services are a human right and vital to human health (United Nations 2017). Unfortunately, 1.8 billion people across the world do not have access to clean drinking water and Palestinians are no exception (World Health Organization 2017). Water shortages, combined with a lack of adequate sanitation services, mean that the refugee population in the West Bank is under constant risk of waterborne diseases (UNRWA 2011). To help address this deficiency, students in the Water: Systems, Science and Society (WSSS) Program at Tufts University have been working in the West Bank since 2012. The work involves developing water quality monitoring programs and conducting surveys in Palestinian communities.

The WSSS program, created in 2004, is an interdisciplinary graduate certificate program that provides students with the tools to understand and develop practical solutions to water problems around the world. The first WSSS student team traveled to Aida, a Palestinian refugee camp in 2012, where with the support of the Lajee Center, a non-profit organization in Aida Refugee Camp, they established a water quality monitoring program. This included testing household drinking water and conducting public health surveys. They also helped raise funding for an environmental coordinator to manage future testing and recruit youth to maintain the program (WSSS 2012). The 2013 team also tested water and conducted surveys in Aida Camp. They helped expand the water program by providing mitigation tools, including chlorine tablets and point-of-use filters to households with contaminated water (WSSS 2013). The main objective of the 2014 team was to expand the youth involvement in the water program in Aida Camp. They held after school workshops on water quality testing and health impacts of contaminated water (WSSS 2014). To involve more community members, WSSS partnered with 1for3, a US-based non-profit organization, in 2015. In 2016, the team went to a different refugee camp, Al-Azza, also in Bethlehem. The team replicated the water quality monitoring program in Aida, including testing water and conducting surveys on public health issues (WSSS 2016). With the success of the work in these two camps, 1for3 and the Lajee Center decided to expand to the neighboring community of Al-Walaja village for this year's WSSS project.

Our team consists of graduate students from Civil and Environmental Engineering, Urban and Environmental Policy and Planning, and the Fletcher School of Law and Diplomacy. We used strategies previously developed by WSSS students working in Aida and Al-Azza camps to develop a water quality monitoring program in Al-Walaja in collaboration with their community center, the Ansar Center. This area was chosen because drinking water often becomes contaminated with pathogenic bacteria, which have negative impacts on the health of village residents.

The goal of our project was to expand access to safe drinking water by developing and implementing a water quality monitoring and education program in the village of Al-Walaja.

Specifically, our three objectives were to:

- Expand previous work done by WSSS students elsewhere in the West Bank to Al-Walaja village.
- Identify issues in the village around water quality and quantity.
- Leave the center with the necessary equipment and resources for future testing and community education.

In order to fulfill these objectives, we spent five days conducting surveys and collecting and testing water samples in Al-Walaja village. We also met with various stakeholders including the Palestinian Water Authority (PWA), United Nations Relief and Works Agency for Palestine (UNRWA), community leaders, and Palestinian and Israeli researchers.

Part 2: Background

2.1 Water Resources in the West Bank

There are four main sources of freshwater in the West Bank: The Jordan River and the North-Eastern, Western, and Eastern Aquifers, collectively referred to as the Mountain Aquifer (depicted in Figure 1).

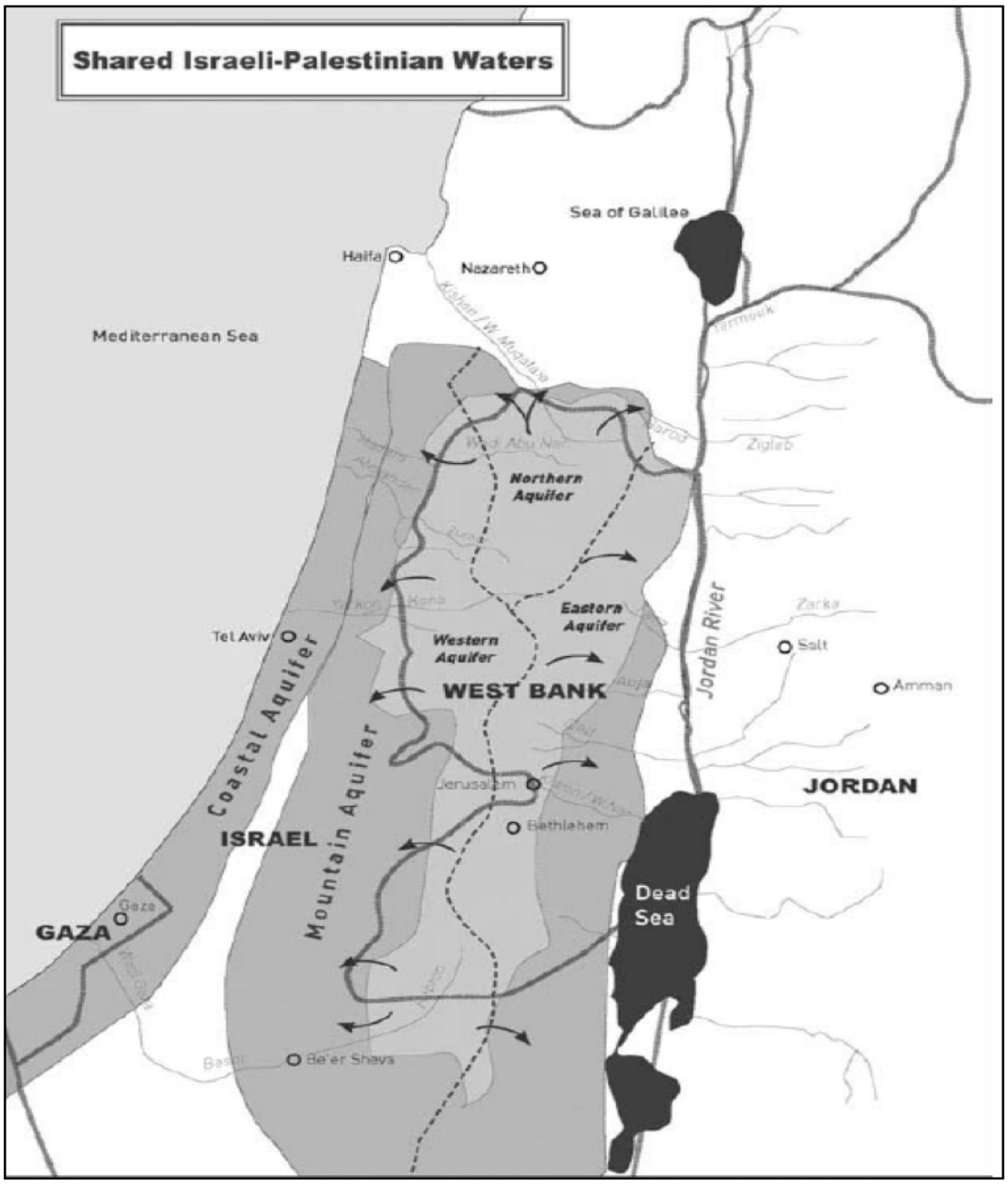

Figure 1. Aquifers in Israel and Palestine
Source: Brooks et al. 2013

Table 1 gives a breakdown of each aquifer's annual recharge and their estimated potential yield (amount of water) based on Article 40 of the Oslo II Accords analysis (discussed later).

Table 1. Estimated annual recharge and potential yield from Article 40

Aquifer	Estimated Recharge (10^6 m^3)	Estimated potential (10^6 m^3)
Western	335-450	362
North-Eastern	130-200	145
Eastern	155-237	172
Total	620-887	679

Source: Estimations from World Bank 2009

The four resources were once shared waters. Before 1967, the Jordan River was shared by Israel and Palestine, with Israel accessing 60% of the total annual flow, 75 million cubic meters (MCM), and Palestinian farmers the remainder (World Bank 2009). Likewise, the Mountain Aquifer served both communities, with Palestinians digging shallow wells to access groundwater below their land and Israel digging deep wells to access the aquifer within the Green Line (Ferragina 2008). However, following the 1967 (Six Day) War, Palestinian water rights to the Jordan River were abolished and control of the water resources, as well as the development of wells across the West Bank, fell under Israeli administration (World Bank 2009). Israel imposed restrictions on the development of wells in the Mountain Aquifer and the use of wells dug before 1967 that were contiguous with Israeli wells (Ferragina 2008). The turmoil in the region resulted in the redistribution of water resources and the revoking of water rights for many Palestinans, including Al-Walaja residents. Today, control over water resources including the Eastern Aquifer, which almost completely lies in the West Bank, primarily remains under Israeli jurisdiction (Brooks et al. 2013).

2.2 Water Rights: The Oslo II Accords

To better understand how control over water sources between Israel and Palestine became complicated, we need to review the agreement put in place, which marked progress in water negotiations but also promoted a system of limitations. To establish Palestine's position in water negotiations in the region, the Oslo II Accords, signed in September 1995, became the historical document that initiated the recognition of Palestinian water rights, although they remain undefined. In particular, Article 40, "Water and Sewage," calls for a coordinated effort for water management and development of water and sewage systems between the two parties (World Bank 2009).

The goal of Article 40 was to augment and maintain existing water reserves as well as to prevent the deterioration of water quality (Article 40). Table 2 below specifies the water levels each party is eligible to withdraw from the various water sources in accordance with Article 40.

Table 2. Annual allocation of water resources of the aquifers in the West Bank under Article 40 drafted in 1995

Aquifer	Estimated Potential (10^6 m^3)	Total Palestinian (10^6 m^3)	Total Israeli (10^6 m^3)	Total (10^6 m^3)
Western	362	22	340	362
North-Eastern	145	42	103	145
Eastern	172	54	40	94
Eastern (unallocated)	-	-	-	78
Total (MCM)	679	118	483	601*

*Does not include unallocated portion

Source: World Bank 2009 (adopted from Article 40 Oslo III Accords)

Article 40 further allocated 20.5 MCM per year to serve Palestinians' immediate needs during the interim period. They also estimated 70-80 MCM per year for future needs (Article 40). To help meet these quotas, the agreement recognized the Palestinian Authority's role in water management in the West Bank. As a result of these water negotiations, the Palestinian Water Authority (PWA) was established.

Other bodies that were formed to assist in the implementation of the Oslo II accords include the Joint Water Committee (JWC) and the Joint Supervision and Enforcement Teams (JSET). JWC consists of an (unspecified) equal number of representatives from each side and their primary purpose is to coordinate the management of aquifers by reviewing proposals for the construction of new wells and the development of water systems (World Bank 2009). JWC also regulates future changes in extractions based on climate and hydrological variability.

Alongside the JWC, JSETs, comprised of at least two representatives from each side, were formed to supervise and enforce the agreement and to resolve any breach of the accord, particularly regarding unauthorized connections and water uses, drilling of wells, contamination and pollution of water resources, and maintenance of domestic and industrial sewage systems (World Bank 2009).

Five Interim Years Later...

Although the accords were intended to be a five-year interim agreement until permanent negotiations were held, no further negotiations or agreements have been made since their drafting in 1995 and the two parties continue to function as though the accords are still in place. An asymmetrical power structure has resulted because important sections in Article 40, including the transfer of authority of water and sewage infrastructure in the West Bank, rely on the settlement of permanent status negotiations to better define ownership. Currently, the PWA has less control of water management, in part due to the division of jurisdiction in areas A, B, and C. This distinction of areas is also a limitation to the implementation of Article 40 of the accords.

The agreements stipulate that full administrative and civil control over Area A is under the Palestinian Authority, while civil control in Area B is under Palestinian Authority and its security under joint Israeli-Palestinian control. On the other hand, Area C (about 60% of the West Bank) is under full Israeli civil and military control (World Bank 2009; Al Haq 2013). Al-Walaja village is located in Area C (97.4%) and Area B (2.6%) (ARIJ 2010). The restriction of Palestinian jurisdiction over Area C has resulted in fragmented territorial authority, which makes it difficult for the PWA to establish a water and sewage system. Moreover, the Israeli Civil Administration's jurisdiction over infrastructure in the West Bank has resulted in a long bureaucratic permitting process for water infrastructure construction by Palestinians (World Bank 2009; Brooks, Tottier & Doliner 2013). One of the major complaints from community members is the restriction of the construction of rainwater catchment and sewage infrastructure, as well as the long and difficult construction approval process through the Israeli administration. Figure 2 below illustrates the different institutions responsible for water distribution in the West Bank. Missing from the chart is the Israeli Civil Administration, which plays a role in regulation.

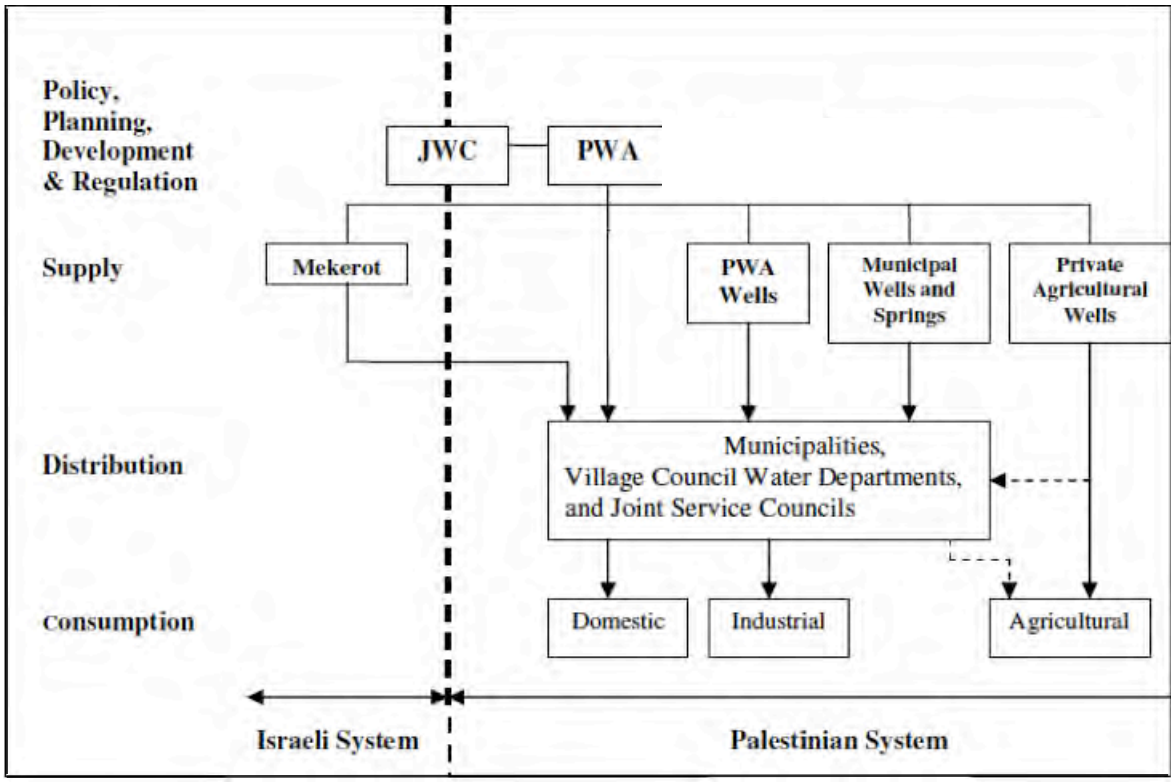

Figure 2. Institutions in charge of water in the West Bank
Source: World Bank 2009

The Oslo Accords have also been instrumental in shaping the political boundaries of the West Bank, as well as its complex water resource system and distribution infrastructure (World Bank 2009). The lack of a permanent agreement prolongs the delay in addressing the ownership of water and sewage related infrastructure in the West Bank. Therefore, until permanent status negotiations are reached, Oslo II and in particular Article 40, continues to play an essential role in defining and promoting the unequal distribution and control of water and sewage in the West Bank.

2.3 Water Resources Today

In recent decades, water quantity has been rapidly declining due to the overdrawing of water. Based on 2012 data, Brooks et al. (2013) reported that water withdrawals in Israel and Palestine were approximately 15% higher than the average annual rate of recharge. While Israel has desalination technology to increase freshwater supplies, the West Bank has limited supply as they exclusively rely on the Eastern aquifer and water sold to them by Israel's national water supplier, Mekorot. Palestinians' access to water quantities is on average 73 liters per person per day (Al Haq 2013), well below the minimum of 100 liters per person per day recommended by the World Health Organization and a fourth of the average Israeli consumption of 300 liters per person per day (Al Haq 2013). Table 3 shows Israeli and Palestinian water withdrawals in 2005 and annual average recharge of the previously mentioned water resources.

Table 3. 2005 water withdrawals in Israel and Palestine in million cubic meters (MCM) per year

Water Source	Israel	Palestine	Total withdrawn	Average annual recharge*
Jordan River basin	700	0	700	565
Mountain Aquifer	485	115	600	550–620
Western Basin	340	62	402	320–360 [12%]**
Northern Basin	105	30	135	131–144 [10%]
Eastern Basin	40 (in settlements)	23	63	95–110 [28%]
Coastal Aquifer	430	125	555	330
Israel	420	5	425	250–270
Gaza Strip	10	120	130	60
Desalination	300	0	300	Not applicable
Reused wastewater	220	0	220	220
Total	2,135	240	2,375	2,300

Source: Brooks et al. 2013
* Figures in this column are based on 2009 estimates of average yearly recharge in contrast to other columns based on 2005 estimates.
** Figures in square brackets show the proportion of saline water in each basin.

The region also suffers from declining water quality due to pollution from aged and deteriorated cesspits and septic tanks, as well as the illegal solid waste dump sites that produce leachate that seeps into groundwater (Brooks et al. 2013). In addition, the lack of a sewage system in areas such as Al-Walaja threatens the water quality in the Mountain aquifer (Brooks et al. 2013).

2.4 Desalination in Israel

Over the past decade, desalination has become one of the largest suppliers of water for Israel, filling the gap between the demand for water and the natural resources readily available. Water from desalination allows Israel to meet its water demands and without this water there would likely be a strong shift in allocation and availability of water resources in the West Bank.

There are currently five operating desalination plants in the country: Ashkelon, Palmachim, Hadera, Sorek and Ashdod. In 2010, Israel consumed a total of 1,260 million cubic meters (MCM) of water, 689 MCM of this for domestic use (Tenne 2013). The total combined capacity of these five desalination plants (based off figures from 2010) is approximately 542 MCM per year, accounting for approximately 79% of Israel's domestic water use (Spiritos 2013 & Tenne 2010).

In Israel, desalination is operated as a public-private partnership between the government and private companies. These partnerships operate under the terms of two different 25-year contracts: Build-Operate-Transfer (BOT) and Build-Operate-Own (BOO) (Spiritos 2013). In BOT projects, the government grants a private company the right to develop and operate a facility for a set period, in this case 25 years. The private company finances, constructs and operates the facility until the period has expired and the facility is transferred to the government. In BOT projects, the government agrees to a minimum purchase of water per year (Concessions, Build-Operate-Transfer and Design-Build-Operate Projects 2016). In BOO projects, unlike BOT projects, after the terms of the project end, the company is not required to transfer ownership of the facility to the government (Build-Own-Operate 2017).

Table 4. Contracts and production of desalination plants in Israel

Facility	Annual Production	Length & Type of Contract	First year of Contract
Ashkelon	120 x 10^6 m^3	25-year BOT	2005
Palmachim	45 x 10^6 m^3	25-year BOO	2007
Hadera	127 x 10^6 m^3	25-year BOO	2009
Sorek	150 x 10^6 m^3	25-year BOT	2013
Ashdod	100 x 10^6 m^3	25-year BOT	2013
Total	542 x 10^6 m^3		

Sources: (Tenne 2010 & Spiritos 2013)

A concern with desalination as the main source of water is related to a lack of essential nutrients, including calcium, magnesium and sulfate, in desalinated water (Spiritos 2013). Additional concerns related to desalination include its high energy requirements and the environmental impacts of the byproduct, a concentrated brine solution. Israel's desalination plants are connected directly to the national grid and supplied with electricity by the Israel Electric Corporation (Spiritos 2013). Egypt supplies 40% of Israel's electricity and 43% of their natural gas.

In 2011, these supplies were blocked by terrorists in boycott of the exports (Spiritos 2013). Israel's unpredictable electricity supply and dependence on foreign resources could impact the reliability of its supply of desalinated water and ability to rely on this as a sole source of freshwater (Spiritos 2013).

Lastly, the disposal of the brine solution produced by desalination has raised concern in regard to environmental pollution and damage to marine ecosystems. This brine is highly concentrated with salt and contains additional chemicals, including chlorine, sodium bisulfite and heavy metals, among others (Spiritos 2013). At desalination plants in Israel, this brine is diluted and pumped back into the sea (Spiritos 2013). The high specific weight of this brine can cause it to sink to the bottom of the sea and form highly concentrated areas that can lead to ecological consequences for deepwater marine communities (Spiritos 2013).

These concerns could impact the future of desalination as the predominant water source in Israel, and consequently, the availability and distribution of water in the West Bank. In Al-Walaja, where the water supply is often intermittent and unreliable, a further decrease in water availability could force residents to rely more heavily on alternative water sources, such as harvested rainwater or bottled water.

2.5 History of Al-Walaja village

Situated northwest of Bethlehem city, Al-Walaja village sits on 4.328 square kilometers of land between the 1948 Green Line, Beit Jala town, Battir and Husan village, and the Har Gilo Israeli settlements (ARIJ 2010). Since the establishment of the 1948 Green Line, which divided Al-Walaja, and the annexation of the remaining land by Israel through the building up of Gilo and Har Gilo settlements and the separation wall (depicted in Figure 3), Al-Walaja village, over time, has been reduced in size (ARIJ 2010). The residents of Al-Walaja are mainly descendants of residents from the original village, preceding the 1948 establishment of the Green Line, who were displaced to the remaining village lands.

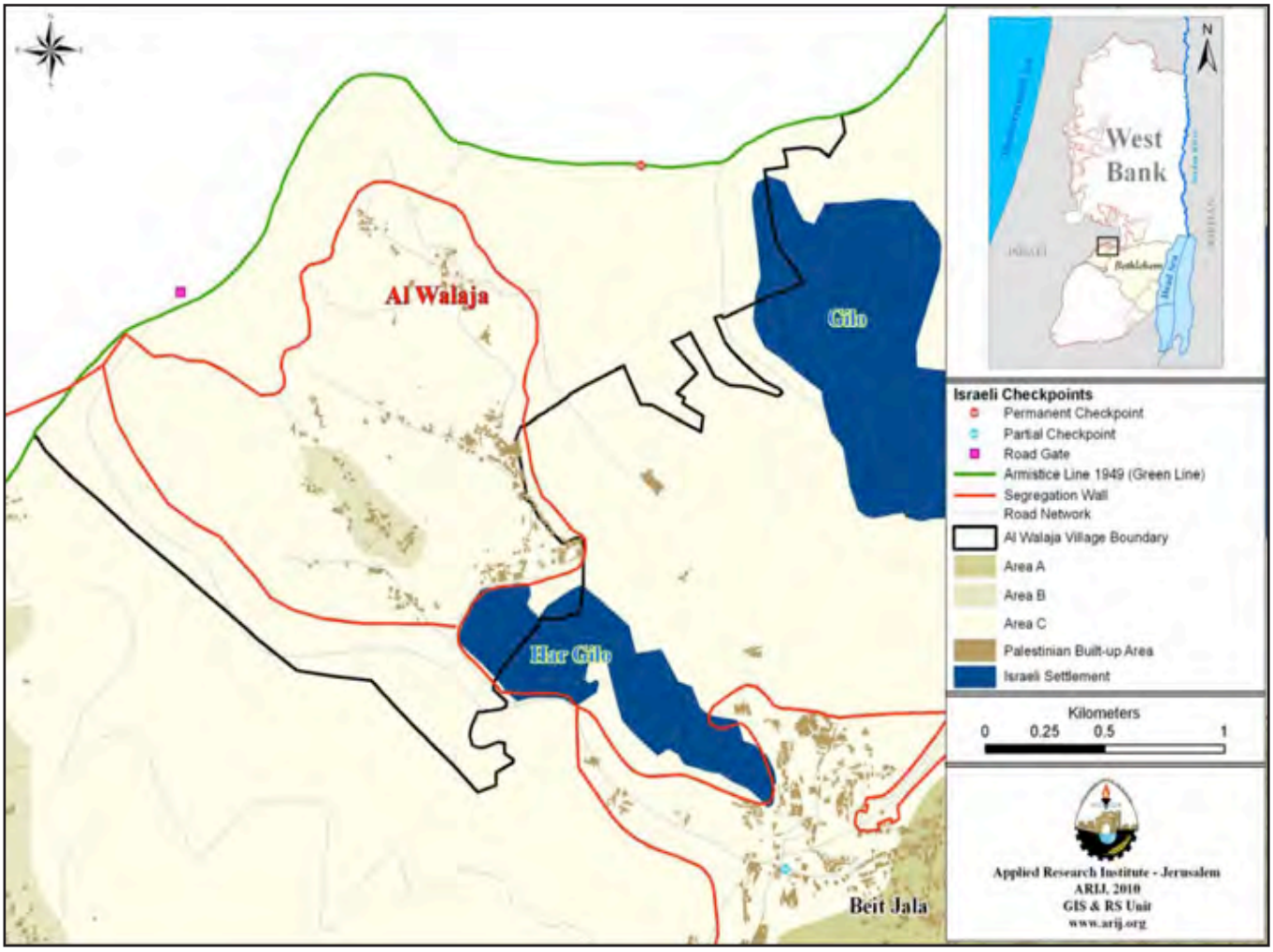

Figure 3. Location of Al-Walaja village
Source: ARIJ 2010

In 2007, the village had a population of 2,041 with 390 households (ARIJ 2010). It is governed by a village council, consisting of nine members who are appointed by the Palestinian Authority. Part of the village lies under the Bethlehem Governorate jurisdiction and the other under the Jerusalem Municipality, including the Ain-Jawaizeh neighborhood, which was part of the WSSS' team survey area.

2.6 Water Resources in Al-Walaja

There are three main sources of water in Al-Walaja: piped water from the Palestinian Water Authority (PWA), rainwater collected in underground cisterns and bottled water or tankered water, water delivered in large quantities by water trucks.

Many households in Al-Walaja are connected to the PWA distribution network. This water is purchased by the PWA from Mekorot, Israel's national water company, and then distributed to residents of the West Bank. Much of this water supplied by Mekorot is pumped from the Western aquifer underlying the West Bank by Israel, and thus constitutes a "selling back" of the West Bank's own water resources (World Bank 2009).

Estimates suggest that 39% of Al-Walaja's water supply is lost through the distribution network (ARIJ 2010). The distribution network is old and in need of repair (see Figure 4). Illicit connections, which are often improperly connected to the mainline, can result in leakage and increased water losses. In addition, the variation in pipe size (see Figure 5), which can affect water pressure, was noted as a contributing factor to the unequal water supply distribution throughout the village.

Figure 4. Leak in pipe distribution network in Al-Walaja
Source: Hiromi Hashimoto

A second source of water in Al-Walaja is harvested rainwater stored in underground cisterns. Approximately 60% of the households we visited in Al-Walaja (33 of the 52 homes surveyed) had cisterns. The method of collection and size of these cisterns varies from household to household but generally includes a system of pipes, hoses and gutters running from the roof to the underground cistern. Many of these cisterns were connected to rooftop storage tanks. Some homes pumped water into their rooftop tanks, which were directly connected to their in-home plumbing, while others had an exterior spout or access point where water could be collected directly from the cistern.

Figure 5. Variation in pipe size in Al-Walaja distribution system
Source: Hiromi Hashimoto

Other families have cisterns but do not collect rainwater and use their cisterns as storage for PWA piped water or tankered water.

The third source of water in Al-Walaja is purchased bottles from local stores and tankered water, which is delivered in large quantities from water trucks. According to a project by the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), in some of the poorest communities in the West Bank, the cost of tankered water can "account for up to half of a family's monthly expenses" (OCHA 2016).

Part 3: Water Quality Analysis & Implications

3.1 Methodology

In March 2017, our team visited the West Bank to conduct household surveys and collect and analyze water samples to assess water availability and quality in Al-Walaja village. The team surveyed three different neighborhoods in the village: Al Khala, Al Thahar and Ain Jawaizeh (Figure 6). The households were randomly selected for survey and sample collection over five days. Surveys (n=52) were conducted in Arabic with local translators and in accordance with a Tufts IRB approved protocol. Water samples (n=58) were collected at the same time as surveys were conducted. A water sample was also collected from the village's health clinic.

The samples were taken from either a kitchen or bathroom tap, as well as from cisterns (n=3) and point-of-use filters (n=4), after disinfecting the faucet with a flame for 10 seconds and running the cold water tap for 10 seconds. Sample collection bottles were washed in a chlorine dilution and then rinsed with drinking water. Cleaned sample collection bottles were rinsed three times with sample water before water was collected. This protocol was designed to be similar to that of the United Nations Relief and Works Agency for Palestine Refugees (UNRWA). Negative controls were taken from unopened bottles of drinking water purchased in Bethlehem. Refer to Appendix A: Sample Testing Protocol.

For *E. coli* and total coliform, 125 mL of sample water was filtered through a sterile 0.45 µm filter within 6 hours of collection. The filters were plated with mColiBlue 24 media and placed in an air incubator at 35 ± 0.5 °C for 24 ± 2 hours. Plates were counted by two team members.

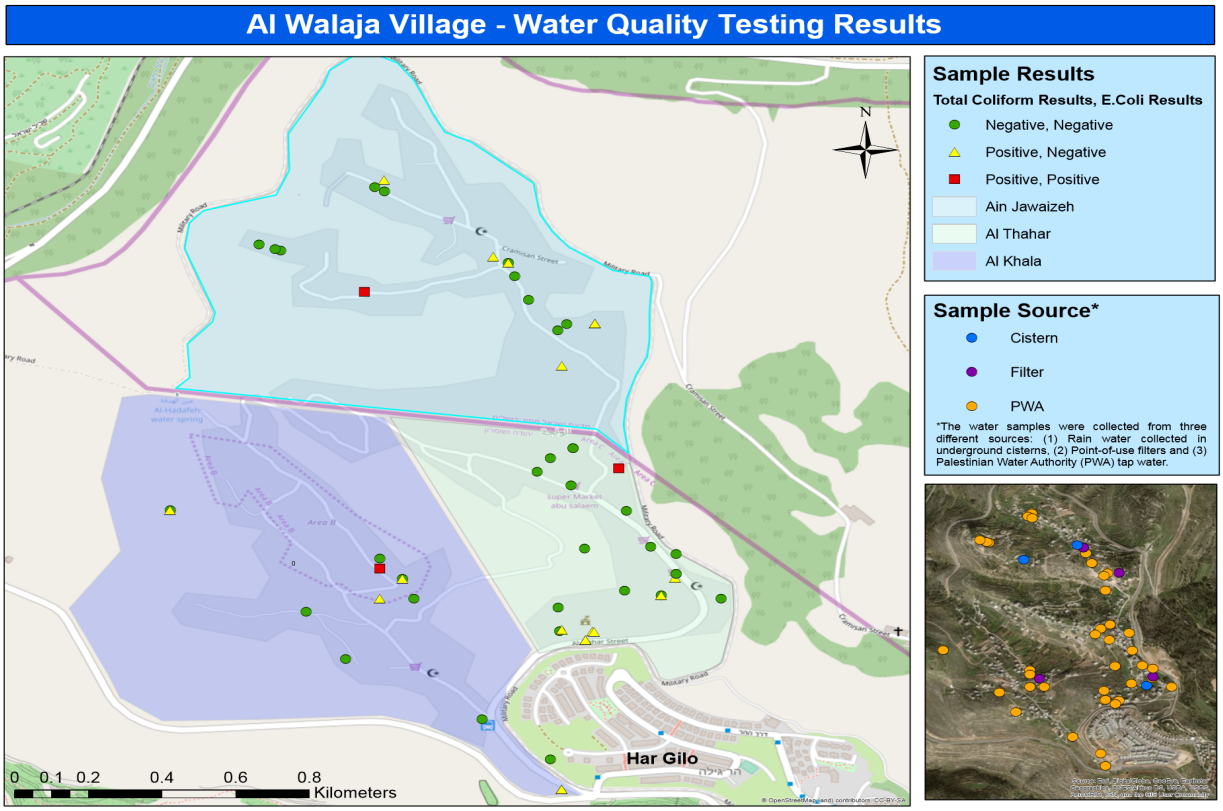

Figure 6. Water quality results map (positive results indicate one or more colonies found)

3.2 Water Quality Results

Water test results indicated a trend between positive coliform results and water samples from cisterns and point-of-use filters attached directly to the faucet (Figure 7). We tested a total of four filters and three cisterns. All cistern samples gave positive results for total coliform and three of the four filter samples gave positive total coliform results. The positive filter and cistern samples represented 22% of positive samples (n=23). See Appendix B for detailed results.

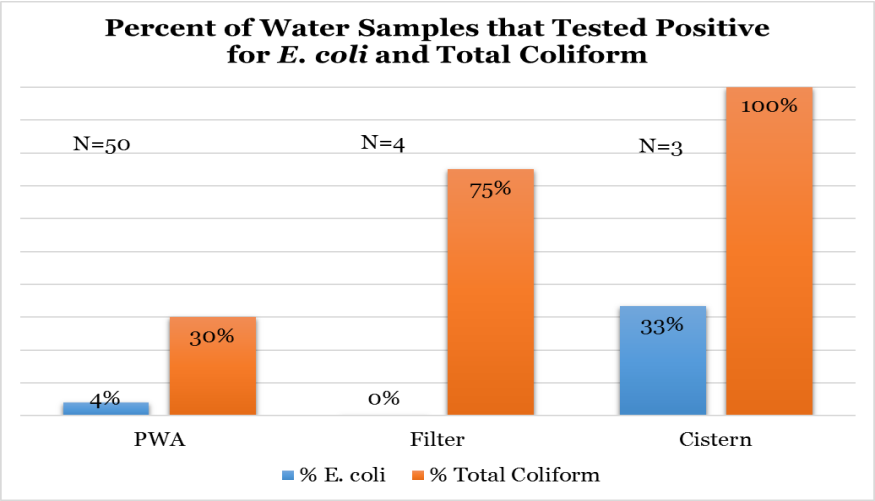

Figure 7. Percent of samples contaminated based on sample source

3.3 Ansar Center Summer Test Results

In the summer of 2016, the Ansar Center conducted an assessment of water quality in homes in Al-Walaja village, collecting 174 samples from August 3 to October 8 of 2016. Out of the the samples collected, 143 tested positive for total coliforms and 22 tested positive for *E. coli*. Positive samples indicate one or more colonies found. The results provided by Ansar Center did not specify the source of the samples (cistern or filter) or the locations of the homes. The Ansar Center results are significant because they show higher positive results for both total colilforms and *E. coli* in the dry season, compared to our testing results in the wet season for the same geographic area. This suggests more studies are required in the summer to better assess and understand the water issues in Al-Walaja. See Figure 8 and Appendix C for detailed results.

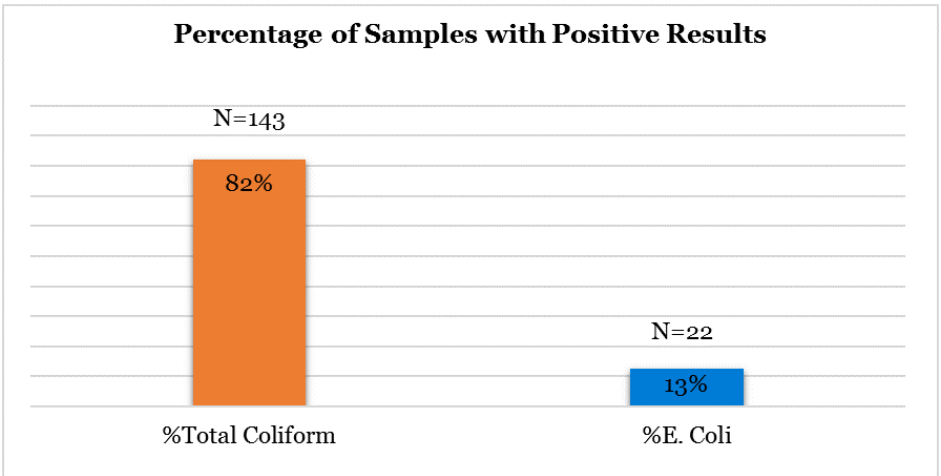

Figure 8. Percentage of positive samples from Ansar Center water quality testing program (August-October 2016)

3.4 Survey Responses

Our surveys (n=52) revealed no water shortage problems in the wet season and mixed water shortage problems in the dry season (Figure 9). Ten households (19%) claimed to suffer from water shortages for 15-60 days during the dry season and two households (3.8%) suffered water shortages for the entire dry season (around the months of April to October). A total of 20 households (38%) reported no shortage problems and 12 households (23%) reported losing water "sometimes" during the dry season.

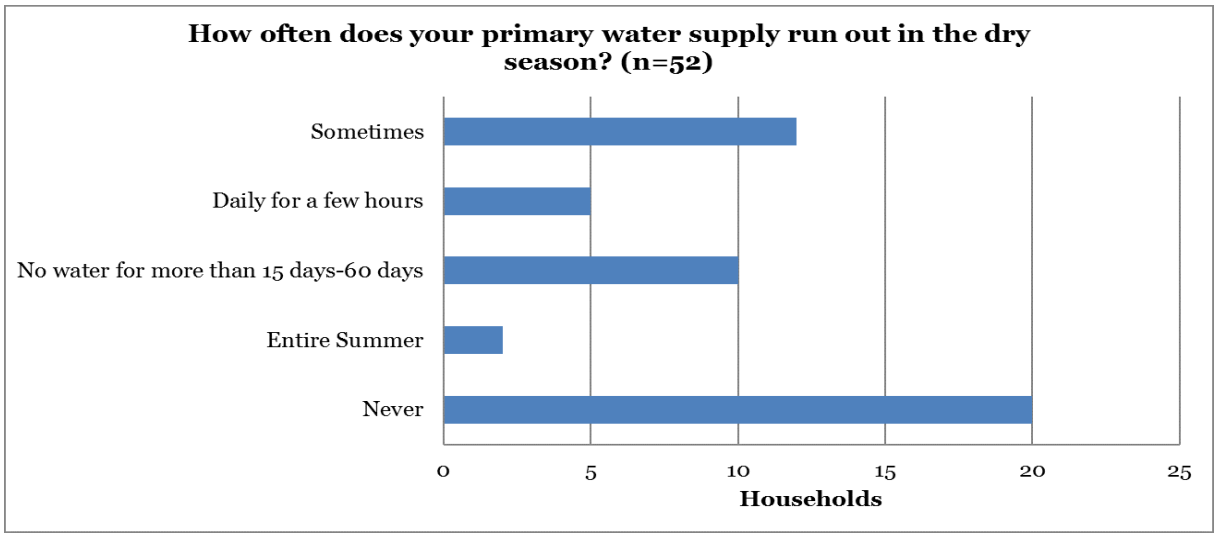

Figure 9. Prevalence of water shortages in Al-Walaja

Colds and flu were the most prominent illnesses reported (Figure 10), with coughing making up the bulk of the symptoms (54%), followed by runny nose and fever at 33% each. Of the households who tested positive for either *E.coli* or coliform, or both, six (35%) reported diarrhea, vomiting or both.

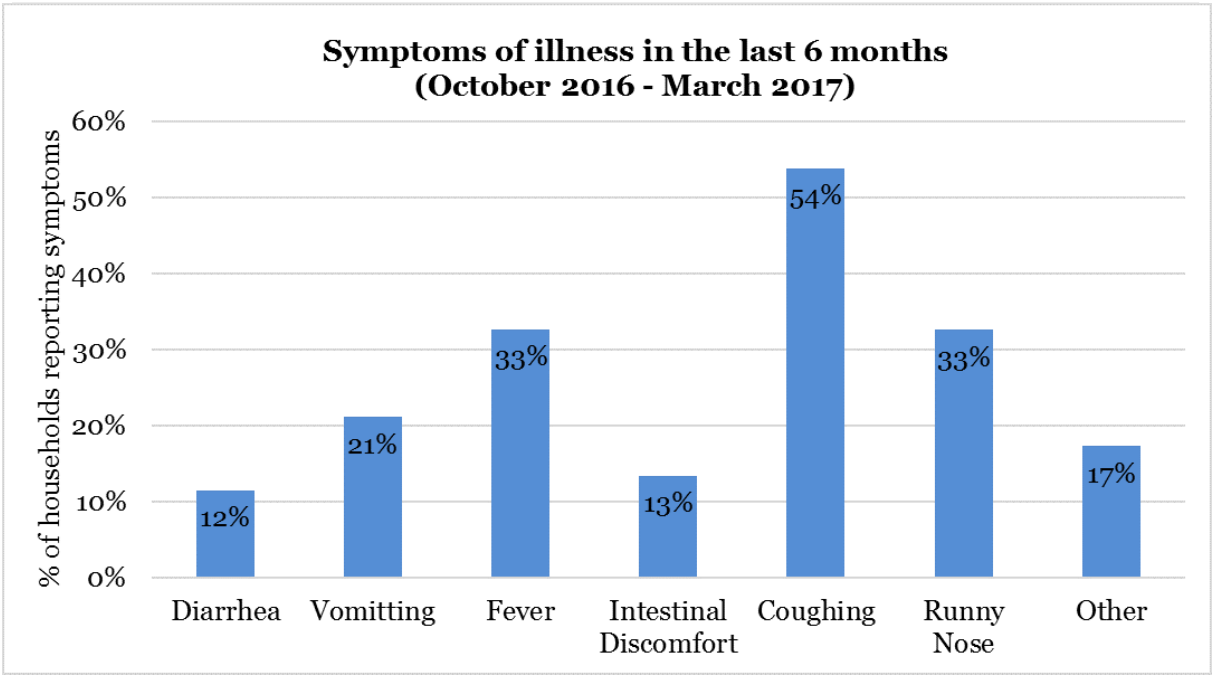

Figure 10. Symptoms of illness in Al-Walaja

A mean of 5.78 individuals live in each household we surveyed (n=52) and 4.88% of respondents live in households with members that are younger than 5 years old and 6.62% with members that are older than 65.

An overwhelming number of households believe there is a water quantity problem in Ain Jawezzah. According to 84% of households (n=52) there is a variation in water distribution and availability in certain areas of the village (Figure 11). Out of these respondents, 25% indicated that Ain Jawezzah suffered the most water shortages in the village. Other respondents indicated that availability/distribution varied due to changes in altitude, differences in pipe sizes, as well as settlers or neighbors cutting off pipes.

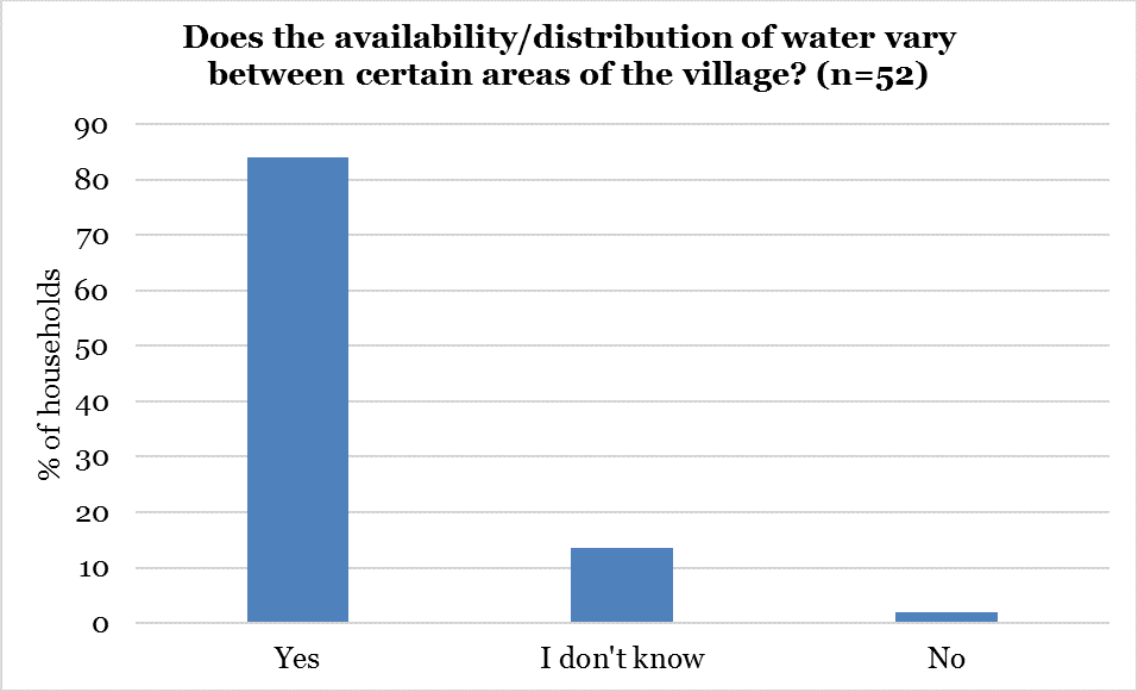

Figure 11. Availability and distribution of water in Al-Walaja

Part 4: Discussion

The goal of our team was to expand knowledge of safe drinking water by developing and implementing a water quality monitoring and education program in the village of Al-Walaja. Specifically, our three objectives were to:

1. Expand previous work done by WSSS students elsewhere in the West Bank to Al-Walaja village.
2. Identify issues in the village around water quality and quantity.
3. Leave the center with the necessary equipment and resources for future testing and community education.

We set up these objectives, believing that they make up the three pillars of a successful water monitoring program. Given that this is the first year of WSSS involvement in Al-Walaja village, it is too early to tell if we have successfully expanded the water program established in Aida camp. Nevertheless, our team set up the foundation to continue the work and efforts to set up a water quality monitoring program in Al-Walaja.

Our team effectively identified issues in the village around water quality and quantity through surveys and water testing. The information gathered during our research highlights the water situation in the village. For instance, one of our greatest concerns is that our team worked in the wet season. Based on survey answers our team concluded that both water quantity and quality issues are more prevalent in the dry season when households suffer the greatest water shortages. During this time, some families often rely on cistern water as a secondary water source. Because cistern samples and three out of four filters samples returned positive, follow-up with the community should be conducted to determine if households who depend on cistern or filter water take appropriate measures to clean their water or change their filters. In addition, further studies would help illuminate why parts of the village, such as Ain Jawaizeh, suffer from water shortages in the dry season.

While our work with youth was limited by time constraints, our presence and meetings with villagers may encourage future participation in the Environment Unit. One piece that was particularly motivating is the answer to the question: “Would you be willing to serve as a volunteer checking water quality in the camp? Yes/No/I don’t know.” A total of 22 respondents said they or a family member would be willing to serve as a volunteer. While some may have responded “yes,” out of politeness, these numbers are encouraging and with continued efforts by the Ansar Center the water monitor program could benefit from the involvement of interested community members.

Finally, our last goal was to leave the Ansar Center with the necessary equipment and resources for future testing and community education. We left the center with equipment for up to 250 samples using the membrane filtration method. This included a portable incubator, petri dishes, filter units and m-ColiBlue24, a liquid media used for *E. coli* and total coliform. Brands and exact quantities of equipment are detailed in Appendix D.

In addition, for the next six months, experienced members from the water quality program at the Lajee Center (Shatha Al-Azzah) and the Ansar Center (Lubna Abed Al-Rahman) will provide the technical expertise and guidance for leaders and volunteers in Al-Walaja who would like to participate in the water monitoring program.

4.1 Limitations

Given the need for further studies and follow-up, it is important to note the various limitations that should be considered by future groups, including language barrier, time constraints, and geography.

We conducted all of our surveys through translators who are fluent in English. As non-Arabic speakers, our group had limited control of the conversation between translators and respondents. While most of the questions are straightforward, there are a few questions where members of the investigation team felt limited in their ability to follow-up or where there was more room for miscommunication or for translators to accidently leave out parts of an answer. For instance, there is not a lot of nuance in the following questions: "How many people live in this household?" or "How do you store your water?". But questions that merit longer or more subjective responses increase the likelihood of miscommunication or misunderstanding. One example is the question, "Does the availability/distribution of water vary between certain areas of the camp? Yes/No/I don't know?" with a follow-up question of "If yes, do you know why?"

Another constraint was time. For instance, we could not survey after dark given that this was when translators ended their shift. And because men and younger women in Al-Walaja often work or study during the day, most of our surveys are made up of middle-age female respondents. We believe men and women of varying ages in the village might have different experiences, knowledge, or opinions of the water situation in their homes and in Al-Walaja. A more diverse group of voices may have revealed new or different information for the study.

Along with this, we faced geographic limitations. At 4.328 square kilometers, Al-Walaja village is a fairly large area, with homes widely spread out, often across a hillside. This made it particularly time consuming to travel through certain neighborhoods by foot, taking up valuable survey time.

Given that Al-Walaja village faces the bulk of its water problems during the dry season, our visit during the wet season was an added hurdle in our research since we were unable to analyze the water situation at its worst. While we were able to ask questions about the dry season, we were limited to wet season water samples. During water shortages many households depend on cistern water as a secondary source. This water is often left untreated and at times respondents stated that cistern water is better and cleaner than tap water (although our water samples reveal otherwise). Nevertheless, many cisterns are not connected to a water storage tank during the wet season making it difficult to sample this source. We have reason to believe that further sampling during the summer would be beneficial to the study given that all of the cistern water samples we did obtain returned positive for *E. coli* or coliform, or both. Moreover, surveys in the summer would be helpful in revealing symptoms of illness that may be less apparent when we surveyed households during the wet season.

Lastly, we tested the water for total coliform and *E. coli*, limiting our ability to test for other bacteria, heavy metals, or chlorine levels. In the particular case of Al-Walaja village, it may be beneficial to conduct residual chlorine tests. Many households reported that water from the PWA tasted and smelled like chlorine.

4.2 Possible funding sources for future work

In order to keep the work of our practicum thriving and expand the program to other refugee areas, 1for3.org and Lajee Center need more funding sources. In addition to funding from student graduate programs, we also recommend that the organizations apply for grants to accomplish more. The following organizations are great examples of funding sources because they all address humanitarian problems and environmental challenges such as lack of clean water access. First, the United States Agency for International Development (USAID) provides funding to U.S. and non-U.S. based nonprofits that are trying to address health and humanitarian challenges. To be eligible for this funding 1for3.org would need to register as a Private Voluntary Organization and go through a screening process before applying for a grant (USAID 2016). Second, the Bill and Melinda Gates Foundation makes grants available through partnerships with other non-profit organizations. The Gates Foundation has a program specifically geared at fixing water and sanitation problems in developing countries. While sanitation is their main focus, they also support projects on innovative clean water and hygiene solutions (Bill and Melinda Gates Foundation 2017). Lastly, the Rockefeller Foundation is another organization that strives to bring well-being to vulnerable communities through technology, improved health or resilience measures. Given that most grants have a research component, we believe this would be an ideal source of funding for continued collaboration with Tufts University students and professors.

While the UN recognizes that water is a human right, the case in Al-Walaja demonstrates that this right is not given equally for all residents of the village. In the future, our efforts can serve as a foundation for other clean water initiatives. This would only be possible through continued research and funding that can help strengthen the program as it develops.

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Source: Julia Miller

Appendix A: Sample Testing Protocol

Water Sample Collection & Testing Supplies:

- 125 mL sample bottle (disinfected with chlorine and rinsed before use)
- Labeling tape
- Permanent marker
- Lighter or disinfecting wipes
- Gloves
- Petri dishes with absorbent pad (one per sample)
- Membrane filters, 0.45 µm pore size
- m-Coliblue24 2mL liquid ampoules
- Syringe or hand pump
- Membrane filtration units
- Filter forceps
- Incubator

Sample collection procedure

1. Disinfect the faucet or point of collection with a flame or disinfecting wipe.
2. Run the flame around the edge of the faucet for 10 seconds.
3. Attach labeling tape to sample bottle and label with sample name or ID.
4. Run the water for 10 seconds.
5. Fill the bottle with a small amount of water. Cap bottle, shake vigorously and discard. Repeat two additional times.
6. Fill bottle to the top and cap.

Sample testing procedure for *E. coli* and total coliform

Samples should be tested within 8 hours of collection. All team members handling samples should wear clean gloves throughout the testing procedure. All equipment should be disinfected with chlorine and rinsed with clean water before use.

1. Label top and bottom of petri dishes with Sample name or ID.
2. Using forceps, place one absorbent pad into each petri dish (if petri dishes do not already have a pad in place).
3. Empty one ampule of m-Coliblue24 into each petri dish.
4. Remove the plastic cap and funnel of the membrane filtration unit.
5. Using forceps, place one pad onto the membrane filtration unit.
6. Use forceps to remove one membrane filter from its packaging and place grid side up on top of the pad.
7. Firmly re-attach the cap and funnel back to the filtration unit. Check that the funnel is flush with the unit and there is no chance of water leaking through.

8. Attach tube and syringe or hand pump to the filtration unit.
9. Remove the plastic cap and pour the entire 125 mL sample into the funnel.
10. Using the syringe or hand pump, pump the entire sample through the filter.
11. Once the sample has been filtered through, remove the funnel and carefully remove the membrane filter from the pad and place grid side up into the petri dish.
12. Flip the petri dish so the outer lip faces upward and place into the incubator.
13. Incubate for 24 hours.
14. After 24 hours remove the dishes from the petri dishes and inspect for colony growth. *E-coli* colonies appear as blue and total coliform colonies as red.

Appendix B: Water Quality Testing Results

Sample No.	E. Coli Result	No. E. Coli Colonies	Total Coliform Result	No. Total Coliform Colonies	Sample Source[1]
1	Negative	0	Negative	0	PWA
2	Negative	0	Negative	0	PWA
3	Negative	0	Positive	4	Cistern
4	Negative	0	Positive	1	PWA
5	Negative	0	Negative	0	PWA
6	Negative	0	Negative	0	Filter
7	Negative	0	Negative	0	PWA
8	Negative	0	Positive	1	PWA
9	Negative	0	Negative	0	PWA
10	Negative	0	Positive	20	PWA
11	Negative	0	Negative	0	PWA
12	Negative	0	Negative	0	PWA
13	Negative	0	Negative	0	PWA
14	Negative	0	Positive	1	PWA
15	Negative	0	Negative	0	PWA
16	Negative	0	Positive	1	PWA
17	Negative	0	Positive	1	PWA
18	Negative	0	Negative	0	PWA
19	Negative	0	Positive	2	PWA
20	Negative	0	Negative	0	PWA
21	Negative	0	Negative	0	PWA
22	Negative	0	Negative	0	PWA
23	Negative	0	Positive	5	Filter
24	Negative	0	Negative	0	PWA
25	Positive	2	Positive	1	PWA

Sample No.	E. Coli Result	No. E. Coli Colonies	Total Coliform Result	No. Total Coliform Colonies	Sample Source[1]
26	Negative	0	Negative	0	PWA
27	Negative	0	Negative	0	PWA
28	Negative	0	Negative	0	PWA
29	Negative	0	Negative	0	PWA
30	Negative	0	Negative	0	PWA
31	Positive	5	Positive	35	PWA
32	Negative	0	Negative	0	PWA
33	Negative	0	Negative	0	PWA
34	Negative	0	Negative	0	PWA
35	Negative	0	Positive	34	PWA
36	Negative	0	Positive	4	PWA
37	Negative	0	Negative	0	PWA
38	Negative	0	Negative	0	PWA
39	Negative	0	Negative	0	PWA
40	Negative	0	Negative	0	PWA
41	Negative	0	Negative	0	PWA
42	Positive	4	Positive	TNC	Cistern
43	Negative	0	Negative	0	PWA
44	Negative	0	Positive	3	PWA
45	Negative	0	Negative	0	PWA
46	Negative	0	Negative	0	PWA
47	Negative	0	Negative	0	PWA
48	Negative	0	Positive	1	Filter
49	Negative	0	Positive	1	Cistern
50	Negative	0	Negative	0	PWA

Sample No.	E. Coli Result	No. E. Coli Colonies	Total Coliform Result	No. Total Coliform Colonies	Sample Source[1]
51	Negative	0	Negative	0	PWA
52	Negative	0	Negative	0	PWA
53	Negative	0	Positive	3	PWA
54	Negative	0	Positive	3	Filter
55	Negative	0	Positive	1	PWA
56	Negative	0	Positive	1	PWA
57	Negative	0	Negative	0	PWA

[1] The samples obtained came from three different sources: (1) Palestinian Water Authority though the water distribution system, (2) Rain collected in an underground cistern and (3) Point-of-use filters.

Appendix C: Ansar Center Test Results

Ansar Center Results

		Results	
Sample No.	Date	TC	E. Coli
1	3-Aug-16	4	0
2	8-Aug-16	2	0
3	8-Aug-16	2	0
4a	8-Aug-16	0	0
4b	8-Aug-16	4	0
5	8-Aug-16	4	0
6	8-Aug-16	0	0
7	8-Aug-16	0	0
8	8-Aug-16	3	0
9a	10-Aug-16	3	0
9b	10-Aug-16	37	28
10	10-Aug-16	1	0
11	10-Aug-16	20	15
12	10-Aug-16	7	0
13	10-Aug-16	4	0
14	10-Aug-16	8	2
15	10-Aug-16	9	1
16	10-Aug-16	6	0
17	10-Aug-16	10	0
18	10-Aug-16	6	0
19	10-Aug-16	17	0
20	10-Aug-16	0	4
21	10-Aug-16	13	0
22a	11-Aug-16	40	0
22b	11-Aug-16	1	0
23a	11-Aug-16	7	0
23b	11-Aug-16	10	0
24a	11-Aug-16	20	0
24b	11-Aug-16	NL	0
25a	11-Aug-16	1	1
26a	11-Aug-16	2	0
26b	11-Aug-16	NL	0
26c	11-Aug-16	NL	0
27	11-Aug-16	NL	0
25b	11-Aug-16	50	0
28a	14-Aug-16	23	0
28b	14-Aug-16	7	0
29	14-Aug-16	6	0
30a	14-Aug-16	1	0
30b	14-Aug-16	14	1
30c	14-Aug-16	20	0
31a	14-Aug-16	7	0

Ansar Center Results

		Results	
Sample No.	Date	TC	E. Coli
31b	14-Aug-16	0	0
32a	14-Aug-16	7	0
32b	14-Aug-16	8	23
33	14-Aug-16	20	0
34	14-Aug-16	33	0
35	14-Aug-16	36	0
36	14-Aug-16	10	0
37a	14-Aug-16	14	0
37b	14-Aug-16	7	0
38	14-Aug-16	10	0
39	14-Aug-16	16	0
40	14-Aug-16	3	0
41	14-Aug-16	9	0
42	14-Aug-16	2	0
43a	14-Aug-16	5	0
43b	14-Aug-16	26	0
44	14-Aug-16	0	0
45	14-Aug-16	0	0
46	15-Aug-16	35	0
47	15-Aug-16	0	0
48	15-Aug-16	TNC	0
49	15-Aug-16	40	0
50	15-Aug-16	9	0
51a	15-Aug-16	29	0
51b	15-Aug-16	0	0
52	15-Aug-16	29	0
53	15-Aug-16	TNC	0
54	15-Aug-16	0	0
55	15-Aug-16	4	0
56	27-Aug-16	TNC	0
57	27-Aug-16	8	0
58a	27-Aug-16	TNC	6
58b	27-Aug-16	TNC	18
59	27-Aug-16	TNC	0
60	27-Aug-16	TNC	0
61	27-Aug-16	TNC	0
62	27-Aug-16	TNC	0
63	27-Aug-16	TNC	0
64	27-Aug-16	0	0
65	27-Aug-16	TNC	0
66	27-Aug-16	TNC	0
67	3-Sep-16	TNC	3

Ansar Center Results

		Results	
Sample No.	Date	TC	E. Coli
68	3-Sep-16	TNC	0
69	3-Sep-16	8	0
70	3-Sep-16	6	0
71	3-Sep-16	TNC	0
72	3-Sep-16	TNC	0
73	3-Sep-16	TNC	0
74	3-Sep-16	1	0
75	3-Sep-16	TNC	0
76	3-Sep-16	TNC	0
77	3-Sep-16	0	0
78	3-Sep-16	TNC	0
79	3-Sep-16	TNC	0
80	29-Sep-16	TNC	0
81	29-Sep-16	TNC	0
82	29-Sep-16	TNC	0
83	29-Sep-16	TNC	1
84	29-Sep-16	TNC	0
85	29-Sep-16	3	0
86a	29-Sep-16	TNC	0
86b	29-Sep-16	TNC	0
87	29-Sep-16	TNC	0
88	29-Sep-16	TNC	0
89	29-Sep-16	1	0
90	29-Sep-16	TNC	0
91a	30-Sep-16	0	0
91b	29-Sep-16	TNC	0
92	29-Sep-16	0	0
93	29-Sep-16	0	0
94a	29-Sep-16	3	0
94b	29-Sep-16	TNC	0
95a	30-Sep-16	TNC	0
95b	30-Sep-16	TNC	0
96a	30-Sep-16	4	0
96b	30-Sep-16	0	0
97	30-Sep-16	TNC	0
98a	30-Sep-16	2	0
99	30-Sep-16	0	0
98b	30-Sep-16	2	0
100	1-Oct-16	0	0
101	1-Oct-16	6	0
102a	1-Oct-16	TNC	3
102b	1-Oct-16	TNC	4

Ansar Center Results

		Results	
Sample No.	Date	TC	E. Coli
103a	1-Oct-16	1	0
104a	1-Oct-16	2	0
105	1-Oct-16	0	0
106	1-Oct-16	0	0
107	1-Oct-16	0	0
108	1-Oct-16	4	0
109	1-Oct-16	2	1
110	1-Oct-16	0	0
111	1-Oct-16	2	1
112	1-Oct-16	4	0
113	1-Oct-16	5	0
114	1-Oct-16	3	1
115	1-Oct-16	1	0
116	1-Oct-16	5	0
118	6-Oct-16	TNC	0
119	6-Oct-16	0	2
120	6-Oct-16	5	0
121	6-Oct-16	5	0
122	6-Oct-16	TNC	0
123a	6-Oct-16	TNC	0
123b	6-Oct-16	TNC	0
124	6-Oct-16	2	5
125	6-Oct-16	TNC	TNC
126a	6-Oct-16	5	0
126b	6-Oct-16	TNC	0
127	6-Oct-16	0	0
128	6-Oct-16	TNC	0
129	6-Oct-16	TNC	0
130a	6-Oct-16	0	0
130b	6-Oct-16	5	0
131	6-Oct-16	3	0
132	6-Oct-16	0	0
133	8-Oct-16	TNC	0
134	8-Oct-16	0	0
135	8-Oct-16	TNC	0
136	8-Oct-16	0	0
137	8-Oct-16	2	0
138	8-Oct-16	2	0
139	8-Oct-16	TNC	0
140	8-Oct-16	2	0
141a	8-Oct-16	0	0
141b	8-Oct-16	TNC	TNC

Ansar Center Results

		Results	
Sample No.	Date	TC	E. Coli
142	8-Oct-16	TNC	TNC
143	8-Oct-16	TNC	0
144	8-Oct-16	TNC	0
145a	8-Oct-16	0	0
145b	8-Oct-16	0	0
146	8-Oct-16	TNC	0

Appendix D: Water Quality Testing Materials

Water Sampling Material	Quantity for Al-Walaja	Price	Company/website
125 mL sample bottles, narrow mouthed, polyethylene	72 bottles/case	$ 62.30	Nalgene, product: 2089-0004
Colored labeling tape	1 in X 14 yds	$ 9.50	www.chromalabel.com
Permanent marker	1 pack	$ 6.89	Sharpie (12-pack)
Water proof notebook	1	$ 6.61	Rite in the Rain (All weather notebook)
Bacterial analysis Material	**Quantity**	**Price**	**Company/website**
Incubator	1 portable incubator	$ 1,229.00	hach, product number 2569900
Gloves	100 latex powder-free gloves/box	$ 9.49	Curad Powder-Free Latex
Goggles	1	$ 2.97	3M TEKK Protection Chemical Splash/Impact Goggle
Lab coat	1	$ 16.94	Natural Uniforms Unisex 40 Inch Lab Coat
Petri dishes with absorbant pad, one per sample	300	$ 157.03	Simport D210-18B Polystyrene Absorbent Pad Petri Dish with Pads, Sterile, 50mm Diameter x 9mm Height
Membrane filters, sterile, white, grid-marked, 0.45 µm pore size	300	$ 229.90	Whatman 10406870 Cellulose ME25/21 ST Mixed Ester Filter Membrane, 47mm White Circle with 3.1mm Black Grid Sterile, 0.45 Micron
m-ColiBlue liquid ampoule 2ml	300	$ 78.35	Hach, product # 2428550
hand pump	1	$ 103.00	Hach, product number 1428300
Membrane filtration units	5	$ 87.90	0.45 microns pore size, 50 mm membrane
Syringes for vaccum filtration units	1	$ 9.99	https://www.amazon.com/Karlling-Plastic-Hydroponics-Nutrient-Measuring/dp/B013DI05HI
Filter forceps	1	$ 3.97	Equinox Professional Tweezers Set - 2 Pack
Hand tally counter	1	$ 6.00	miniscience.com

Appendix E: Institutional Review Board Documents & Survey

Tufts UNIVERSITY | Office of the Vice Provost for Research

March 17, 2017 | Notice of Action

IRB Study # 1602018 | Status: ACTIVE

ATTENTION: BEFORE CONDUCTING ANY RESEARCH, PLEASE READ THE ENTIRETY OF THIS NOTICE AS IT CONTAINS IMPORTANT INFORMATION ABOUT PROPER STUDY PROCEDURES.

Title: 2017 Palestine Practicum (OLD TITLE: WSSS Palestine Practicum)

PI: John Durant
Co-Investigator(s): Andrea Becerra, Colleen O'Brien, Julia Miller, Hiromi Hashimoto, Mariela Medina Castellanos

The PI is responsible for all information contained in both this notice of action and on the following **Investigator Responsibilities Sheet.**

Only copies of approved stamped consent forms and other study materials may be utilized when conducting your study.

The *Request for Continuing Review with Modification* has been reviewed by the IRB under the guidance set forth by the Office for Human Research Protections in 45 CFR 46, and approved under Expedited Category 7. The modifications include:

1) Change in study title.
2) Change in funding.
3) Changes in study personnel.
4) Addition of a new study site.
4) Administrative revisions to consent form, debriefing form, and procedures document.
5) Minor revisions to the study instrument.

Reviewed 3/17/2017 – Expires 3/16/2018

- Approved for 120 participants for the duration of the study.

Protocol Management:
- All translated study documents must be submitted for review, approval, and stamping prior to use.
- For all changes to the protocol, submit: *Request for Protocol Modification* form
- All Adverse Events and Unanticipated Problems must be reported to the Office of the IRB promptly (no later than 7 calendar days after first awareness of the problem) using the appropriate forms.

Social, Behavioral, and Educational Research • Institutional Review Board • FWA00002063
20 Professors Row, Medford, MA 02155 • T: 617.636.3417 • F: 617.636.3673 • E: SBER@tufts.edu

- Six weeks prior to the expiration of the protocol on 3/16/2018, investigators must submit either a *Request for Continuing Review* or a *Request for Study Closure*
- All forms can be found at: **http://www.tufts.edu/central/research/IRB/Forms.htm**

IRB Administrative Representative: _____

Survey/Interview and Water Sample Collection Procedures

1. Interview Planning

Select the team – preparation and planning
Conducting the interview requires a trained interviewer and a trained translator. A second person may serve as a note-taker but is not necessary. The interviewer, with the assistance of the translator, will: conduct informed consent, complete interview survey, write up the interview summary following the interview, request and, if permitted, collect a water sample to test for the presence of contaminants.

Decide on the time and location
Interviews are expected to last approximately 30 minutes. The team will randomly select homes within the camp for in-person surveys and collection of water samples for testing. The time of day during which the surveys/water sample collection will be conducted will be varied so as to avoid selection bias. In the instance that no one is present at the randomly selected residence, the surveyor will approach the residence immediately adjacent. This process will continue until a residence with an eligible and consenting individual is found, and the survey will be completed at that location and, if possible, a water sample will be collected, thereby starting the random selection process over again. The location of the home will not be recorded in any way that could connect the survey to any specific home. An Arabic-speaking translator will be present at all times. Surveying and water sample collection should be conducted at the most comfortable setting possible for the individual (i.e., in the home, in front of the home, etc.).

Eligibility Criteria

- *Inclusion criteria*: Participants of interviews and/or water sample collection will be long-term residents of al-Walaja village (defined as having lived in the camp for greater than 12 contiguous months), aged 18 years or more, and who provide informed consent to participate in the process.
- *Exclusion criteria*: Individuals will be excluded from participating in the interviews and/or water sample collection if they do not provide verbal consent to participate, are less than 18 years of age, or if the study team and/or other implementing partners determine that participation may cause harm to the participant.

2. Informed Consent

Consent scripts will be developed to provide information on project objectives and activities, risks and benefits associated with participation and study contact information. Before data collection begins, the appropriate consent script should be read aloud to each participant by the interviewer and communicated to the potential participant by the interviewer and/or trained translator. The potential participant should be asked if he/she has any questions or concerns about participation. They may be reminded that they can choose not to answer any questions they do not wish to answer, and that they can end their involvement in the interview or water sample collection at any time. Their decision to participate or decline participation in the interview/water quality testing will not influence services they receive from any affiliated programs in any way. If there are no further questions, the participant will be asked if he/she gives verbal consent to

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participate in the survey and/or water quality testing. **No signature, name, or identifying information should be provided on the consent script.**

All participants will receive a unique participant identification number (participant ID) at enrollment when consent is provided. This number will be generated sequentially and agreed between team members conducting simultaneous interviews. These numbers will be used (with the date) on all study documents.

This study uses oral consent scripts—this method ensures the confidentiality of the participant because no participant is required to sign their name for consent but must provide verbal agreement. **It is important to note that although signed consent is waived, the consent process is still required and the interviewer/translator is responsible for documenting that consent was obtained.** Consent will be documented by entering the following information: participant ID, date, and whether informed consent was provided by the participant.

3. Conducting the interview/water sample collection

Roles and responsibilities of interviewers, sample collectors, and notetakers

- Bring all materials needed (e.g., surveys, notebooks, pens, interview guide, consent scripts, water sample collection materials).
- Keep all participants focused, engaged, attentive, and interested.
- Monitor time and use limited time effectively.
- Use prompts and probes to stimulate discussion.
- Be prepared to explain or restate questions—a list of key phrases or local/commonly used terms may be useful.
- Ensure confidentiality.
- Collect water sample efficiently.

Leading the discussion

Establish rapport: Often participants do not know what to expect from survey questions and interview discussion. To set the participants at ease, the interviewer should describe the purpose and format of the discussion at the beginning of the session. Participants should be told that the survey questions are standardized, and that discussion is informal. Participants are not required to provide personal experiences. Participants should be reminded that they are sharing their expertise and opinions, so there are no right or wrong answers.

Protecting participants during interviews/discussions and water sample collection

It is important that project staff remember the communities in which participants reside are small, people often know each other, and unintentional disclosure of participation or experience can place a participant at social or physical risk. The interviewer/coordinator should develop a contingency plan to prevent unintentional disclosure of the individual's participation. The contingency plan should include: 1) a topic to which the interview should change to if someone else enters the room during the interview and 2) fake name(s) and/or titles(s) of the interviewer/translator. It is the responsibility of the project team to continuously assess the environment and stop project activities to avoid placing the participant and/or project team at risk.

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Verbal Consent Script

Background and Purpose: You are being asked to participate in a research project organized by a group of Tufts University students and professors in the Water: Systems, Science and Society (WSSS) program. Tufts is a research university located near Boston in the United States. The purpose of the project is to investigate potential water quality issues in al-Walaja village and a possible connection between water quality and health problems. As a member of the community, you are in a position to provide insight into water quality at the camp. I would appreciate it if I could ask you some questions, in the form of a survey, about these issues. Also, if you are willing, I would like to collect a small water sample from your household water source to test for the presence of contaminants.

Procedures: If you agree to participate, one of our group members will ask you some questions directly or through a translator. Our survey should take about 30 minutes. One of my colleagues will take notes. Afterward, we will collect the sample of your water, if permitted.

Risk and Confidentiality: There are no physical risks arising from your participation in this project. We will not record your name, and have designed the questions to avoid obtaining information that can be used to identify you. Please be aware that, although your responses will be maintained in complete confidentiality, there is a chance that someone may discover that you participated in this study. We believe that the risk of harm to you and your family by participation in this survey and water quality testing is minimal. However, you should consider whether you want to be associated with this study prior to providing your consent.

Voluntary Participation: Participation in this project is strictly voluntary – there are no consequences if you do not wish to be surveyed or to provide a sample of your water for testing. Furthermore, if you decide at any time during the survey that you no longer wish to participate, you may withdraw your consent without consequence and we will not incorporate any of your responses into our research.

Benefits: There are no direct benefits to you for participation in the project. However, your participation will help to determine whether or not there may be a link between health issues and water quality in al-Walaja village and the testing of a water sample from your household source for contaminants may help us to determine what water quality issues currently exist in the camp. This information may assist future efforts to improve water quality in the camp, and may provide a framework for future projects conducted by other students and faculty from Tufts University.

Request for More Information: If you have any questions or concerns about the project or your participation in it, please do not hesitate to contact Study Coordinator Andrea Becerra at andrea.becerra@tufts.edu or, until March 25, 2017, via the Lajee Center. We will provide you with an information sheet with this contact information to keep after we leave.

Permission: Now that I've explained the purpose of the survey, would you be willing to participate in it? Would you be willing to allow my team to collect a sample of your water for testing?

Signature: I confirm that the purpose of the research, the study procedures, the possible risks and discomforts as well as benefits have been explained to the participant. All questions have been answered. The participant has agreed to participate in the study.

Signature of Person Obtaining Consent _____ Date _____

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Tufts University
Medford, MA 02144
USA

Participant Information Sheet

2016 Water: Systems, Science and Society Palestine Practicum

Purpose of the study

The purpose of the study is to provide members of the al-Azza Camp community with the skills and equipment necessary to test water quality in al-Azza Camp, and to investigate a possible connection between water quality and health problems there.

Contact information

If you have any questions of would like to receive a report of this study (or a summary of the findings) when it is completed, please contact us.

Researcher: Andrea Becerra
- Email: andrea.becerra@tufts.edu

Faculty Advisor: John Durant
- Email: john.durant@tufts.edu
- Telephone (in the USA): +1-617-627-5489

If you have concerns about this study or your rights as a participant, you are encouraged to contact the relevant Tufts University Institutional Review Board (IRB).

IRB Administrator: Lara Sloboda
- Telephone (in the USA): +1-617-627-3417

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Public Health and Water Quality, Usage and Storage Survey

Section I – Public Health

1) How many people live in this household?
2) How many are children under the age of 5?
    a) Adults over the age of 65?
3) Has anyone in your family been sick in the last 15 days? Yes / No / I don't know
    a) In the last 6 months? Yes / No / I don't know
    b) Who (no names—categorize by age)?
    c) What was the nature of the illness? Check all symptoms associated with illness (even if symptoms occur singly):
        - o Diarrhea
        - o Vomiting
        - o Fever
        - o Intestinal discomfort
        - o Coughing
        - o Runny nose
        - o Other: _____
4) How frequently does an illness occur like this in your household?
        - o Less than once a year
        - o 1-2 times a year
        - o More than twice a year
        - o Once a month
5) Are there types of illnesses that occur at specific times of year in the camp? Yes / No / I don't know
    a) If so, what are they and when do they occur?
    b) What caused the sickness described above?

Section 2 – Water Usage and Storage

6) Where does your primary water supply come from? Where does your secondary water supply come from?
7) How do you store your water?
        - o Tank (Plastic / Metal) Quantity: _____ Volume: _____
        - o Cistern Quantity: _____ Volume: _____
        - o Dubba Quantity: _____ Volume: _____
        - o Other: _____ Quantity: _____ Volume: _____
8) Where are your water storage containers located?
9) Do you ever take measures to clean your water? Yes / No / I don't know
    a) If so, what are they? Check all that apply:
        - o Boil
        - o Filter
        - o Refrigerate
        - o Other: _____
    b) How did you learn about these measures?

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10) If you don't take measures to clean your water, would you be willing to do so in the future?
    a) Which interventions would you be more likely to use?
        - Adding chlorine to water
        - Using a filtration system (ceramic filters?
        - Using flocculant/disinfectant powders (PUR Purifier of Water)
        - Placing water bottles in the sun for 6 hours (solar disinfection)
        - Boiling water
11) Do you clean your water storage vessels? Yes / No / I don't know
    a) If so, how and how often?
    b) If not, why not?
12) Would you request tank cleaning services if they were available? Yes / No / I don't know
    a) If so, how much would you be willing to pay for these services?
13) How much water did your family use in the last week?
    a) Do you know your monthly water usage?
14) How does usage vary between the dry season and the wet season?
15) How often does your primary water supply run out in the wet season?
    a) In the dry season?
16) When water supplies are low, what are your priority uses? (Please rank.)
        - Drinking water
        - Cooking/food preparation
        - Bathing/personal hygiene
        - Gardening
        - Livestock/animal care
        - Other: _____
17) Do you ever buy water? Yes / No / I don't know
    a) If so, how much does it cost?
    b) Where do you get it?
        - Water truck
        - Water bottles or other water-based drinks
        - Other: _____
18) How long does it take to fill one tank when water is running from the public supply? (Please indicate tank size.)
19) Does the availability/distribution of water vary between certain areas of the camp? Yes / No / I don't know
    a) If yes, do you know why?

Section 3 – Water Quality

20) What do you think of the quality of water delivered (taste, smell, color) from your primary and secondary water supplies?
    Primary supply (Where you generally get your water)
    a) Taste
        - Very bad
        - Bad
        - Normal

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- Good
- Very good

b) Smell
- Very bad
- Bad
- Normal
- Good
- Very good

c) Color
- Very bad
- Bad
- Normal
- Good
- Very good

Secondary supply (Where you get water when your primary supply is not available)

a) Taste
- Very bad
- Bad
- Normal
- Good
- Very good

b) Smell
- Very bad
- Bad
- Normal
- Good
- Very good

c) Color
- Very bad
- Bad
- Normal
- Good
- Very good

21) Have you had your water tested recently?
   a) If yes, when?
   b) How did you learn about the water quality testing service?
   c) If you didn't have your water tested, are you aware these services are available? Yes / No

22) If your water was tested recently, did it contain coliform bacteria? Yes / No / I don't know
   a) If so, did you take any measures to treat your water if it was contaminated? Yes / No / I don't know
   b) What were those measures and how did you find out about them?
   c) If you didn't take any measures, why not?

23) Do you monitor the quality of the water you use in your home? Yes / No / I don't know
   a) If yes, who in your home is responsible for this task?

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24) Is your household connected to a sewer? Yes / No / I don't know
25) If a water quality issue were identified:
    a) Who would you go to with your complaint?
        - UNRWA
        - PWA
        - Mekorot
        - Other: _____
    b) Who would you expect to deal with it?
        - UNRWA
        - PWA
        - Mekorot
        - Other: _____
    c) Does this organization generally deal with complaints effectively? Yes / No
26) What do you think might be some solutions to the water issues in the camp?
27) Would you be willing to serve as a volunteer checking water quality in the camp? Yes / No / I don't know
28) Would you be willing to pay $3/month for clean water? Yes / No / I don't know
    a) $5/month? Yes / No / I don't know
    b) $10/month? Yes / No / I don't know
29) Would you be willing to reuse waste water (from showering, washing dishes, and washing clothes) to flush toilets?

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