POTABLE WATER QUALITY ISSUES IN UPPER EGYPT

A comparative qualitative study on drinking water quality in the rural villages of Minya, Upper Egypt

A Thesis submitted to the Public Policy and Administration Department in partial fulfillment of the requirements for the degree of Master of Public Administration

By

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ABSTRACT

Water is life and Egypt faces an ongoing problem of unsafe water quality. People, especially in rural areas, are becoming ill and might not even be aware it is partially due to unclean water they are consuming. This is a qualitative study that, from both social and public health lenses, aims at comparing the perception of families in Egyptian villages (end users) towards the water they are receiving in their homes with the situation as described (and seen by the author) by the service provider (government) within the entire process of clean water provision. In-depth interviews were conducted with families from three villages in Upper Egypt, government employees and a project manager from a non-profit organization that has carried out water projects with the government. Additionally, four samples of water were taken from the villages and tested to compare results with international standards. The analysis of the data is divided into themes under the main sections of end users and service provider. Findings reveal the reality of contaminated water despite the presence of water treatment stations. Further investigation is needed into the effectiveness of water treatment stations and into new low-tech solutions to ensure the safety of drinking water provision.
Chapter One: INTRODUCTION

Egypt faces a major issue of poor water quality. The country is located in a dry climate zone, is mostly covered in desert and rainfall is scarce. While water demand has multiplied due to agricultural expansion, population growth and industrial development, the quota for allocated water to Egypt, according to the 1959 Water Agreement with Sudan, remains at 55.5 bcm per year (Jaskolski, 2016). Much effort is being made into making water available for the entire population of Egypt, but it is facing many challenges and these efforts are not felt by users. The primary reason for that is the growth rate of the population, which is much faster than the country’s infrastructure (Shamrukh & Abdel-Wahab, 2011). Ninety-seven percent of Egypt’s population lives on 4% of the land (Ministry of Water Resources and Irrigation, 2005). In addition to the water shortage, the country faces a critical issue with the cleanliness of drinking water. Several sources of water face constant polluting factors, including semi-treated/untreated industrial waste and sewage water, solid and liquid wastes of Nile cruises, flash floods full of sediments, and agricultural drainage water (Allam, 1995). Due to the contamination of the water, by the time it reaches the villages of Upper Egypt, clear qualities can indicate its cleanliness (e.g. color, taste, odor, texture). This contamination can lead to different kinds of illnesses (discussed in chapters to follow), which in extreme cases for some, can lead to death.

The Nile River is Egypt’s main source of fresh water followed (not closely) by non-renewable groundwater from scattered aquifers and finally from the reuse of agricultural water (Bottoms, 2014). With 98% of all drinking water coming from the Nile (El-Zanfaly, 2015), this creates a tremendous burden on the river. The United Nations reports that Egypt could run out of water by the year 2025 if it continues down the current path of water
consumption in addition to the population growth and pollution rate (UN Water, 2014). One of the main issues facing clean and safe drinking water is the amount of pollution being dumped into the Nile. Nevertheless, there is a cycle the water goes through until it reaches the tap at people’s homes in Upper Egypt. Part of the study will be focused on identifying this process through key informant interviews with administrators.

Water from any source, in order to reach people’s homes, needs a complete water delivery infrastructure. The aim of a proper municipal water delivery system is to transfer safe and clean drinking water from the source of that water to the homes of the citizens to use for drinking and cooking. That water system has two main requirements it needs to fulfill. It needs to deliver adequate amounts of water to meet the consumption demand of the users and it also needs to be reliable. In other words, the service needs to be uninterrupted every day for all hours of the day, all year round (Hickey, 2008). The two factors affecting water supply are the quality of the water and the quantity of the water. The water must be treated according to specific standards and the water needs to meet the consumption needs of the users. Having a continuous supply and flow of water is challenging, however, because of many reasons. Some of these reasons are droughts (or dry desert countries), increasing demands that cannot be met by the existing water treatment plants (lack of infrastructure relating to any number of reasons including electricity and pumping needs), lack of maintenance, and insufficient storage capacity (Hickey, 2008). In Egypt specifically, additional examples of challenges faced when attempting to main a proper municipal system are aging of networks, sewer system and groundwater leakage, deterioration of municipal water reservoirs, and chlorinated compounds (Donia, 2007). Furthermore, there are three basic characteristics that determine the potability of the water. They are the physical quality
of the water, which refers to the aesthetic qualities such as taste, color, odor, the bacterial content of the water and the water chemistry. Water can pick up many other chemicals because of its composition. Some of these chemicals are harmful and need to be treated (Hickey, 2008).

The aim behind this study is to perform a situation analysis and to compare the process of governmental water provision with what is seen taking place on the ground in people’s homes, and whether the water provision procedures that take place translate into safe drinking water from the families’ perspectives. In other words, it will compare the service provision side with the end user perspective side. Firstly, with the families, an identification of the process of obtaining a water connection will be done. Secondly, general awareness regarding water cleanliness will be checked, and whether the interviewee believes the water is clean or unclean through identifying its aesthetic properties (color, taste, odor and texture). Thirdly, if awareness is established, a discussion will occur to find out what the interviewee believes are the reasons behind the water uncleanliness and their suggestions for improvement. Finally, the interviewees will be asked about the remedies used (if any) to clean the water themselves. In the midst of the data analysis and during the interviews, families will also be asked whether they are aware of the cycle the water goes through by the government until it reaches their homes. Furthermore, water samples were taken from four homes across two of the three villages where the interviews took place and were tested for pH, salinity, iron, hardness and chlorine levels and compared with the World Health Organization global standards.

From a service provision side, firstly, general knowledge will be obtained with regards to the entire process of potable water provision. Secondly, information about
accountability will be obtained by understanding the hierarchy of all governmental institutions responsible for the water provision. Thirdly, data will be collected regarding the quality of the water provided and how it is ensured and maintained. Finally, an attempt will be made to find any knowledge on whether public communication occurs from the government side in order to assist people in becoming aware of water cleanliness procedures. Information from field visits to two water treatment stations in Minya will be presented as well. A qualitative approach was chosen for this study because the focus of the study is the perspective of the families that live in the villages and the gathering of data on what takes place from a water service provision standpoint. Interviews were conducted in the forms of conversations.

In discussing any issue, it is important to identify the stakeholders involved and their roles. There are six main stakeholders to be mentioned when it comes to the topic of this study, whose roles will be discussed in the chapters to follow:

1. Government policy makers
2. Government service provider
3. Government regulatory agencies
4. NGOs
5. Local administration
6. Local households

Three villages in Upper Egypt in Minya governorate from two different districts were sampled for the family interviews, two out of which four water samples were obtained for testing. The two water treatment stations were also in Minya governorate. The research was carried out in an area of poor rural villages in Upper Egypt and does not cover urban communities.
Research Question

Based on the focus of this study, the research tackles the following research question and sub-questions:

• How does what the provider claims regarding efforts of clean and safe drinking water provision compare to the end user’s perception of the state of the water provided?
  o Service Provider
    ▪ What is the process of providing clean and safe drinking water from the supplier’s side? What are the roles of different agencies in each step?
    ▪ What measures are put in place to ensure cleanliness and safety of the drinking water reaching consumers? How is the water cleanliness maintained?
    ▪ What kind of information is provided to the consumers with regards to the process of providing clean and safe drinking water?
    ▪ How far does the drinking water provision process adhere to good governance?
  o User/Consumer
    ▪ What is their awareness with regards to the water quality? Do they think it is clean and safe, or not?
    ▪ What is wrong with the water quality from their perspective?
    ▪ What, if any, remedies are used to cope with the quality of the water?
    ▪ What are these remedies dependent on?
    ▪ What are their demands from the service provider?

Study Outline

The study outline for this research study is as follows:

• A literature review about water quality and perception.
• The methodology in data collection will be explained thoroughly (types of interviews, size and type of sample, sample sites, ethics and procedures, and the limitations of the study and researcher)

• Data and analysis: divided among a service provider section and an end user section.
  a. Service Provider
     i. Water Supply System
     ii. Governance
     iii. Standards / Quality
     iv. Communication with Users
  b. End user
     i. Water Supply Service
     ii. Household Awareness
     iii. Water Quality
     iv. Methods of Remedy
     v. Communication / Complaints

• Conclusion and recommendations

Personal position

It is important to note that the researcher works as the National Director of a nonprofit organization – called HG for the purpose of this study – that carries out child sponsorship programs and development projects in villages in Upper Egypt. HG’s field staff that work on the projects and with the children and their families on a daily basis are from each of the local villages HG works in. The staff’s locality leads to establishing real and deep relationships with the families and not just providing financial assistance. The vision of HG is to see holistic village transformation through several aspects, one of which is health. The
health aspect consists of personal hygiene and access to safe and clean water for drinking and cooking. HG installs high-capacity water filters in the villages and provides hygiene awareness including what to use the water for and what not to use it for. For example, the organization’s staff teach people to use the water for drinking and cooking but not for bathing and washing clothes. HG also puts up a large banner next to the water filters showing cartoons and explanations of the proper uses of the clean water, which helps both the educated and the illiterate. The reason behind these statements is to give background information on why and how this topic, the sample, and the sample sites were chosen. In order to remain partial to the study, the researcher’s identity as an employee of HG was never disclosed to any interviewee. The field staff that joined the home visits were given specific instructions not to relay the researcher’s involvement with HG. Instead, the information provided to the families was that the researcher is a friend of the field staff from Cairo, working on his thesis study. The limitation that could have been present, however, is the partiality in the field staff interviews. Due to the researcher’s position as the manager of the nonprofit organization, the staff could have felt compelled to participate to avoid facing any harm from refusing the organization’s manager’s request, even though it was clarified their participation was completely voluntary and would cause no harm or benefit to them within the organization.

There are several photos that are worthy to be shown because they inspired the research topic (Fig. 1 below). These photos were taken in the field in Minya by the media team of HG, so they are copyrighted by the organization.
<table>
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<td>Trash thrown into the canal, where little children swim, where clothes are washed, and where pots, pans and dishes are washed as well.</td>
<td>Dead animal carcass laying in the water of the canal where clothes are washed, and where pots, pans and dishes are washed as well.</td>
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<th>Photo #3</th>
<th>Photo #4</th>
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<tr>
<td>Water pumped from the canal for irrigation and personal use (untreated water)</td>
<td>Dead animal carcass laying in the water of the canal.</td>
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*Fig. 1 – Photos from the field demonstrating the reason behind the interest in the given topic*
Chapter Two: BACKGROUND

Sources of water

Even though the Nile River is almost the exclusive source of water for Egypt, there are other sources. However, they are not fully utilized for different reasons. According to the Nile water agreement with Sudan, Egypt is allocated 55.5 billion cubic meters per year, which is ensured and regulated by the High Aswan Dam (Ministry of Water Resources and Irrigation, 2014). However, since Egypt is the last of nine countries to receive the water flowing from the Nile, many contaminants are already present in the water.

Rainfall is another source of water; however, Egypt only gets a few scattered showers every year, so it cannot be considered a reliable source due to its scarcity and unpredictability. The average utilized rainfall per year in Egypt is almost 1.3 billion cubic meters (Ministry of Water Resources and Irrigation, 2014). Next, there is both deep and shallow groundwater, which exist in aquifers. The deep groundwater, which is nonrenewable, is found mostly in Sinai and the Western Desert. Its capacity is estimated to be around 40,000 billion cubic meters per year and Egypt uses two billion cubic meters per year. The shallow groundwater abstraction from aquifers is 6.5 billion cubic meters per year while its rechargeable capacity is 7.5 billion cubic meters per year (Ministry of Water Resources and Irrigation, 2014). However, the source of the shallow groundwater aquifers is mainly seepage from the Nile River or irrigation drains and canals. In other words, these shallow aquifers could be considered a reservoir of the Nile rather than a standalone water source. The main obstacles in using aquifers as a source of water is the depth they are found and the deteriorating water quality at those increased depths (Ministry of Water Resources and Irrigation, 2014).
The final two sources of water are desalination of seawater and the reuse of treated sewage water and agricultural drainage water. Desalination of seawater for a long time was unutilized due to its extremely high cost of treatment. Recently, however, the Egyptian government announced the establishment of several new desalination plants for use in the coastal cities [1]. According to a phone interview on “Kol Yom” talk show with Dr. Sayed Ismail, the Ministry of Housing Facilities Advisor (2017), from 1990-2015, Egypt’s desalination efforts amounted to an average 70,000 cubic meters per day of water. Since 2015, the number of cubic meters per day of desalinated water currently produced is 700,000 throughout the coastal cities [2]. Based on another phone interview on the same show with Major Kamal El Wazir (2017), Head of the Egyptian Armed Forces Engineering Authority, the government is building one of the biggest desalination plants in the world in the coastal city of Ain Sokhna with a capacity to produce 164,000 cubic meters of desalinated water per day. In total when all plants are operational, the number of cubic meters per day could reach upward of 1.6 million [3]. The initiative is to make all coastal cities self-sufficient in their water supply needs and therefore, alleviate some of the burden on the Nile, which would be dedicated to non-coastal cities [3]. Finally, the last source of water, which cannot be considered a standalone source, is treated sewage water or agricultural drainage water. This source will not be discussed further as its primary use is for irrigation rather than for drinking.

2 “Kol Yom” hosted by Amr Adib. Aired on ON TV. Phone interview with Dr. Sayed Ismail, Ministry of Housing Facilities Advisor. Published on November 13, 2017 on YouTube - https://www.youtube.com/watch?v=rk4Rwd80i8
3 “Kol Yom” hosted by Amr Adib. Aired on ON TV. Phone interview with Major Kamal El Wazir, Head of the Egyptian Armed Forces Engineering Authority. Published on November 13, 2017 on YouTube - https://www.youtube.com/watch?v=5TtHPD-iLs4
Water pollution

Drinking water quality mainly depends on three aspects: quality of the raw water used, the polluting content in the water, and the treatment process and technology used (El-Zanfaly, 2015). Consuming unclean water can lead to serious health problems due to the possible accumulation of even small doses of contaminants in the course of a lifetime. Industrial waste is a main contributor to the water contamination and pollution crises. According to El-Zanfaly (2015), around 350 industries are discarding their toxic and untreated waste either through the municipal system or directly into the Nile. Some of the most hazardous chemicals are found in this waste like pesticides, heavy metals and detergents. Furthermore, some pollutants are not affected by traditional treatment methods, which means they remain in the water (El-Zanfaly, 2015).

Drainage/sewage water from areas all over Egypt, including some slums is also emptied into the river prior to any treatment, which is full of bacteria. There are many logged cases of wastewater leakage and dumping of dead animal bodies (Dakkak, 2016) in addition to disposal of solid waste directly in in the nearest waterways and canals (El-Zanfaly, 2015). Agricultural draining water is another main player in water pollution. It contains residue of fertilizers and pesticides in addition to dissolved salts washed from agricultural lands (Shamrukh & Abdel-Wahab, 2011). In addition, from an agricultural perspective, the use of fertilizers and pesticides results in the flourishing of weed “which increases evapotranspiration, blocks the waterways, and provides habitats for bilharzia snails” (Abdel-Shafy & Aly, 2002). Most of the industrial waste comes from urban areas while most of the agricultural waste comes from the rural areas in Egypt.
Effects of consuming contaminated water

Contaminated water not only causes many forms of diseases, but deaths as well. According to the World Health Organization (2017), three in ten people globally lack access to safe drinking water at home. This translates to 2.1 billion people worldwide (World Health Organization, 2017). Numerous diseases can be caused by contaminated water. Examples are diarrhea (which in extreme cases can cause deaths, especially when combined with malnutrition), arsenicosis (skin-related), cholera (intestinal, which can cause diarrhea), fluorosis (bone disease), guinea worm disease (larvae that grow inside the body), intestinal worms, malaria (which can be caused through attracting malaria-filled mosquitos due to standing, uncovered water), trachoma (eye infection which can lead to blindness), hepatitis A, hepatitis C, liver damage, typhoid fever, lead poisoning and schistosomiasis, which is perhaps one of the most common in Egypt, known as bilharzia (UNICEF, 2003).

According to UNICEF (2018) and the World Health Organization (2018), diarrhea is the second leading cause of death among children under five years old globally, accounting for 8% of total child deaths under five years old, which amounts to 1,300 children every day (around 480,000 per year). In a press release conducted by Sanjay Wijesekera (2013), global head of UNICEF’s Water, Sanitation and Hygiene Programme, she states that 90% of all diarrhea-related deaths among children are directly associated with water and hygiene (Wijesekera, 2013). In Egypt specifically, 5% of all child deaths under five years old are diarrhea-related, amounting to 3,500-4,000 children every year (World Health Organization, 2015) (UNICEF, 2018). In addition, a 2009 report issued by the Egyptian Organization for Human Rights states that 76% percent of water in the villages is mixed with sewage prior to treatment. The report goes further in saying that about one hundred thousand Egyptians are
infected with kidney failure every year due to water pollution (The Egyptian Organization For Human Rights, 2009).

Examples of existing common water filtration process in Egypt

The water in Egypt used for drinking comes in two forms: surface water or groundwater. In either case, and as will be seen in the data discussion, it is common for chlorine to be added as the main disinfectant. This causes the production of some other chemicals as by-products (Geriesh, Balke, & El-Rayes, 2008). A common technique in water treatment plants is the use of basins that are made up of either one or two layers of sand and gravel filters. They then have one or two reservoirs where the water ends up after the chlorination process. For the larger, main water treatment stations, chlorine gas is commonly added two times – one time before the filtration process and a second time after the filtration process. The time varies between the two stages and ranges between twenty minutes to sixty minutes (Geriesh, Balke, & El-Rayes, 2008). The study further shows that even when the water is bacteria-free after the completion of the filtration process, it becomes bacteria-rich on its way to its destination if not enough chlorine is added and depending on how far a village is from the water treatment station. The bacteria are most likely formed due to the leakages of the polluted shallow groundwater when water pumping is not active (Geriesh, Balke, & El-Rayes, 2008).

According to the Holding Company for Water & Wastewater’s website, the water should be going through the following stages of treatment (this is not the case in all water stations, though):
1. Screening: first step and it removes all particles or hard things that can stand in the way of the steps to follow.

2. Coagulation: smaller particles in the water are hard to remove, so alum is added in this step, which sticks to the smaller particles, forming a hardened element.

3. Flocculation: the gathering of the hardened elements formed by coagulation, forming bigger elements together than can be removed easily.

4. Sedimentation: the second main step in the water filtration process, which allows “sludge” to settle at the bottom, then be removed.

5. Percolation: the water passes and seeps through an element to further filter it, which in this case, is usually sand and/or gravel.

6. Sterilization: the final step where bacteria is killed through the addition of certain elements such as chlorine, ozone and the use of UV lights.

(Holding Company for Water & Wastewater, 2018)

Each of the stages is done in different chambers, but the addition of alum is done in a special chamber called flash mixer, which automatically mixes the element with the water in a fast and efficient way. This process is comparable to international methods. According to the CDC (Centers for Disease Control and Prevention), which is one of the major operating components of the Department of Health and Human Services in the US, the most currently common steps in water treatment include coagulation and flocculation, sedimentation, filtration - what is referred to as percolation on the HCWW website, and disinfection - what is referred to as sterilization on the HCWW website (CDC, 2015). Even though the water treatment steps are comparable to international methods, not all water treatment stations in Egypt or even in Minya Governorate alone follow them. There are several factors that
determine the steps taken at a water treatment station, which mainly depend on the facility’s location and how big of an area it serves. There is not one standard practice that applies to all water treatment stations across the country. One example of a large water treatment plant that follows the steps stated on the Holding Company of Water & Wastewater website is a plant in the city of Mansoura commissioned in 1998 and operational since 2002, and its process can be portrayed in the following diagram (low quality from source):

![Diagram showing the water treatment plant's treatment process](image)

*Fig. 2 – Diagram showing the water treatment plant’s treatment process* (Water Technology, 2018)

A new innovation that is being used around the world, and needs further investigation for Egypt specifically, is RBF units (river bank filtration). This system uses wells that gather water that has effectively circulated through natural filtration via soil aquifers or riverbanks (Jaskolski, Managing Egypt’s Limited Supply of Fresh Water – Challenges of Sustainability, Water Scarcity and Food Security, 2016). Based on the naturally occurring filtration, RBF
units are able to provide clean drinking water at a fraction of the cost of traditional water treatment methods. Currently, according to Thomas Grischek and Kamal Ghodeif, river bank filtration’s usage in Egypt is at 0.1%, but has the potential to be developed on a wide scale, especially after its tremendous success in Germany (Grischek & Ghodeif, 2016). The authors go on to say that RBF units can solve some problems Egypt is facing like contaminated spills and accidents, disposal of treatment plant waste, and contamination arising from flash floods, especially since they are a highly sustainable and low-cost technology. The following diagram illustrates how RBF units operate:

![Diagram of river bank filtration](image)

*Fig. 3 – Schematic of river bank filtration* (Grischek & Ghodeif, 2016)

As portrayed, water from the Nile seeps through the river bank, passing through soil aquifers and clay, at which point a well is built to pump out the water, which has already gone through natural filtration. RBF units have been tested at several location along the Nile, but unfortunately, have not yielded the results expected. Nevertheless, further investigation needs to be conducted on how to properly implement the solution. Egypt can learn from the technology’s successful usage in Germany.
WHO standards

It is important to discuss international standards when it comes to drinking water quality. The World Health Organization has established a guideline for drinking water quality (World Health Organization, 2017). Of all the standards available in this guideline, the following will be mentioned as they pertain to the testing conducted on the water samples taken from the villages: chlorine, iron, hardness, pH, and TSD's (salinity).

Chlorine is an effective disinfectant when pH levels are less than 8. Lower pH levels of 7 or less can cause corrosion of water pipes so it has to be controlled (World Health Organization, 2017). People can generally taste or smell chlorine in drinking water when its level is below 5 mg/l and as low as 0.3 mg/l. The WHO's health-based guideline value for chlorine is 5 mg/l, but for effective disinfection, the residual of free chlorine should be at a minimum of 0.2 mg/l at point of delivery (World Health Organization, 2017). The WHO guideline has not established a guideline value for iron concentration because it is not of health concern at the levels found in drinking water. However, according to the National Testing Laboratories, Ltd. (2014), the national standard in the US for iron concentration is 0.3 mg/l. It also states the national standard for water hardness as 100 mg/l (National Testing Laboratories, Ltd., 2014). Hardness is “is the traditional measure of the capacity of water to react with soap, hard water requiring considerably more soap to produce a lather” (World Health Organization, 2011). The WHO has not established a guideline value for hardness because it is not of health concern at the levels found in drinking water (World Health Organization, 2017).

With regards to pH levels, the national standard, according to the National Testing Laboratories, Ltd., (2014), is between 6.5-8.5. The WHO has not established a guideline value
because it is not of health concern at the levels found in drinking water. Finally, for total dissolved solids (TDS), which measures salinity, levels of less than 600 mg/l are considered good. Levels higher than 1000 mg/l causes the water to become undrinkable and unsafe (World Health Organization, 2017). TDS usually originates from natural sources such as agricultural and urban run-off, sewage, and industrial wastewater (World Health Organization, 2003). TDS concentrations vastly vary according to the solubilities of minerals in different geological regions.

**Egyptian standards**

Water production in Egypt comes from 2,715 water treatment plants. These plants produce 2.5 billion cubic meters of water per day, which are pumped through 165,000 km of water distribution network and pipes (Holding Company for Water & Wastewater, 2018). The efficiency of the delivery network is the main factor affecting the amount of water available for municipal use, which is reported to be at 50% efficiency (El-Zanfaly, 2015). Egyptian standards for drinking water quality were originally set by the Ministry of Health & Population in accordance with WHO guidelines (El-Zanfaly, 2015). According to Egypt 2012 State of the Water Report by the Monitoring and Evaluation for Water in North Africa Project, the government requires the following indicators to be measured and reported at all water treatment stations (Egypt MWRI, CEDARE, & Ahmed, 2015):

- Dissolved Oxygen (ppm)
- pH (dimensionless)
- Electric Conductivity
- Total Dissolved Solids (ppm)
- Nitrogen Concentration (ppm)
- Phosphorous Concentration (ppm)
- Fecal Coliform (Colonies/100 ML)
- Biological Oxygen Demand (BOD)(mg/l)
- Chemical Oxygen Demand (COD)(mg/l)
- Chloride Concentration
- Total Hardness

The Egyptian standards for elements present in drinking water, based on the guidelines of 2007, are as follows:

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<tr>
<th>Parameters</th>
<th>Egyptian standards (2007)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbidity (NTU)</td>
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</tr>
<tr>
<td>pH</td>
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<tr>
<td>Conductivity</td>
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<tr>
<td>Ammonia (mg/l)</td>
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<tr>
<td>Nitrite (NO₂) (mg/l)</td>
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</tr>
<tr>
<td>Nitrate (NO₃) (mg/l)</td>
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<tr>
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</tr>
<tr>
<td>Total coliforms</td>
<td>Not exceed 2 cells/100 cm³</td>
</tr>
</tbody>
</table>

*Fig. 4 – 2007 Egyptian standards for water parameters*

(El Bahnasy, El Shazly, Al Batanony, Gabr, & El Sheikh, 2013)

**Governmental structure & accountability**

According to the websites of different governmental agencies, the following diagram illustrates the hierarchy of the entities within the water sector:
The Potable Water & Sanitary Drainage & Consumer Protection Regulatory Authority is responsible for all licensing of any water project in Egypt. No water station can operate (or any water project) without the operational approval of this authority. The approval is given not from a water quality perspective, but from a licensing one. However, from the research and interviews, there is no indication that Holding Company for Water & Wastewater actually reports to the Potable Water & Sanitary Drainage & Consumer Protection Regulatory Authority, even though it is a regulatory authority. The National Authority for Potable Water & Sewage is responsible for all planning related to any water project, including funding. The Potable Water & Sanitary Drainage & Consumer Protection Regulatory Authority and the National Authority for Potable Water & Sewage both report to the Ministry of Housing, Utilities & Urban Communities. The Holding Company for Water & Wastewater (HCWW), which also reports to the Ministry, is responsible for the operation, treatment, distribution, and sale of potable water in addition to the collection, treatment, and safe discarding of wastewater (Holding Company for Water & Wastewater, 2018). Under the HCWW, there are twenty-five subsidiary companies, one of which is the Minya Water & Wastewater Company.
Each subsidiary has the same responsibility as the HCWW, but in their own territory and governorate and they all report back to HCWW. From the wording of the job functions of each of the three authorities, there seems to be overlap. For example, the National Authority for Potable Water & Sewage is supposed to be responsible for the planning of water projects while at the same time the Holding Company for Water & Wastewater seems to be managing the entire sector. Overlap creates inefficiencies and hinders good governance.

Another player is the Ministry of Health & Population, which has the power to shut down or authorize the operation of any water treatment plant according to the results of tests run on water samples from these plants. In addition to the Ministry of Health & Population, other entities involved in the regulation and monitoring of the water projects and water quality in Egypt are the Ministry of Environment, which monitors the effect any water project has on the environment and the Ministry of Water Resources & Irrigation, which is responsible for the big water development projects in Egypt like, for example, the High Dam and the 1.5 Million Acres project.

With all these entities in place, it would seem like the government is trying to ensure a full process managed with good governance and accountability. However, this is unfortunately not true. In the 1990s, international donors to Egypt pushed for reforms in the water sector with the aim to create decentralized autonomous public water companies in addition to bringing in the private sector (Schiffler, 2015). After studies were commissioned and completed, the Egyptian Cabinet charged the Ministry of Housing in 1998 with the task of producing two documents: a law on enterprises for water & wastewater and a decree on the reorganization of the water and wastewater sector (Schiffler, 2015). The Cabinet approved both documents and sent them back to the Ministry of Housing, which only passed
the reorganization decree and discarded the law, and in turn, excluded the provision of the participation of the private sector. Furthermore, the decree in its original form was discarded and instead, the government created the Holding Company of Water & Wastewater in 2004. Most of the agency’s tasks overlap with ones from other existing agencies, which causes complications and inefficiencies in the midst of the existence of many agencies in the water and sanitation sector (Schiffler, 2015). According to Catarina Albuquerque, the UN Special Rapporteur for the human right to safe drinking water and sanitation, when she visited Egypt in 2009, the overlap of responsibilities creates an atmosphere where no institution deems itself accountable for the problem in question (Schiffler, 2015).
Chapter Three: LITERATURE REVIEW

Safe Water

In the context of drinking water, the study discusses the core issue of its quality and safety. However, first, the meaning of ‘safe’ needs to be defined. In their book “Safe Drinking Water: Lessons from Recent Outbreaks in Affluent Nations”, Steve and Elizabeth Hrudey (2010) state that safe does not mean zero risk, meaning there is no clear line separating safe from unsafe. Rather, safe can be relative. What can be considered safe for someone according to certain risk factors might not mean the same to another. Elderly people, young children, or people with weak immune systems will react differently to contaminants found in drinking water (U.S. Geological Survey, 2008). When it relates specifically to water, safe can defined as not expecting to die or become truly ill from drinking it (Hrudey & Hrudey, 2010). According to the United States Geological Survey (2008), safe water means water that will not cause you harm if you come in contact with it. It goes on to say that water must have appropriately low concentrations of unsafe contaminants in order to be considered safe. Some examples of these harmful contaminant include strong acids, some metals, viruses, bacteria, pesticides, petroleum products, just to name a few (U.S. Geological Survey, 2008). According to WHO guidelines, safe drinking water means that it “does not represent any significant risk to health over a lifetime of consumption. Hence, drinking water should be clear and free from objectionable tastes and odors and from harmful chemicals and microorganisms” (World Health Organization, 2011). Therefore, the water should be clear and free from Zero risk can never be achieved as there are many ways mistakes can take place, especially when factoring in human intervention within, for example, water treatment
plants. The focus should not be on human errors, but rather building and maintaining a system that is able to produce safe outcomes if and when human error does takes place (Hrudey & Hrudey, 2010).

**Water perception**

There are some studies that have been conducted in different areas of the world regarding people’s perception of drinking water quality, which will be discussed below. Usually, studies such as these are done in rural areas, regardless of whether the nation being discussed is a developing country or a developed one. The research revolves around the idea of water quality perception, the health risks associated with drinking unclean water, and the fact that governments should consider these perceptions when forming and implementing water quality interventions.

**Aesthetic qualities**

A study about water quality perception in rural Australia argues that color, taste, smell and hardness can influence perceptions of risk and quality. However, when people are too exposed to these hazards, they can become used to them and become desensitized, which affects their risk assessment (Jaravani et al, 2016). In a cross-national study about the perceptions of drinking water quality and risk and its effect on behaviour in the UK and Portugal, the researchers reach the conclusion that the perception of water quality by consumers is mainly persuaded by their satisfaction of the aesthetic qualities of the water, specifically flavour, risk perception, and their perception of chemicals present in the water, like chlorine and hardness (Doria, Pidgeon, & Hunter, 2009). Another study about the
perceptions of United States consumers of water quality concluded that the decision to switch to bottled water as the primary source of drinking water was directly related to consumer perceptions of ground water quality and local water supply safety. In this study, it did not matter whether the consumers’ water source was a small water system or large municipal water supply system. If the consumer considered his/her local water not safe, he/she is more likely to switch to bottled water as the primary drinking water source (Hu, Morton, & Mahler, 2011). There is always a risk when collecting consumer reported data on aesthetic characteristics of water as it is subject to variability. What some people consider bad taste or odor, others might not.

In another study, public perceptions of drinking water safety were measured to see if they had any association with outbreaks of diseases, household characteristics and water supply characteristics in South Africa (Wright, Yang, Rivett, & Gundry, 2012). Again, public perception was mainly based on aesthetic properties of the water. This was surprising to the researchers because they perceived that the large cholera outbreak that took place in South Africa from 2000-2002 would impact the public perception of the drinking water safety. However, it did not affect the public perception. The trend remained the same in South Africa, even with the cholera outbreak. The authors concluded that perceived drinking water safety was mainly related to clarity, odor and taste of the water rather than demographic or socio-economic characteristics (Wright, Yang, Rivett, & Gundry, 2012).

Risk

Many studies have associated perception with risk. However, it is shown in the literature that risk is dependent on many factors. One study defines risk perception as an
individual’s subjective judgement, whether it is based on non-aesthetic or aesthetic characteristics, about drinking water from their city’s water system. It further elaborates:

“the notion that risk perception about drinking water has been described as subjective is because people depend on intuitive risk judgements to assess risks about drinking water. This view is borne out by past studies that show people’s safety concerns are based on their subjective feelings about the physical properties of water and potential chemical and microbial water contaminants; these concerns are augmented by media coverage of drinking water problems.”

(Anadu & Harding, 2000, pp.82-83)

Risk perception, is persuaded not just by the aesthetic qualities, but also by perceived chemicals, previous health issues, and external information (Doria, Pidgeon, & Hunter, 2009). It can be driven by cultural, social and psychological factors in addition to objective information like that obtained from media. Furthermore, when looking at the perception of chemical risk specifically, it can be strongly driven by the level of distrust one might have towards his/her government service provision institutions. This distrust can convert into insecurity and suspicion about the safety and appropriate regulation of general drinking water treatment (Anadu & Harding, 2000). “The psychology of drinking water quality: An exploratory study,” further investigated the risk perception and found that the data they collected with regards to people’s acceptance of their water quality (in Western Australia) and water quality risk judgements was “related to perceived credibility of societal institutions and feelings of control over water quality and environmental problems” (Syme & Williams, 1993, p. 4004). According to Jaravani et al., (2016) inhabitants might consume water of unknown quality, like rainwater, because of a lack of trust in government water supplies. Another study conducted in rural Columbia shows that some people have a risk
perception that links river pollution to waterborne diseases and health risks (Rojas & Megerle, 2013).

**Awareness**

Awareness of the true qualities of water is not always present. In many villages and rural areas, people are unaware of any problems with their water and drink from it normally. They are just thankful they have it. In a study conducted in a rural region in Ghana that gathered site-specific information regarding local water sources, the researchers conducted a focus group that combined people from eight villages in the Ashanti region in Ghana (Arnold, et al., 2013). Their overall response that piped water was the safest to drink from was shocking to the researchers because in carrying out scientific tests, they found the water to contain many contaminants. The women even stated (in this country, it is the woman’s job to bring water for the family) they did not feel they needed to perform any in-house treatment to the water from the pipes. Their problem was the reliability of the water, which would sometimes not be available for days or even weeks. In that case, they would have to travel much further to bring water. It was obvious that there was no awareness regarding the contamination of the piped water and the women all expressed their satisfaction and trust that the piped water was the safest to drink as they were not aware of the waterborne diseases even if someone in the village suffered from one (Arnold, et al., 2013). Awareness should be increased, as another study states (Hunter, 2009). This study indicates that household water treatments (HWT for short) are being widely promoted as a suitable intervention for alleviating the problem of waterborne diseases in rural communities of developing or underdeveloped countries (Hunter, 2009).
A similar study to a portion of what this study aims at investigating was conducted in the Bungamati Locality in Kathmandu Valley, Nepal by Pradhan et al., 2004. The study indicates that, after testing different water samples from different places, and comparing it with the World Health Organization's standards, it was determined that the water was not potable. Therefore, the study wanted to measure community awareness with regards to water quality and knowledge about possible waterborne diseases (Pradhan et al., 2004). Many studies conducted by several organizations indicated that almost one third of total child deaths under five years old in the rural area of Nepal is due to waterborne diseases (Pradhan et al., 2004). It is discussed that the inhabitants of rural communities choose the most accessible and closest water source for their drinking needs, regardless of the perception of the quality of that water. Due to their deep-rooted religious beliefs, the inhabitants believed the reasons behind the waterborne diseases to be traditional rather than from contaminated water. They remained unaware of knowledge related to diseases caused by non-potable water (Pradhan et al., 2004).

Different studies show different reasons behind people’s perception of drinking water and their correlations. One study on rural Pakistan found a significant relationship between education and income of the participants and experiencing waterborne diseases due to ill-advised clean water best practices (Ali & Akhtar, 2015). Less educated people tend to not follow necessary precautions to avoid, in this case, waterborne diseases. Yet another study on rural India argues that several factors hinder the acceptance of change when it comes to water sources: a fake sense of protection from water that is available locally, a lack of knowledge about health dangers linked to drinking unclean water, a wrong perception on
the treatment of water, and a resistance to change in the odor or the taste of the water (Francis, et al., 2015).

**Government intervention**

A study by Wedgworth et al. (2014) studied the association between the perception of drinking water and actual measured drinking water quality in rural Alabama, USA. The overall objective of the study “was to determine whether consumer interview data and subjective consumer perceptions were predictive of objectively measureable water quality data” (Wedgworth, et al., 2014, p. 7378). Although the study was a quantitative one, there are key points to be taken specifically from the data collection regarding the perception of the drinking water. Information about two key areas of water service condition were collected from nine hundred and ten households served by fourteen small water systems. The two areas were delivery conditions (lower water pressure and intermittent service) and main aesthetic characteristics (odor, taste and color), which provided five condition values (Wedgworth, et al., 2014). The researchers also took microbial water samples from a kitchen tap from the distribution network as well as measure water pressure. The study indicates that obtaining representative and reliable data in rural areas can be complicated and challenging, let alone time-consuming and expensive. Nevertheless, this kind of data is important for pinpointing water quality risk management priorities and can be used in environmental health studies that aim at quantifying the link between health outcomes in populations and microbial water quality (Wedgworth, et al., 2014).

Many studies indicate the need of government intervention. However, these interventions cannot take place without the direct involvement of the local community. One
study suggests partnerships be formed between local communities and service providers to make sure that interventions are responsive to the real needs of the community, and that they would be done in a culturally appropriate manner (Jaravani et al, 2016). The interventions, the study goes on to show, cannot be considered comprehensive without a better understanding of cultural issues, people’s perception of drinking water quality, and true active community engagement (Jaravani et al, 2016). It is important to effectively involve communities in the decision making process and during different stages of implementation to ensure the success of longterm water quality interventions (Francis et al, 2015). Only through the understanding of local residents’ perception of drinking water quality can officials and public health professionals target outreach activities and education that can essentially be considered effective (Jones, et al., 2005). Research has to be carried out within local communities before water supply systems are installed and after they are installed to appropriately ensure their effectiveness based on the local community's needs.

The studies move on to discuss what is needed to ensure successful interventions. It was already mentioned that interventions need to be customized to each local community according to its needs. There is no “one size fits all” concept when it comes to local perception of the quality of their drinking water. Health literacy can be developed through better and more focused consumer engagement. There is also great need for the creation of health campaigns that plainly demonstrate drinking water safety messages. If these messages are targeted, they can help avoid some potential health risks (Crampton & Ragusa, 2016). Prior to implementation, research on the factors affecting water quality interventions can ensure vaster acceptance and sustainability of these interventions by the local community and its residents (Francis et al, 2015). One study shows a difference in the responses of residents
of different age groups who have different water systems. This highlights the possible need of targeted education strategies and health awareness campaigns (Jones, et al., 2005).

**Egypt’s current position**

Unfortunately, Egypt is not a main player when it comes to global initiatives tackling the issue of water. Even though it is contributing to many of the SDG’s, according to WASH’s webpage (Water, Sanitation and Hygiene), which is part of the 2015 UN Sustainable Development Goals (SDG’s) and aims to provide access to improved water sources and sanitation to all by the year 2030, Egypt is not one of the partner countries (United Nations, 2015). Nevertheless, Egypt, as part of its adherence to the SDG’s, has created Egypt Vision 2030. One of the pillars of the vision is the environmental pillar and there are several programs and indicators aimed to tackle (or tackle in part) the water issue (copied from website):

- Strengthening the institutional and legislative structure of water resource management
- Expanding infrastructure for supporting a sustainable water system
- Adopting fiscal policy reforms to encourage sustainable consumption patterns of water and natural resources
- Raising awareness to reserve environment and natural resources, providing incentives for more advanced alternatives and technologies for water conservation and natural resources protection

(SDS Egypt 2030, 2016)
This shows initiative, however, the website for Egypt Vision 2030 does not show much information on how these programs will be achieved. On the website of the Holding Company for Water and Wastewater, however, it does mention partnerships with international organizations like UNICEF, GIZ, USAid, and The World Bank to meet the company’s vision of reaching an international level of standards with regards to creating and operating water and wastewater companies in Egypt (Holding Company for Water & Wastewater, 2018). Nevertheless, according to UNICEF, many villages in rural Egypt are constantly relying on water delivery systems that are unhygienic and outdated, and hence, unsafe (Jaskolski & Otter, 2016).

Not enough research or studies have been conducted on the topic of perception of water quality by the people in Egypt, especially in the rural villages. Most of the studies that have been conducted comprise of topics such as water scarcity, water pollution, water quality and its impact on human health, and recommendations for solutions combating these issues. In the study by El-Zanfaly (2015), he argues the link between poverty and pollution in Egypt. He draws the association between poverty and lack of hygiene, or ‘dirtiness,’ which in turn is associated with pollution. Another way, he argues, poverty is linked to pollution, more specifically in relation to drinking water, is the way poor people have the tendency to be excessively affected by lack of access to clean drinking water (El-Zanfaly, 2015). Relating this to child health (and health in general), the author states that in two villages, one in Qaliubeya and one in Menufiya Governorates, women, despite the availability of piped water, still went to the canal several times a day to wash plates, pots, pans, and food utensils after meals. They preferred not to use the home water frequently for fear the sceptic tanks would fill up quickly. They rather chose to go to the canal where the water is plenty and flowing (El-
Zanfaly, 2015). It is also a way for them to be distracted from daily routines and socialize with other women. This highlights the significance of considering not only water access, but usage as well when relating child health with water supply.

A study by Mandour, R. A. (2012) researched health impacts of contaminated water on thirty patients who were being treated at Dakahliya hospital due to complaints about poor water quality in their homes. The study, through taking water samples and urine samples from the patients and testing them, found relationships between hair loss and nickel, renal failure due to lead and cadmium in the water, and liver cirrhosis due to high iron-contaminated water (Mandour, 2012). Studies link these diseases with industrial waste and agricultural activities that resulted in the release of toxic and hazardous material in the drinking water (Mandour, 2012). From the Aswan High Dam, the water released portrays little degradation and stays extraordinarily clean from chemical pollution until it reaches the Delta region (Abdel-Satar, 2005).

The research already conducted on this subject can be summarized in the following points: a) perception of drinking water quality by local residents is important to consider when government intervention is being studied, b) interventions should not be performed without the active involvement of the local community to understand its needs, c) based on the information gathered from the local community, interventions should be customized to its needs, d) targeted health campaigns and sufficient research needs to be implemented in local communities to ensure the success and sustainability of water quality solutions, and e) more awareness needs to be spread with regards to the presence and dangers of waterborne diseases.
Chapter Four: CONCEPTUAL FRAMEWORK and METHODOLOGY

Conceptual Framework

The research is based on the assumption that the water available to the people in the villages of Upper Egypt, which they drink from and cook with, affects their hygiene, health and quality of life. In addition, it is quite possibly a major cause of many diseases among both children and adults. If the potable water supply in the villages is not regular and/or unclean, it is both unsafe and uncomfortable to the rural families. This assumption is based on the researcher’s observation as an NGO worker operating in Upper Egypt as well as the body of literature about the low standard of services and infrastructure in Upper Egypt rural areas. Governmental negligence towards the rural areas and limited resources allocated to services in this region are highly probable causes of unclean water. Other assumptions that this research aims to validate are the correlation between good governance of water supply service provision and the quality of the service delivered as well as the satisfaction of users. In particularly, the transparency in availing information about the service and the accountability of service providers to end-users highly affect the quality of the service in rural Egypt. The following framework will be used to construct this study:
Fig. 6 – Conceptual framework of the study (source: Author)
The study tackles two important issues simultaneously. The first side is a public health one (left side of Fig. 2). Information will be obtained on this throughout the study, from both the end user and service provider side, but mainly from the service provider. Data is collected regarding the entire process of potable water provision including what is performed to clean the water and also the degree of adherence to good governance, accountability, and transparency. The second is a social side (right side of Fig. 2). This will be shown through the information obtained from the end users pertaining to their perspective on the quality of the water they drink, the water service and what, if any, home remedies are used. It will also be covered by the general knowledge people possess with regards to clean water uses and illnesses caused by drinking contaminated water.

Methodology

Primary sources were used as well as secondary sources. Primary data was collected through semi-structured, in-depth interviews with families from villages in Upper Egypt (Minya region) as well as personal observations while conducting the interviews. Interviews were also conducted with six officials who work in the water sector of the government and one individual who works for an organization that has done a water project in collaboration (and working closely with) the government. In-depth interviews were chosen because, as mentioned above, it is a method that aligns with qualitative studies. Secondary sources are in the form of online research of which the information gathered would be shared throughout the study, especially in the literature review section.
**Sample**

The sample of the families to be interviewed was chosen after talks with the researcher’s field manager and some of the field staff. The purpose of the study was shared with them, so they could suggest villages. This was how the sample site was chosen, mainly because of ease of access to these villages through HG’s work there and its field staff that already know the families on a personal basis. Interviewing families from a village where HG has not yet installed a water filter as well as families from a village where HG has no presence and does no development work was intentional. The desire was to also interview families from a village where a water filter is installed for comparison reasons. The sample of the service provider side was chosen based on relevance of the position of officials in the water supply system and through personal indirect connections, meaning acquaintances who led to further acquaintances. Below is a summarized overview of the sample chosen for the families’ side.

**Consumer Interviews**

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<th>Village 2</th>
<th>Village 3</th>
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</thead>
<tbody>
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<td>BN</td>
<td>SH</td>
<td>AS</td>
</tr>
<tr>
<td>District</td>
<td>Minya</td>
<td>Abo Korkas</td>
<td>Abo Korkas</td>
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<tr>
<td>HG presence</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>HG filter</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>No. of interviewed families</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
In order to obtain a relatively diversified sample, the researcher chose the following villages:

- Two families from one village where HG has a presence and has installed a water filter for the entire village.
- Two families from one village where HG has a presence but has not installed a water filter for the village.
- Two families from one village where HG neither has a presence nor installed a water filter.
- One male HG field staff member who is twenty-nine years old.
- One female HG field staff member who is thirty-one years old.
- One male HG village supervisor who is thirty-eight years old.

Each interview lasted between twenty to thirty minutes. All end user interviews in the three villages were conducted in the span of one day. It was important to not only interview families that HG (it works with the poorest families in the villages) works with and assists to discover any differences in the information provided, which would indicate of some bias from the families HG works with. The definition of poor that HG uses, and is used for the
purpose of this study, is the international definition of the United Nations for people living under the poverty line by having income less than $2/day (United Nations, 2009). HG also works with families, obviously, that are under the extreme poverty line, which is considered having income less than $1.25/day (United Nations, 2009). All families were interviewed in their homes to allow them to feel at ease. The field staff members were interviewed in the car on the way to the villages and between village visits. A village staff member and a village supervisor from HG accompanied the researcher during the home visits because they have existing relationships with the families.

**Villages**

Three villages were chosen to conduct interviews in and to obtain water samples from (water samples from two of those villages). Information is based on HG’s database.

- **BN village (HG presence but no water filter)**
  - District: Minya
  - Population: 6,000
  - Poverty: 20%
  - Uneducated: 20%
  - Main occupations: farming, carpentry and plumbing
  - Piped water reaches the village

- **SH village (HG presence and HG water filter)**
  - District: Abo Korkas
  - Population: 6,000
  - Number of families: 1,200-1,500
  - Poverty: 30%
  - Uneducated: 30%
  - Main occupations: agriculture
  - Piped water reaches the village
- AS village (no HG presence and no filter)
  - District: Abo Korkas
  - Population: 4,000
  - Number of families: 800
  - Poverty: 25%
  - Uneducated: 25%
  - Piped water reaches the village

Even though there might be main occupations in the villages, a significant percentage of working-age males tend to travel to larger cities for work if they receive a chance to do so.

Below are some images from the villages:
Service Provider Interviews

- One Project Manager who works for an organization that worked with the government in producing and implementing ten riverbank filtration systems in several Minya water filtration stations [ii].

- One operational technician that works at a water filtration substation in Minya Governorate (smaller water stations) [iii].

- One operational technician that works at one of the main water filtration station in Minya Governorate [iii].

- One person in upper management at the Minya Water & Wastewater Company, which is one of the branches of the Egyptian Holding Company for Water & Wastewater supervised by the Egyptian Water & Wastewater Regulatory Agency, which is all governed and under the umbrella of the Ministry of Housing, Utilities & Urban Communities [iv].

Fig. 7 – Photos from the villages
- One Station Manager at one of the small water stations in Minya Governorate.
- Lab Manager at one of the main water stations in Minya Governorate.
- Senior Chemist, colleague of the Lab Manager in the same main water filtration station.

The service provider interviews with the two technicians and the person from upper management at Minya Water & Wastewater Company were conducted over the phone while the interview with the project manager at the non-governmental organization was conducted in person in Minya. The interview with the water filtration station manager, the Lab Manager and the Senior Chemist were all also conducted in person, each at their respective water filtration stations. Each interview lasted between thirty and forty minutes except for the interview with the project manager at the non-governmental organization, which lasted one hour.

**Ethics & Procedure**

The researcher obtained approval from the Institutional Review Board of The American University in Cairo for the research topic and methodology prior to commencing the field research and interviews. Participants for each interview gave their verbal consent after being told their identities would be confidential. The researcher’s position with HG was not revealed to any interviewees and was kept confidential even when accompanied by the organization’s field staff during the home interviews with the families. The field staff were given specific instructions to refrain from revealing that the researcher worked in HG. The research paper and its purpose were briefly explained before each interview as well and it was made clear that participation, or lack thereof, was completely voluntary and would bring
no harm or benefit to the interviewee. Even though the interview questions were prepared beforehand, the researcher did not use a paper to read off question by question. The interviews, however, were informal conversations. This method was chosen because it allowed the interview process to be informal, therefore, making the interviewee comfortable and hence yielding the most information. The outline of the informed consent form from the American University in Cairo was used as a verbal consent. The interviews were all recorded (voice) and prior to recording, verbal consent will also be given by the participants. The audio recordings will be saved on a password-protected computer that is only accessible by the researcher for a period of three years. Two interviews (the water treatment plant manager and the interview with the Lab Manager and Senior Chemist) were not recorded because it was forbidden to take photos or record interviews. The concept of “do no harm” was thoroughly followed (Babbie, 2007) throughout the research process.

**Interview questions**

As a guide, the following list of questions were used to steer the interviews, both on the end user and the service provider side. The questions were not present with the researcher during the interviews to allow for an informal, non-structured interview.

**Service Provider**

**Water Supply System**

1. Please walk me through the process/steps of the drinking water provision until it reaches peoples’ homes in villages.
2. Is the water for the villages always flowing, or stored somewhere?

**Governance**

3. What authorities/ministries are responsible for each step?
4. Who is accountable to who? Who reports to who?
5. Are there any quality checks procedure/tests? (governance)
6. What evaluation and monitoring are put in place?
Standards/Quality
7. What standard guidelines/rules are followed to provide clean water?
8. Are these international standards or local? If local, who sets them and what is the reference?
9. What is the process of cleaning the water? Is it only done one time along its path until it reaches the homes, or at multiple points along the path?
10. What about pipe systems? Even if the water is clean, can it be contaminated along the way? How are they maintained?
11. For water containers, how are they cleaned/maintained? Who is responsible for maintaining them?
12. How is the maintenance ensured?

Communication with Users
13. What kind of awareness is given to people with regards to the measures in place in providing clean and safe drinking water?
14. What kind of awareness is given to people with regards to drinking water cleanliness?
15. Is there a “customer service” department? What are the means of communication/interaction with users? Where can people go to submit complaints about unclean water?
16. What process takes place once a complaint is received?

End User

Water Supply Service
1. What is the source of your water at home? What is the source of the water in the village?
2. What was your experience in getting a water connection in your home?
3. Who do you contact if there are issues with the water supply service (availability/consistency)?
4. How consistent is the water in your home? Is it ever cut off (daily, weekly, several times a month, etc.)? If so, how long does it usually last (each cut for several hours/days, etc.)?

Household Awareness
5. Do any household family members experience any illnesses?
6. Are you aware of any illnesses caused by drinking unclean water?

Water Quality
7. What have you observed with regards to the water quality? Taste, color, odor, texture?
8. How familiar are you with the process of cleaning water before it reaches the homes?
9. What do you see as the problem with the water, if any?

Methods of remedy
10. Do you use the water as-is for drinking? Cooking? Cleaning? Do you do something different with the water before each of its uses?
11. If so, what do you do with the water? What kind of method do you use at home, if any?
12. Where did you learn about this method?
13. (if no methods are used) Why are you not doing something for the water cleanliness (assuming they talk about a problem with the water)?
**Complaints**

14. Have you ever tried submitting a complaint about the water? Where did you go to submit the complaint?
15. How was the process of submitting a complaint? Easy/complicated? What was the response? Did you see any results from the complaint?

**Water sample tests**

Four water samples were taken from four homes, two in BN village and two in SH village on September 3rd, 2018. Permission was requested and granted by the families, including permission to photograph the area where the home tap is. The samples were tested within 10 minutes of extraction. pH levels were tested using a pH-2016 pen type pH meter. Conductivity, salinity and TDS were tested using an Extech ExStick II. Iron, chlorine and hardness concentrations were tested using an Aqua Lytic AL410 device and all the results were recorded on paper.

**Limitations**

Several limitations were present during the interviews and while the researcher was in the field. The first limitation was that the researcher was not fully following the grounded theory principle. The study is based on a preconceived theory rather than attempting to form a theory through the gathering of data and its analysis. This perhaps will limit the kind and quantity of information received from the participants. Another limitation is the clear difference between the families being interviewed and the researcher. From past experience in the field, it is difficult, even after persistent trials, to fully blend in. This, understandably, sometimes makes people feel reserved. The researcher’s personal position as the National Director of the nonprofit organization that works in two of the three villages in this study also poses a limitation with regards to the interviews with the field staff. The staff work in
the same organization and therefore, might feel obligated to participate in the study to avoid possible harm they could experience in rejecting their manager’s request to be interviewed, even if it was clear their participation was completely voluntary and poses no harm or benefit to them. Finally, it was difficult to obtain more in-depth information regarding the insides of the water provision system because, even if you are able to reach someone high up in the chain of government command, they are beyond reluctant to share information since the topic of water, especially at this time, is a sensitive one and pertains national security concerns.
Chapter Five: DATA and ANALYSIS

In this section, the data collected from the fieldwork will be presented with analysis. Based on the information obtained during the interviews, the data and analysis was divided into two sections, one for the service provider and a second for the end user, according to the below themes:

Service Provider

- Water supply system
- Governance
- Standards / quality
- Communication with users

End User

- Water supply service
- Household awareness
- Water quality
- Methods of remedy
- Communication / complaints

The formalities and small talk that takes place at the beginning of the interviews to break the ice will not be discussed. Diving into the sections and themes considers that the formalities are already out of the way.
First and foremost, general information was needed regarding the entire process the drinking water goes through from the source until it reaches peoples’ homes. Even though the Nile River is the main source of water in Egypt (whether the Nile itself or the riverbank), according to the Minya Water & Wastewater Company employee, another source of water is wells. Wells are dug in different areas and the depth of digging depends on the area, with a range of 2-500 meters (Salim, 2011). In Minya governorate, especially when close to the Nile, the depth required is less (2-50 meters) than farther away from the Nile (Salim, 2011). Usually the water is cleaner and needs less treatment when coming from a well due to preliminary natural filtration that occurs by sand and gravel, as long as enough depth is reached. Nevertheless, the Nile remains the main source of water. Whether from the Nile River or from the wells, the water has to pass through a water filtration station. According to the Holding Company for Water & Wastewater, there are 2,715 water stations spread geographically all over Egypt as of the year 2017 (Holding Company for Water & Wastewater, 2018). From the water stations, after the treatment process, the water is pushed out through the pipe grid to the cities and villages. The interviewees were also asked whether the water was constantly flowing out to the pipes or stored somewhere. One of the technicians from the smaller waters station stated:

“It depends on the water station and the area it serves. For my station, we serve a smaller area, so we have storage chambers because sometimes the demand on the water is not very high, so the water is stored until it is needed. At other times or in other bigger...
stations that serve larger areas, there is no need for storage because the demand is very high.”

The storage need depends on the consumption needs of the people the station serves. Usually, water can be stored when the water treatment plant is a small one or serves a small area. He further explained that within the same water station, there are several valve-operated chambers. From each chamber, the water is pushed through the pipe grid to go to the different areas the station serves. This makes it easier to deal with a problem, should one arise, since they can isolate the problematic water path through its valve chamber instead of having to cut-off the entire water supply of the station. The author witnessed a water tank, which had a capacity to hold 100 cubic meters of water, overflow due to low consumption need during the interview. The technician has to shut off the pumping for, on average, two hours then start again until consumption increased. This observation took place in a small water treatment plant where the plant manager was interviewed. This particular water treatment plant only operates around one well with a depth of 67 meters. It serves 4 villages and smaller surroundings, with an average of 16,000 people. However, the treatment station was built to supplement water coming into the villages through a larger water treatment plant in the district of Samalout. According to the plant manager, the water travels 20km to come from the main water station, at which point its pressure is significantly weak, so this water station complements it. The water meets the incoming water and gets pushed out to the grid together, even though they are treated differently (discussed in coming sections).
Governance

One of the most important issues regarding any governmental public service is whether it is managed with good governance or not. The interviewees were asked about the authorities responsible for each step of the water service provision and where the accountability lies. Also, it was crucial to know what evaluation and monitoring measures are put in place. Referring to Fig. 5, in addition to the three authorities from the diagram, according to the project manager interviewee and also the Minya Water & Wastewater Company employee, the Ministry of Health & Population is another entity that has authority over the operation of the water stations.

Project manager: “Based on water samples the Ministry of Health & Population takes from the water stations regularly and tests, if the water is not up to code, the Ministry has the authority to shut down the water station due to the fact that the water is not suitable or safe for drinking.”

Both the water treatment plant manager and Lab Manager at the large water station also confirmed that the Ministry of Health & Population conducts unexpected visitation and takes samples of water to test, as well as see reports already conducted by the local lab, if available. Even though HCWW does not directly report to the Ministry of Health & Population, the Ministry is the one that has the final say as to whether the water is safe or not, and if not, it has the authority to close down water projects or water stations.

The field staff mentioned that specifically in the area of Upper Egypt (close to Minya city), one new water station was built and has been operational for several years. In addition, another large water station is currently being constructed, which will eventually feed a large area of villages to the west of Minya city. This seems to shows initiative by the government.
to build better water filtration systems. There is supposedly active cooperation taking place between different ministries, authorities and agencies in an attempt to abide by the SDG’s despite overlap present in functions of entities. On the Holding Company for Water & Wastewater website, one of the goals is to put in more care towards people’s health when it comes to potable water, according to Egypt’s 2030 vision plan (Holding Company for Water & Wastewater, 2018).

According to the interviews with all the officials working at water stations, samples are taken regularly to be tested, not just inhouse if there is a lab, but also by the Ministry of Health & Population. These samples are taken at random by the Ministry and they do not announce when they are going to a water station to collect samples. After testing, reports are sent back and the Ministry has the power to shut down a water station if it deems the water unsafe. Reports from inhouse testing have to also be sent to the Ministry for review. The Senior Chemist mentioned that a long time ago, there was active cooperation between several entities of water service provision. He said that their station, along with someone from the Ministry of Health & Population in addition to some people from different regulatory agencies would come together and test water samples at the same time, each with his own equipment. The results would be shared, and it would be encouraging when the results are similar. Now, each entity works on its own with no cooperation. On the contrary, there is some tension between the different entities because of the distribution of power [10].

What was observed during the field visit of the two water stations was the lack of transparency. Even though they shared information freely, the author was not allowed to record the interviews or take samples of the water. If the stations are adhering to good
governance and following protocol, and believe the water they are producing is clean, then it is surprising that they would not be willing to allow water samples to be taken.

**Standards / Quality**

This theme deals with the questions related to the quality of the water, whether it is at the water station or through the pipes, in addition to maintenance and monitoring of the ongoing cycle and infrastructure. The interviewees were asked about the more detailed process of cleaning the water, what standards are used, and how the standards are ensured. As mentioned earlier, the two types of water are surface water (mainly from the Nile River) and groundwater, which is pumped up through wells. In either case, the water passes through a water station before it is pushed into the pipe grid. A summary of the treatment of the water is given by one of the technicians that works at a water station.

Technician: “Water is pumped from the Nile or from groundwater into chambers. If it is from the groundwater, it is more filtered than from the Nile. After several steps of passing through different chambers, the main elements added to the water to clean it are chlorine and alum. Then the water is pushed through the grid.”

Next, we examine the standards/guidelines used to ensure the safety of the water. According to all interviewees, samples of water are taken at a regular basis and tested to make sure it is up to code. The station manager at the plant explained in more detail:

“Each main water station has its own laboratory and doctors in chemistry who take regular samples and test it in-house. Some samples are taken daily, some are weekly. It depends on which stage of the water filtration process the sample is taken from, but it is ongoing.”
The MWWC employee further elaborated:

"The Ministry of Health & Population take frequent samples from some stations (frequency changes from station to station) to make sure the water is safe for drinking. This is in addition to the samples taken regularly in house (some on an hourly basis even) and tested in the water station laboratory." 

There are four kinds of laboratories, according to the HCWW website that are under the supervision of the HCWW itself.

1. The main laboratory, which is the reference one for all the others.
2. Central laboratories located at the twenty-five subsidiary companies, reporting back to the main laboratory.
3. Water station laboratories, reporting back to the central laboratory of its governorate. This does not apply to all water stations.
4. Mobile laboratories, which are cars equipped with the necessary tools to take samples and test them on-the-go.

(Holding Company for Water & Wastewater, 2018)

In addition to the HCWW affiliated laboratories, the Ministry of Health & Population has its own laboratories where it tests samples taken from all water stations frequently. Unfortunately, the specificity of the tests and what determines whether the water is suitable or not can only be given by a chemist at the laboratories, who were unattainable for interviewing. The MWWC employee even shared that anyone would be reluctant to share this kind information because they are internal standards and concern public health and water, the latter of which is a national security issue. In that regard, even though accountability seemed to be high, transparency was not. It was also not known whether these
standards were international or local. The only interviewee who said something regarding this topic was the MWWC employee who said they were all Egyptian standards. He even seemed to take offense at the suggestion that Egypt is following international standards, as if we do not need to follow anyone’s standards because our standards are good.

Drinking water only passes through one water station before it goes into the pipe grid to the homes. It is never treated twice. Depending on where the town or village is, the water can be traveling a long way in the pipes before it reaches the homes. What happens to the water along the way? Can it be re-contaminated? According to the project manager:

“I am not sure how long ago, but we used to run on copper pipes. After a while, it became a problem because the copper reacted with contaminated water and caused corrosion, further contaminating the water. Most of the pipe systems were swapped with specific plastic pipes that would not react with the water the same way.”

Obviously, nothing can be done in the pipes to ensure they remain uncorroded. Nevertheless, it is not just the pipes, but the storage containers present at some water stations. As mentioned earlier, sometimes the demand is not high enough and there is surplus of treated water, which in turn is stored until the demand rises again. When asked about the maintenance and guarantee of cleanliness of the water containers, one of the technicians said:

“Every fifteen days, the containers have to be emptied for cleaning. It is done manually. We get inside the container and clean it ourselves with tools of course. After each of the three steps of cleaning, the container has to be filled with water then emptied again to provide a ‘rinse.’ Once all is done, we run water to it and discard of it twice before it is used again to store the treated water.”
The other technician did not mention this process, so it cannot be confirmed that this is a practice run in every water station. However, the water treatment station manager stated that the water container tower is cleaned out thoroughly every two months on average. This is manual job, which, according to him, they use Pril (dish soap) for. The container is emptied out, they lather Pril on all sides and borders, they use large brushes to scrub the walls, ceiling and flat surface, they rinse the container twice while discarding the water, then they fill it up, add chlorine, and push it out to the grid. The Senior Chemist interviewed also explained a process called backwash, which is done on a weekly basis. Water is reversed into the sand/gravel chamber in order to 'back wash' all substances in the water from the week’s treatment cycle. After the backwash is done, the chamber is rinsed twice then it would be ready for use. In addition, the large chambers are thoroughly emptied and cleaned every 6 months with large brushes and disinfectants. Any discarded water goes to what they call a ‘lagoon.’ Water is left to settle for about 6 hours, at which point the top portion of the water is extracted to be reused or pushed out to the grid while the bottom portion (with all the residue) is discarded completely.

The station manager works in a small water station as mentioned earlier. It serves around 16,000 people. It does not have a lab on-site. When the author visited the station, he was told that this station, which works with water from a well 67 meters deep, only adds chlorine once to the water. This is the whole treatment process. Below are photos taken of the treatment room and process.
In the interview with the Senior Chemist, the author was told that this station serves most of the south region of Minya city. It is a large station and treats Nile water rather than water from wells. There was an inhouse laboratory and tests were being conducted frequently. One of the ways they ensured water quality remains well is a Flocculation device in the lab. The Senior Chemist explained that this was like a miniature water station. Once a week (unless there is a natural phenomenon like a flash flood that affects the Nile water significantly), samples are taken and run through the device, simulating each step of the treatment process. There are 5 beakers in this device and in each beaker, different levels of alum (and in another step, chlorine) are added. After the entire simulation is run, the water is tested and the one with the closest levels to Egyptian standards determines the amount of alum and chlorine that will be added for the entire week.

Four samples of water were taken from four homes, two in BN village and two in SH village. The samples were tested for pH levels, EC, Sal, TDS, iron, chlorine and hardness.
With each sample taken, the author photographed the area where the house tap is. Lack of hygiene is prevalent in the photos.

Fig. 9 – BN home #1 water sample

Fig. 10 – BN home #2 water sample
The results of the tests were as follows:

<table>
<thead>
<tr>
<th>Parameter / Standard (range)</th>
<th>BN #1</th>
<th>BN #2</th>
<th>SH #1</th>
<th>SH #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>28.8</td>
<td>28.4</td>
<td>28.2</td>
<td>28.3</td>
</tr>
<tr>
<td>PH (6.5-8.5)</td>
<td>8.3</td>
<td>7.9</td>
<td>7.8</td>
<td>7.8</td>
</tr>
<tr>
<td>PP m S</td>
<td>165</td>
<td>163</td>
<td>165</td>
<td>166</td>
</tr>
<tr>
<td>µ S</td>
<td>353</td>
<td>343</td>
<td>345</td>
<td>345</td>
</tr>
<tr>
<td>PP m (under 500)</td>
<td>245</td>
<td>241</td>
<td>240</td>
<td>240</td>
</tr>
<tr>
<td>Iron (0.3)</td>
<td>0.12</td>
<td>underrange</td>
<td>underrange</td>
<td>0.13</td>
</tr>
<tr>
<td>Hardness, total HR (100)</td>
<td>overrange</td>
<td>overrange</td>
<td>overrange</td>
<td>overrange</td>
</tr>
<tr>
<td>Chlorine, differentiated determination (0.2)</td>
<td>3.09 free 0.48 comb. 3.75 total</td>
<td>2.73 free 0.31 comb. 3.04 total</td>
<td>0.09 free 0.14 comb. 0.22 total</td>
<td>0.08 free 0.10 comb. 0.18 total</td>
</tr>
</tbody>
</table>

Comparing the results to WHO guidelines and US standards, the cells in red mark the elements that are not matching. Even though Iron in BN #1 and SH #1 are under range, the standard of 0.3 illustrates the maximum level, therefore, being under range is not of health concern. Chlorine is the main indicator of quality in this assessment. According to WHO guidelines, “for effective disinfection, there should be a residual concentration of free chlorine of ≥ 0.5 mg/l after at least 30 min contact time at pH < 8.0. A chlorine residual should be maintained throughout the distribution system. At the point of delivery, the minimum
residual concentration of free chlorine should be 0.2 mg/l” (World Health Organization, 2017). At 0.2 mg/l at point of delivery, BN village is at 2.73 and 3.09 mg/l. Although that is high compared to WHO standards, it is within range of Egyptian standards, which is up to 5 mg/l (Ministry of Health & Population, 1995). SH reading of 0.18 and 0.22 are below and at minimum standards, respectively. What is more important to note in these results are not whether they fall within range of either WHO or Egyptian standards, but rather how different the chlorine levels are compared to each other. Both BN and SH villages are in the same governorate and, even though they are not served by the same water treatment plant, they are both governed by the same water company, Minya Water & Wastewater Company. Yet, the average chlorine level of BH is 3.4 while in SH it is 0.2. This shows that standards are not unified even across water treatment plants within the same governorate.

Communication with end users

The final theme deals with the public communication and awareness building by the government for its citizens with regards to drinking water. It is not difficult to recall the television commercials that used to run more than twenty years ago, warning people of bilharzia present in the canals and informing people to stop their children from swimming in the canals or washing their clothes in them. This was used to raise public awareness to the dangers of unclean water and the illnesses that can come of it. The current trend is not the same as now the target of the awareness is more about using water responsibly, especially since the population is growing while Egypt’s share in the Nile is not. According to the MWWC employee, there are newspaper advertisements and television commercials urging people to not use excessive amounts of water and to save it as much as possible.
It was expected to hear about any awareness campaigns that teach the public how to deal with unclean water inside their homes, if encountered. For example, home remedies that can assist families in making sure the water is safe prior to consumption. However, it was apparent that this would mean admission by the government that the drinking water’s quality is not suitable and that the efforts to clean the water are unsatisfactory.

From the research conducted, several websites of the different ministries and agencies involved in the water process have a ‘Contact Us’ page. This is a step forward in the development of customer satisfaction showing the government creating new ways to make citizens heard. Obviously, this is not inclusive of rural inhabitants, most of whom do not have computers or internet connections. However, the more traditional way still exists. For example, the Holding Company for Water & Wastewater has a hotline for any water-related issues or complaints. There is no information available as to how responsive customer service is to citizens who call or send email requests, though. None of the interviewees have tried to call or submit any requests to obtain this kind of information. Furthermore, this is a page on HCWW's website that allows users to calculate their own bill by inputting their meter readings and answering a few basic questions about their service (Holding Company for Water & Wastewater, 2018). This could allow people to not only track their usage, but adjust their consumption behavior accordingly, if need be.

From a media perspective (and public awareness), one of the messages being pushed out is about keeping the Nile River clean. There are three cartoon videos targeting children with a goal on educating them on the Nile River facts along with best practices to keep the Nile clean. Those videos were created by the Ministry of Water Resources and Irrigation and they are on the Ministry’s website as well as YouTube (Ministry of Water Resources &
Irrigation, 2017). They provide awareness on the many factors that contribute to the contamination of the Nile River such as trash, pollution, chemical and industrial waste and sewage. It is not just about drinking water, but contaminated water used for irrigation causes many health problems as the food being grown is being brown using unclean water. The videos teach children to do their part by not throwing any trash in the Nile and spreading the message as well. Furthermore, for media, one of HCWW’s webpages is called ‘Kids Zone’ where there are different videos addressing various topics related to water issues and awareness in addition to another webpage called ‘For You My Lady’ targeting families and housewives on best practice water usage. Finally, there is a webpage where HCWW posts announcements, the most common of which indicate water-cut warnings. These announcements are printed in the newspapers and posted on this webpage (Holding Company for Water & Wastewater, 2018).

End User

Water Supply Service

The first step was to obtain general information about the water in the families’ homes. They were asked what the source of water in their homes was and if they knew what the source of water for the village was. All homes had taps inside their homes and for the three villages, the source of water was through the pipe system, which meant the water was drawn from the Nile rather than wells. In relation to this, the respondents were asked about their experience when making the water connection to their homes (after they confirmed they were the first ones to live in the home). Five out of the six family interviews stated there
were government pipes in their village outside their homes. All they had to do, as is the normal procedure, was apply for a water meter from the Minya Water & Wastewater Company (MWWC). On average, it took from one to two months for the representative to visit the homes and install the water meter for the service to start. The husband in one of the homes in SH village stated:

“There were no pipe connections in our street. The pipes reached our village, but they were not extended to our street. We (neighbors in the street) had to dig and extend the pipes to our homes using our own money.”

For this specific village, which was observed through conversations with HG’s field staff as well, sometimes the government does not extend the pipes to all the streets, especially when homes are not close to the main streets and side streets. They suffice by having the main water pipes connect to the village’s main roads but do not invest in extending to all the homes. People, therefore, are forced to raise the money themselves to extend the pipes, after which they are able to go through the regular procedure of applying for a water meter. They claimed, and rightfully so, that it was a basic right as a legal home owner in the village, to not have to use their own money to build something that allows a public service the government is obligated to provide itself for its citizens.

Concerning the water supply service, it was also important to find out the consistency and reliability of the water flow in the homes. It was not so much about the availability of access to water (this is not a major problem in Egypt like many African countries), but the consistency and reliability of the service. The families were asked whether the flow of water in the homes was consistent or not. Four out of the six homes in addition to two of the three field staff stated that the water service faced cut-offs regularly.
Mother in home in BN: “The water cuts off at least twice a month.”

Male field staff: “A long time ago we experienced many water cut-offs. Now after the new water station was built, it is less, about once a month at least.”

The most common reason the families and field staff portrayed as to why the water cuts off is due to some kind of maintenance. They said usually it is due to pipe replacements or malfunctions. No one stated that the cut offs lasted more than four to five hours. As a follow-up, they were asked whether they felt the need to call a hotline or submit a complaint of sorts to have the water flow again, but no one felt this need. They said they have gotten used to it by now, and it always comes back in a few hours.

Household Awareness

The set of questions related to household awareness had the goal of obtaining general information about the family's awareness regarding health problems related to drinking potentially unclean water. The interviewees were asked whether any family members experienced any illnesses, what the cause of these illnesses was (if they know), and finally if they are aware of illnesses caused by drinking unclean water. The husband in one of the homes in BN village stated that his wife suffered from kidney problems and she was being heavily treated, stating that his assumption was that it was due to the water. When asked whether a medical professional diagnosed this to be as a result of drinking unclean water, though, the husband said no. Therefore, this could only be taken as speculation, although, even though not exclusively, kidney problems can be caused by contaminated water. In one of the homes in BN was a mother with two children and a newborn baby who was being
bottle-fed. She stated that when the baby, who is now thirteen months old, was first born and was being bottle-fed, he had lots of digestive problems.

BN Mother: “We took him to the doctor because we were worried. The doctor diagnosed the problem as snail disease. I have not heard of this snail disease before. He said it was from the water used in the feeding bottles. He told me I needed to get a filter.”

Snail disease, according to the World Health Organization, is another name for schistosomiasis, which is more commonly known in Egypt as a form of bilharzia (World Health Organization, 2018).

This family had to buy a filter (it was a three-stage filter) to ensure the water would be clean enough to feed the baby. Since the filter has been installed, the baby has had no health issues. The problem with this situation is the cost of maintenance for the filter. The mother stated that ideally, the wax in the filter should be replaced every month, but they can only afford to do it every three months. Therefore, by the time it gets changed out it has already turned completely dark brown for almost a month. Only two of the six families knew about diseases that can be caused by drinking unclean water. It did not seem to be common knowledge. The village supervisor shared that even with a filter at home or in the village, people still go to the canals to wash their dishes in order not to drive up their utilities bill, especially if the canal is close to the home. Therefore, even if they are drinking clean water from a filter, they are at risk of getting ill due to using dishes or food utensils that have been washed in untreated canal water.

Water Quality

For the purpose of the end user, the goal was to obtain information, through the observation of the families, about the aesthetic qualities of the drinking water in their homes.
(color, taste, odor and texture) and to elaborate on what they see in these qualities. In addition, it was important to know what the families know or are aware of (if anything) with regards to the process of clean water provision before it reaches their homes. The reason why this is important is because it should be shown whether what the government claims to act upon in providing clean and safe water is known amongst the rural inhabitants or not.

The families were firstly asked generally what they have observed about their water.

Female field staff: “Sometimes the water has a strange layer on top when you leave it to sit for a while. The closest thing I can describe it to is ‘oily.’”  

Mother in BN: “You can open the tap sometimes and the water would come out white, like milk. If you leave it sitting for a while, the white substance settles at the bottom.”  

Father in SH: “Especially after a water cut-off, or even without the cut-off, there are many particles that sometimes flow in the water. It comes out of the tap brown-ish like it is muddy.”  

Mother in AS: “It tastes very bad. You can always tell the bad taste when you make tea. Sometimes, you can feel particles in your mouth, too.”  

Male field staff: “At rare times, if you leave the water sitting long enough, small white particles form that, if big enough, can be picked up because they harden.”  

All the above quotes explain the perception of the people regarding the physical qualities of the water they are receiving at home. People in all six homes and all the field staff have observed something wrong with the water. However, they always said “sometimes.” Families see a combination of things in the water. It is not consistently bad or consistently good. Within the same home, sometimes it is “milky” and sometimes it is brown-ish and sometimes
nothing is visible. Noticing the difference in taste, however, was commonly shared as more obvious when drinking tea.

Five out of the six families in addition to the three field staff stated they knew generally about the water process prior to reaching the village and homes. The same people mentioned water stations nearby their villages. They see the water stations on their way out or in to the village and know water passes through them before reaching the villages. Other than adding chlorine, however, they are not aware of the procedures that take place inside the water stations. A family member in one of the homes in AS mentioned that new piping was done about eight years ago. He said they changed out the copper pipes and replaced them with plastic ones since the copper used to react with the water and corrode. In addition, the village supervisor mentioned that when they were digging to install gas pipes nearby BN village, they dug too deep and broke off some of the water pipes, resulting in sewage being mixed with the water. For several days after that, the water was a brown-ish color and smelled like sewage.

**Methods of Remedy**

This theme tackles the idea of “do it yourself.” First, the families are asked if they use the water in their homes as-is for drinking, cooking, etc. If not, what do they do and how did they learn about this method. If the water is used as-is, what is the reason behind that? Two of the six families had filters in their homes. Nevertheless, the questions still applied because the filters were installed less than three years ago. They still had recollection of what they did before they bought the filters. The mother in one of the homes in SH stated:

Mother in SH: “*We have a ola (large clay urne that keeps water cool) that we fill up, but we never drink the water from the tap right away. We leave it in the ola until the*
evening, then we drink and leave the last little bit at the bottom. That way, all the residue settles at the bottom and we can throw it out.”

Another person in BN stated:

Wife in BN: “We boil the water before drinking tea, but for regular drinking, we just leave it in a container for several hours and everything settles at the bottom.”

It seems the most common two home remedies are either boiling their water, which they say, after a while, leaves some kind of layer in the kettle, or, they leave the water for several hours and drink everything except the bottom section of the container. The people in all of the homes, however, fill up water containers instead of drinking directly. They all stated it was in case the water cut-off. For the village that has the filter installed by HG for the entire village, they fill several containers because they do not want to be walking back and forth from the filter to their homes. Both families in the homes in the village where a filter is installed by HG (SH village) said they could see and taste the difference between the water before the filter and the water after. Again, it all came back to the tea and how it tasted using the water before and after the filter was installed. There was only family, in BN village, that said they drink the water in its regular condition even though they see it is problematic. When asked the reason why they did not attempt any remedy, they said because the water is the way it is and they have been drinking it for many years with, to the best of their knowledge, no negative effects. The same family did not feel it was problematic enough to attempt any remedy.

Another home remedy is installing a water filter in the home. However, the water filter option is dependent on the financial situation of the family as it need consistent maintenance.
Communication / Complaints

The final theme is post-service communication. The families were asked about the existence and quality of customer service, if available. The question asked was in the form of the possibility of submitting a complaint if there was a problem with the water, whether it was cut-off or if maintenance needed to be done to burst pipes, for example. Not one family has ever tried submitting a complaint. Two of the families (one in BN and one in SH) laughed when they were asked the question. This was to indicate that it was out of the question to submit a complaint, or even if it was done, what would be the use. Several families mentioned that if the water was cut-off in the village, people just waited, and it usually came back. They did not feel the need to inform someone or ask when the service would resume. If there was a bigger problem, like malfunctioning or burst pipes, someone usually came to fix it, but no one felt the need to inform any authority. One of the field staff stated that people felt it was a waste of time to submit a complaint. They would not get a response anyways.

Female field staff: “Who would we go to for submitting a complaint? The water company? Who would pay money to make the trip to the water company? People barely have enough to feed their families. The maximum they could do is maybe tell the chief of the village.”

The reason to inform the chief is because he would have the contacts of the proper people to inform of any specific problem. It was obvious from this theme that there is no system for communication between the people and the government. The family in one of the homes in AS, however, stated:

Mother in AS: “The only time we talk to the ‘government’ is when we feel there is a mistake in the water bill. Sometimes the amount is very high, so we either tell the water company representative or we go to the closest office. If it is indeed a mistake, they
usually either lower the amount to pay until the difference is compensated, or they stop billing us for a few months. They always cooperated in that sense.”

When asked whether the government refused to listen or lower the bill or admit a mistake on the bill, the family said it never happened.
Chapter Six: CONCLUSION & RECOMMENDATIONS

Water quality remains a critical issue in Egypt. The government, in theory is trying to implement one set of standards for water provision. However, this does not reflect with what is taking place on the ground. Not all water stations are run the same. Treatment of water is implemented differently in different water stations. The families still see and taste unclean water and are forced to resort to home remedies (the ones that have enough awareness to do so in the first place), some of which are free, and others cost money that many families do not have.

In comparing the perception in people’s homes and what the government is claiming to do in providing clean drinking water, a gap is obvious. Given the limited scope of this study, further research needs to be conducted with regards to people’s perception and satisfaction of the physical qualities of the water they are receiving in their homes. It is not enough for the government to try and implement different strategies and interventions without the involvement of the local community. Further research needs to also be done on the standard, quality and maintenance of the piping system. Otherwise, all measures put in place to thoroughly ensure water is cleaned at the water filtration stations will continue to be in vein, assuming they are implemented properly. If there are any problems with a main pipe coming out of the water station, for example, in addition to water losses through leakage, it is very likely for contaminants to be introduced in the pipes as well as mixing with sewage. Depending on how early the problem lies in the pipe, it can contaminate water going to large areas of the city or governorate. Water samples need to be taken and scientifically tested not just from the water stations (which is being done in some stations), but also from
strategic points along the way in the piping system and, finally, from the tap of the end user’s home. This will show where the issue lies in the whole process.

Another recommendation (could be considered as complementary to the previous one) would be performing a cost-benefit analysis, which would compare the household investment in home filters with collectively replacing the pipes in the street. The government would compare the cost of providing water filters in peoples’ homes, either subsidized or with the option of installments, with the cost of properly repairing all piping problems. This would, however, require more work in creating an efficient and cost-effective plan for filter maintenance as the wax filters need to be replaced frequently and consistently to ensure the water remains safe for drinking.

Unclean water is a critical issue that needs the utmost attention from the government by tackling the water filtration from a core level. People are coming up with solutions on their own, but they are not enough for the ones that cannot afford to invest in a healthier solution. The interviews have shown us that better solutions are available, but poor people living in villages cannot afford them. In fact, the simple filtration and boiling solutions are given as short-term solutions in the study by Geriesh et al. (2008). It mentions filtration through tap filters, which not many people have in the villages. However, the boiling is a more practical solution. Water should be boiled for several minutes then left to cool off and aerated (Geriesh, Balke, & El-Rayes, 2008). These solutions, while solving some issues of some contaminants, do not completely clean the water. This is why efficient and immediate government action is needed.

The question proposed here is not whether the government is acting or not, but whether what is being done is effective enough that it reaches the end user. There is not
enough transparency when it comes to attempting to test or take photos of water treatment stations. There is also overlap between governmental entities. In the interview with the MWWC employee, it was mentioned that the government is receiving large amounts of funding to build wastewater treatment plants, including ones planned for Upper Egypt. Using more of these plants will help ensure different ways for water treatment and will, more importantly, tap into additional water resources other than the Nile River, hence, lightening the load on it.

According to the interview with the project manager of the NGO, his organization worked on a project with the government to build ten RBF’s (river bank filtration). This process of extracting water from along the river bank, which has already gone through natural filtration by seeping through soil needs much less treatment (sometimes no treatment is even necessary). According to him, it can cost ten times less to build a RBF unit than a water station. In addition, it can be built and become operational in three times less time. The RBF units do not take much space and can be built adjacent to, or inside, an existing water station. The government should invest more in this kind of water treatment. There is an entire study named “Riverbank Filtration for Water Security in Desert Countries” that is dedicated to explaining the concept thoroughly. It should be taken as reference when trying to implement this project. One of its authors is from Minya University (Shamrukh & Abdel-Wahab, 2011).

Strict policies need to be put in place in coordination with international agencies that are concerned with the environment that state how, when and where the water should be filtered. Water cannot go to the villages as it is right now. The public health is at risk and already there are many instances of diseases because of the water. People have a part to play
in gaining more knowledge and awareness, especially since they can use simple solutions in their homes to minimize some risk, but there is great need for financial assistance. The World Health Organization’s publication called “Guidelines for Drinking-water Quality” should be considered a manual detailing every specific detail of a potable water system. It has chapters that cover topics like water safety plans, health-based targets, surveillance, verification of drinking water quality, identifying priority concerns, drinking-water regulations, microbial aspects, chemical aspects, local authorities, quality control, water resource management and much more (World Health Organization, 2017).

There are many stakeholders present in this issue and each has a role to play in tackling this challenge.

<table>
<thead>
<tr>
<th><strong>Stakeholder</strong></th>
<th><strong>Role</strong></th>
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<tbody>
<tr>
<td>Government policy makers</td>
<td>Create policies in line with international organizations like the World Health Organization to adhere to international standards.</td>
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<tr>
<td><em>Ministry of Housing, Utilities &amp; Urban</em></td>
<td></td>
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<tr>
<td>Government service provider</td>
<td>Adhere to international standards in what is accepted as ‘safe’ drinking water. Invest in new water treatment technology.</td>
</tr>
<tr>
<td><em>Holding Company for Water &amp; Wastewater</em></td>
<td></td>
</tr>
<tr>
<td>Government regulatory agencies</td>
<td>Investigate why the quality of the water remains unsatisfactory even after all efforts done at water filtration stations. Investigate piping system.</td>
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<tr>
<th>NGO’s</th>
<th>Providing financial assistance and household awareness to implement home remedies or purchase filters.</th>
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<tbody>
<tr>
<td>Local Administration</td>
<td>Assist households with complaints and water connections to make the process easier and quicker.</td>
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<tr>
<td>Households</td>
<td>Invest, as much as possible, in home remedies and in raising awareness. Avoid littering the Nile River.</td>
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Whether each role is large or small, it is ultimately the government’s responsibility to provide the basic infrastructure to care for the health of its people.

This was a limited study and further research need to be conducted on a wider scope all over Egypt regarding perception of water quality. The study only shows a small portion in a specific area.
References

Interviews

a. Interview, village #1 family #1 residents, BN - Minya, 6 August 2018

b. Interview, village #1 family #2 residents, BN - Minya, 6 August 2018

c. Interview, village #2 family #1 residents, SH - Abo Korkas, Minya, 6 August 2018

d. Interview, village #2 family #2 residents, SH - Abo Korkas, Minya, 6 August 2018

e. Interview, village #3 family #1 residents, AS - Abo Korkas, Minya, 6 August 2018

f. Interview, village #3 male family #2 resident, AS - Abo Korkas, Minya, 6 August 2018

g. Interview, HG male field staff 1, Minya, 6 August 2018

h. Interview, HG female field staff 2, Minya, 6 August 2018

i. Interview, HG male village supervisor, Minya, 6 August 2018

j. Interview, Project Manager at nonprofit, Minya, 6 August 2018

k. Interview (phone), Operational Technician #1 – water station, Minya, 7 August 2018

l. Interview (phone), Operational Technician #2 – main water station, Minya, 8 August 2018

m. Interview (phone), upper management, Minya Water & Wastewater Company, Minya, 10 August 2018

n. Interview, Station Manager – water station, Minya, 3 September 2018

o. Interview, Lab Manager – main water station, Minya, 3 September 2018

p. Interview, Senior Chemist – main water station, Minya, 3 September 2018
Works Cited


