Water Source Preferences and Water Quality Perceptions among Women in the Eastern Region, Ghana

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Abstract

Previous research in the Eastern Region of Ghana has shown that residents who have access to improved water sources, such as boreholes and covered wells, will still choose to collect water from unimproved sources, such as rivers and uncovered wells. To assess why this occurs, two field study visits were conducted to coincide with Ghana's rainy and dry seasons. In the first study, semi-structured in-depth interviews were conducted among a convenience sample of 26 adult female subjects in four rural communities. Each subject was asked about their attitudes and perceptions of water sources in their community. The second field study involved field observations of four women for up to four days in length to provide context for water collection and use of water from different sources in homes. A grounded theory approach was used to identify three themes that informed water source choices. The themes were water quality perception, collection of and access to water, and the dynamic interaction of these. Based on the field observations, a larger role for women in water management and supply decision-making would better advance the population health of their communities.

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Chapter 1: Background and Significance

1. The Problem

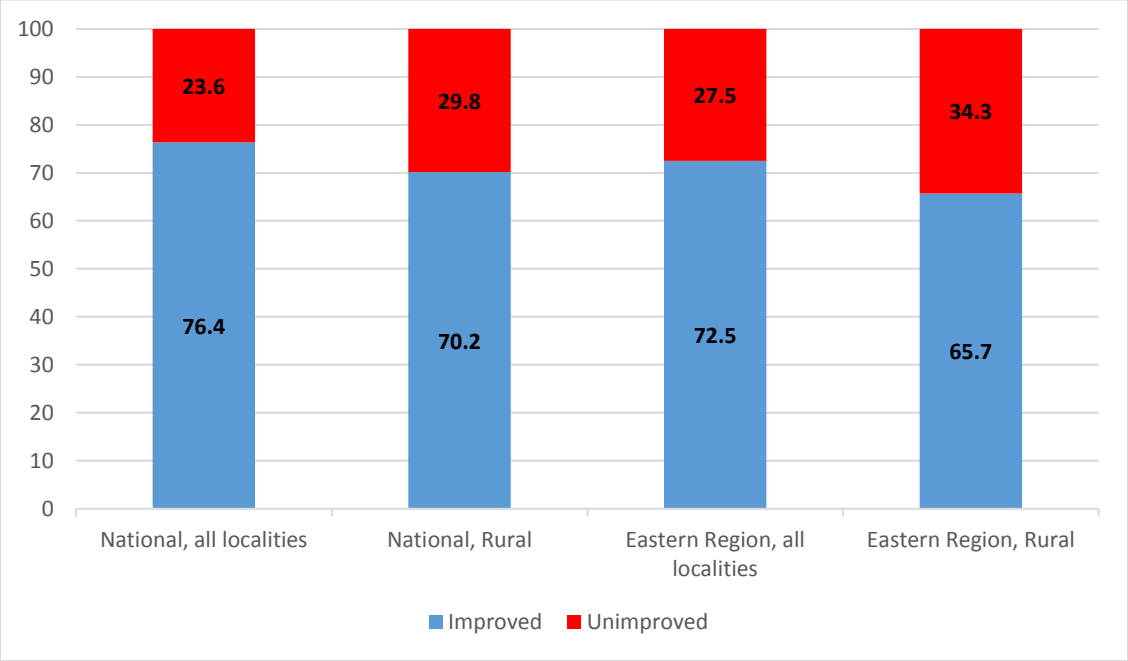
Diarrheal diseases remain one of the leading global causes of child mortality, accounting for 11% of deaths of children under the age of five (Liu et al., 2012). Lack of access to safe drinking water, inadequate sanitation, and poor hygiene leads to diarrheal diseases. Worldwide, 663 million people lack access to an improved water source and eight out of 10 people who lack access to an improved water source live in rural areas (WHO/UNICEF, 2015). The Joint Monitoring Programme defines an improved water source as being achieved through construction and proper use and is protected from outside contamination. Improved water sources include piped water, public tap or standpipe, tubewell or borehole, protected dug well, protected spring, and rainwater. Unimproved water sources include unprotected spring, unprotected dug well, cart with small tank/drum, tanker-truck, surface water, or bottled water (Joint Monitoring Programme, n.d.). Estimates on how much improved water source use decreases the contraction of diarrheal diseases vary since improved does not define water as microbiologically safe, but rather, by the source itself. One systematic review and meta-analysis found that increased access to improved water sources reduced the risk of contracting diarrheal diseases by 5-38% (Fewtrell et al., 2005). Another found that water supply interventions were ineffective and that water quality interventions at point-of-use or at the source were much more effective (Waddington et al., 2009). Thus, it is imperative to pair improved water source access with other interventions.

Like many other countries globally, Ghana suffers from inadequate access to improved water sources, especially in rural areas. In order to ensure access to improved water sources in rural

regions of Ghana, the Community Water and Sanitation Agency (CWSA) was established in 1998. Prior to the establishment of this agency, only 28% of the rural population in Ghana had access to improved water sources—this number is now at 70% (CWSA, n.d.; GSS, 2013b). The CWSA aims to transfer ownership and management of water and sanitation services to rural communities and small towns in order to improve water supply sustainability. They do this by involving communities in designing, planning, and operating the water supply system. The dominant water supply source is groundwater, which accounts for 95% of the available water supply (Awuah et al, 2010). Functionality of these sources have been found to be quite high; one cross-sectional study conducted in two districts of Ghana found that 90.8% of boreholes were functional (Auckhinleck, 2013). Another study conducted in 2004 found that 90% of boreholes in Ghana were operational (Whittington et al. 2009).

In the Eastern Region, where research in this thesis is conducted, approximately 66% of the population that lives in rural communities has access to an improved water source, four percentage points lower than the national average in rural settings (Figure 1; GSS, 2013a). Both the national and Eastern Region access to improved sources in rural settings was lower than the access to improved sources in all localities.

Figure 1: Proportion of Population Using and Improved and Unimproved Water Source, Ghana: 2010



Source: Ghana Statistical Service, 2013b

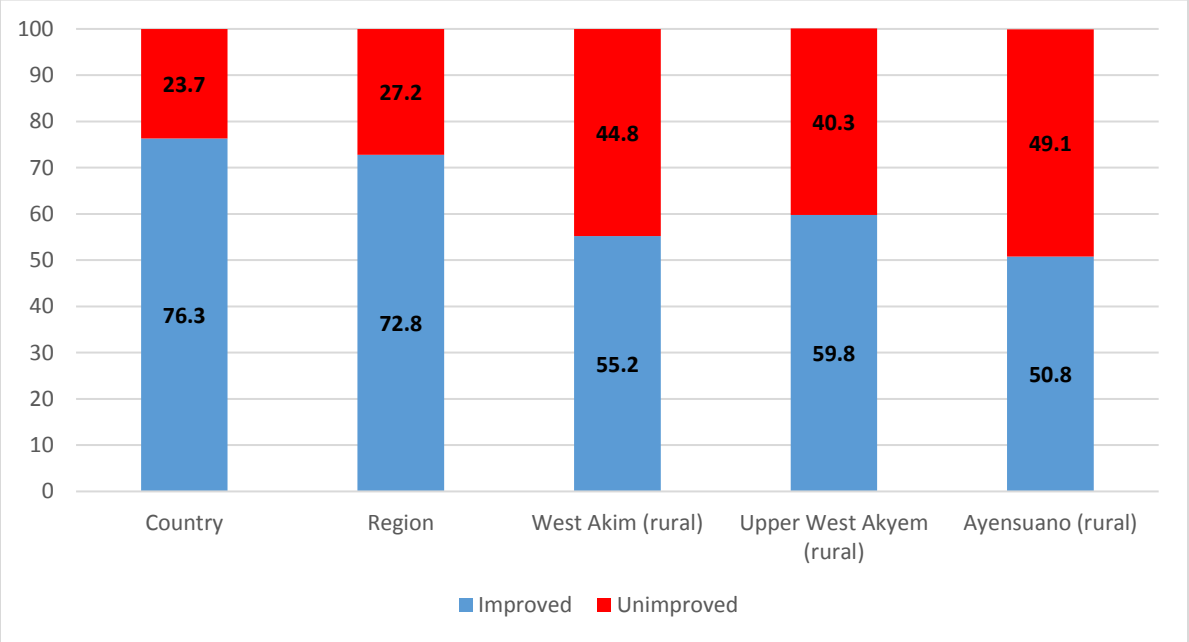
The Eastern Region is the third most populous region in Ghana, accounting for nearly 11% of the total population (GSS, 2013a). Approximately 57% of the population lives in a rural community. The climate consists of two seasons—a dry season, which lasts from November to February and a rainy season, which lasts from March to October. The Eastern Region is primarily agrarian and agriculture is the main source of employment, especially in rural areas. The major traditional cash crap is cocoa while the major non-traditional cash crop is pineapples. The dominant ethnic group is the Akans, which make up 51% of the total population. Other major ethnic groups are the Ewe (19%) and the Ga-Dangue (18%). The illiteracy rate in the population is 35.8%. Chieftaincy is an important aspect of social organization in the region. The dominant religion is Christianity; approximately 85% of the population in the Region practice Christianity. These

characteristics of the community play an important role in how water resource management is conducted and how women decide which water sources to use.

A recent study conducted in the Eastern Region of Ghana on access to improved water sources showed that communities with improved water sources had nearly universal access within 1000 m thus attaining the United Nation Development Goals definition of "basic" access to a water source (Kulinkina et al., 2017; UNDG, 2003). This result calibrates the finding of 66% of the rural population in the Eastern Region having access to an improved source, those with access were able to get to these sources at a reasonable time and distance as defined by the United Nations.

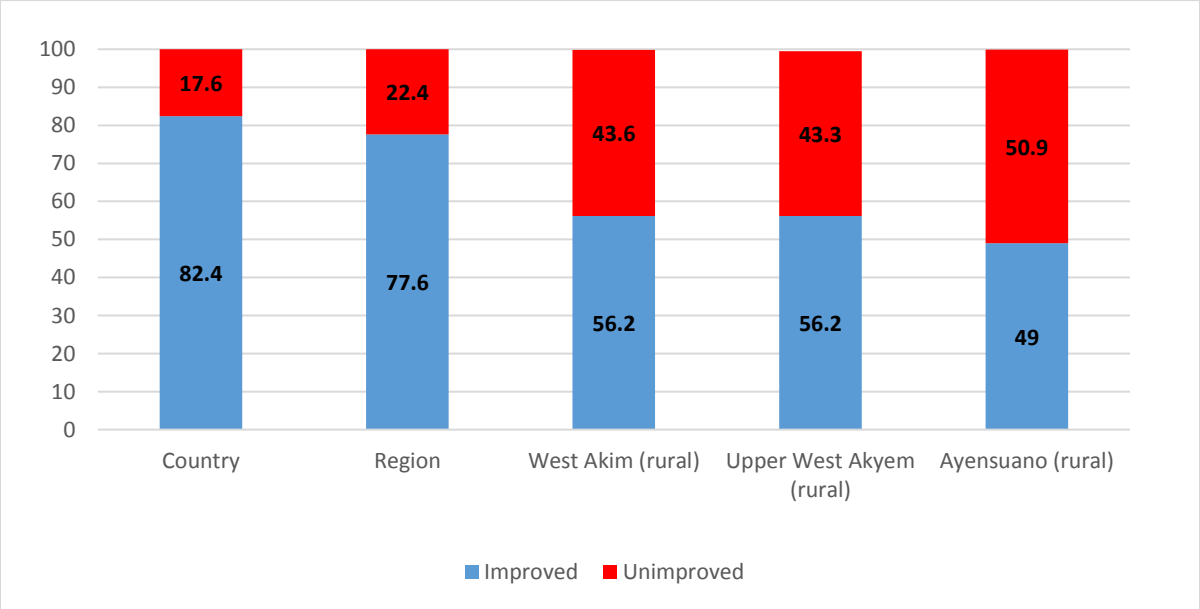
Access does not necessarily translate to use. When looking at the district level in the Eastern Region, use of improved water sources was much lower than access to these sources (Figure 2, Figure 3; GSS, 2014a; GSS, 2014b; GSS, 2014c). For this thesis, I performed surveys and observations in four rural communities: two in the West Akim District (Town C and Town D), one in the Upper West Akyem District (Town B), and one in the Ayensuano district (Town A), all located in the Eastern Region. Of the unimproved water sources, rivers and streams dominated use while for improved sources, boreholes dominated. Only about half the population used improved water sources for drinking and other domestic purposes in 2010, varying from 50.8% to 55.2% for drinking water and 49.0% to 59.8% for other domestic purposes such as cooking, bathing, and washing. These numbers are much lower than the 66% of the rural population that has access to improved sources.

Figure 2: Main Source of Drinking Water for Households, Ghana 2010



Source: Ghana Statistical Service, 2014a; 2014b; 2014c

Figure 3: Main Source of Water for Other Domestic Purposes in Households, 2010



Source: Ghana Statistical Service, 2014a; 2014b; 2014c

2. Perceptions of Water

Previous studies have explored why access to improved water sources does not necessarily translate into use of these sources. One case study using focus groups was conducted in Asamama, a rural community in the Eastern Region (Kosinski et al., 2016). Based on the UN definition of "basic" access, all members of the community had access to an improved water source, as there are eight boreholes located in the community, yet two-thirds of participants regularly reported using river water. The researchers found that distance played a large role in what water sources people chose to use—participants who lived equidistant from a river access point and a borehole chose to use river water. There were several reasons for this trend. The river water was faster and easier to collect compared to the borehole water, especially for water heavy tasks such as bathing and washing. This is especially true if there were queues at the borehole. The borehole was also found to not lather well with soap and separated oil poorly when participants made palm oil. Thus, river water was typically used for laundry, bathing, and dish washing. Risk perception affected community member's behavior. Participants stated that their ancestors had used the river and had not gotten sick, and thus, they would not get sick either. Others also addressed poor water quality of the borehole, including oil sheen on the water, particulate matter and rust on the bottom of their buckets after the water had settled, and a trash dump near two of the boreholes.

Another mixed-methods study conducted in four communities in the Eastern Region of Ghana aimed to understand how factors such as domestic use, relative cost, and convenience played a role in the use of piped water systems (Kulinkina et al., 2016). A qualitative analysis was conducted on responses from 22 women with access to piped water systems to address this

question. People chose not to use piped water systems due to salty taste as well as soap not lathering with the water when laundering. Study communities with participants that complained about water hardness were found to have a higher average water hardness level than communities that did not complain about water hardness, showing that objective measures of water hardness calibrated their view of the water.

Studies in other communities have also shown that perceptions of water quality play a role in what water sources people choose to use. One study conducted in Southwest Sri Lanka evaluated household survey data to gain insight on perceptions of water in 1,125 households without access to piped networks at their homes (Nauges and Van Den Berg, 2009). The researchers found that risk perception depended on the source of water used by the household, especially if participants had a variety of sources to choose from. The perception of risk posed by the water was mostly driven by aesthetic characteristics of the water such as taste, color, and smell. For instance, bad smelling water or water that tasted bad was seen as having a higher safety risk. Those respondents with higher levels of education were more likely to treat their water because of a higher perceived level of health risk posed by the water sources in their community. When households gained additional knowledge concerning the transmission of diarrheal diseases, they perceived a higher health risk from their water sources. This knowledge prompted them to treat their water before consuming it.

Another study conducted in three rural villages in India also looked at perceptions of drinking water (Francis et al., 2015). Two of these villages received a filtration system while one served as a control. The researchers found that many of the participants were able to list health effects of

unsafe drinking water such as diarrhea, loose stools, cholera, and other water-borne and water-related diseases. Despite this understanding that unsafe water could cause diseases, participants in the control location stated that the water in their community was safe to drink and that water from outside of the community was more likely to get them sick, including "mineral water." Respondents in the control group also spoke of their water appearing clean and tasting good. In-home practices of treating the water such as boiling and sieving the water were done mostly for children and sick adults. The researchers noted that respondents understood that these populations were more at risk for disease than the general population. In the two experimental groups, non-compliant families were more likely to live further away from water distribution centers that distributed the filtered water, showing that distance was also a factor in use of the cleaner water. Compliant families were more likely to see the benefits of using the filtered water. The researchers suspected that lack of support from male family members may be a barrier in fetching water even if female members saw the benefits of collecting safer water. This was especially true if payment was required for the water if the women had to consult their husbands first.

Another study conducted in four towns in Kenya also chose to look at how risk perception played a role in what water sources people chose and whether or not they chose to boil the water (Onjala et al., 2014). These towns had several options of sources, which the researchers indicated as piped water systems, non-piped improved water sources, and non-piped unimproved water sources. Seventy percent of the people in these communities had the option to be connected to a piped water system, while 92% had the option to collect from a non-piped improved source. They found that low-income households were 38% less likely to treat water or used piped water

systems as their main source of drinking water. They believed this was due to the cost of treatment and piped water, and thus, advocated for treatment options to be cheaper. They also found that if the water had a perceived health risk, people were more likely to treat it. Surprisingly, the researchers found that men were 21% less likely to treat water than women, which they thought was because women are primarily responsible for children, and thus, want to reduce the risk of the children contracting water-borne diseases.

Findings from the aforementioned studies show that distance to source, perceived health risk, utilization of different water sources, and water quality all play a role in determining why people choose to use water that is microbiologically unsafe for them to drink and to use. None of these studies, however, discussed reasons why people would choose to not use improved or microbiologically safe drinking water when they did not have complaints about these water sources such as taste, smell, and other water characteristics. Furthermore, only the Francis et al. (2015) study alluded to how gender may play a role in water collection and use. Thus, this thesis aims to fill in this gap by looking at communities with acceptable borehole water and the impact gender may play on water source selection and perceived health risk.

3. Gender Disparities in Water Collection

Globally, women share a large responsibility of unpaid work which includes domestic work such as meal preparation, cleaning, collecting water and fuel and direct care of persons such as children and ill or disabled family members (Food and Agriculture Organization of the UN, 2010; Sepulveda, M., 2013). Although a bit dated, one study estimated that in 1998-1999 employed women over the age of 15 spent an estimated 46.3 hours per week on unpaid work

while men over the age of 15 spent an average of 9.7 hours per week, or women spent four times as many hours on unpaid care as compared to men (Chen & UNDFW, 2005).

Water collection, a form of unpaid work, is also female dominated. Globally, women are more likely than men to be primarily responsible for collecting water in households where an in-house or in-yard tap is not available (WHO/UNICEF, 2010). Multiple Indicator Cluster Surveys (MICS) and Demographic Health Surveys (DHS) conducted in 45 countries found that 64% of households usually have women as the main person who collects water. Twelve percent of households had children typically collect water, with girls under fifteen twice as likely to hold this responsibility as compared to boys under fifteen.

Studies conducted in Ghana have similar trends. One MICS survey published in 2011 found that in Ghana, nationwide, 64% of women carried the burden of collecting water (Sorenson et al., 2011). Nevertheless, some participants answered either only women (42.2%) or women and children (22.2%) showing the large burden children may play in collecting water. Children were reported as primarily responsible for collecting water in 15.6% of households. These data aligns well with the WHO/UNICEF global data. The survey also found that 63.7% of participants in Ghana reported that they walked half an hour or less to the water.

Another study conducted in Ghana had slightly different, if not contradictory, results as compared to the previous study. Researchers found that 66% of respondents in Accra reported women and girls as primarily responsible for collecting water in their households without an in-house or in-yard tap (Harris et al, 2016). However, they found that these responses differed by

gender and that men were likely to emphasize men's roles in collecting water while women reported higher involvement by women. In contrast to respondent answers, the researchers found that there were no statistically significant differences in time spent collecting water between men and women. Confirmatory observations also found that both men and women collected water. Although it appeared that men and women collected water about as often as each other, the fact that two-thirds of households stated that women were the ones that collected that the water emphasizes the fact that collecting water is seen as "women's work" and performed more by women. It is important to note, however, that this study was done in a dense urban setting and may not be applicable to what is the norm in rural settings in Ghana.

4. Water Management and Gender in Ghana

Despite the fact that women are primarily responsible for collecting water and have the most intimate understanding of how water is collected, men have traditionally been the primary decision makers for water management and water supply (Boateng et al., 2013). This is due to traditional roles of men and women in which men typically are seen as "natural" leaders (Ostergaard, 1993). Research has shown that involvement in women in decision-making processes would further reduce the time and labor these women spent collecting water (Anokye and Gupta, 2011). Furthermore, women also are more motivated to have access to improved sources and then operate and maintain these systems in their community as they had more at stake when these sources broke down (Mjoli, 1998).

In order to ensure that women played a more active role in water management and decision-making, "demand-driven" approaches were established to increase the role of women in decision-making processes (Whittington et al., 2009). To ensure this, Water and Sanitation

Committees (WATSAN) had a minimum requirement of at least 30% of its members had to be women, usually three out of seven members (ATPSN, 2007). Furthermore, the treasurer of the committee had to be a woman to ensure that women were playing key roles in decision-making processes. This approach also established the collection of fees in order to maintain and operate water resources as well as more heavily involving households in water resource technology as well as institutional and governance arrangements (Whittington et al., 2009).

One study done on community management systems in rural settings found that the median number of women on the water committee in the Volta and Brong Ahafo regions of Ghana was three (Whittington et al., 2009), showing that the established quota had been successful establishing women in WATSAN committee. This was in contrast to Bolivia and Peru, whose median average was zero. They did note, however, that this does not mean that all women participants were active members of the WATSAN committee. Since the study was conducted in two of the 10 districts in Ghana, these findings may not be generalizable to other parts of Ghana.

One report by the African Technology Policy Studies Network further explained the roles women played on WATSAN committees. The report found that only 19% of women reported they played a role in selection of borehole sites and 13% reported playing a role in selection of hand dug wells (ATPSN, 2007). This shows that they did not have an active role in this process despite the impact this would have on their daily routines. By far, the largest role women played were in cleaning around the water systems and over three-quarters of the women reported involvement in this task. Forty-three percent of women reported active involvement in hygiene education using house to house or whole group methods.

A cross-sectional study assessed the roles of women in WATSAN committees in the Akim South District of Asante Region in Ghana (Boateng et al., 2013). They found that apart from the role of treasurer, a role required to be filled by a woman, women were less likely to hold powerful positions such as chairman, vice chairman, and secretary. Even when women were "treasurers" and were responsible for holding the money, sometimes communities had men as bookkeepers, diluting the woman's role. Thus, the researchers concluded that women were only in positions in the WATSAN committee to uphold the 30% quota and not to have a large say in the decision-making and planning processes. They found no statistically significant differences between the roles of men and women in project construction; project implementation; monitoring and evaluation; budget planning, and operation and maintenance. They also found that women did not actively participate in WATSAN committees due to having to complete household chores, shyness and fear of being mocked by their colleagues, and criticism from other women. Thus, these issues must be addressed in order to ensure women have a much larger say in the decision-making processes. It is important to note that this study only looked at one district of the 216 in Ghana so it may not be generalizable to other areas. However, it does give an idea of what may be actual practice in other districts across Ghana.

This evidence shows that despite being members of WATSAN committees in Ghana, women may still hold subservient positions in relation to the men and may be less involved in decision-making processes, especially in planning stages of projects such as selection of improved water source sites.

5. Traditional Systems: Chieftaincy and Spirituality in Ghana

The aforementioned system, describes a civil system of government. However, as mentioned previously, chieftaincy in the region, like in other parts of Ghana, plays a large role in social, political, and religious systems in Ghanaian communities (Odottei & Awedoba, 2009). A chief is defined as, "a person elected or selected in accordance with customary usage and recognized by the Government to wield authority and perform functions derived from tradition or assigned by the central government within specified areas" (Odotei & Awedoba, 2009). They are recognized in the Constitution of Ghana as a traditional form of government.

Historically, Chiefs played a large role in resource management and religion in the community (Alhassan, 2009). For instance, land ownership did not belong to the individual but to the community, and had to be shared with everyone. The same mindset also existed with water (Anokye, 2013), including small streams, ponds, and well water. The Chiefs possessed sacred significance regarding the land and for natural resources, and enforced land tenure systems that believed in collective ownership (Alhassan, 2009). For instance, the traditional systems believed in giving the Earth a day of rest. The practice of taboos were important in environmental conservation. Taboos and norms helped control water pollution, enhance conservation and catchment protection of fisheries (Anokye, 2013). The chiefs, fetish priests/priestesses through various sanctions, enforced these norms and taboos.

The traditional system also held that rivers and other water bodies seen as gods and goddesses and cannot be defiled. It is the job of community, chief, and religious leaders to protect water bodies (Opoku-Agyemang, 2005). Priests/priestesses banned washing of clothes or collecting of

water on certain taboo days of the river (Anokye, 2013). They believed that river Gods who should not be seen by any person could be seen on those days. Containers for fetching were also regulated by rules of the traditional system.

Some of these beliefs are starting to lose their power, as Christianity and modern beliefs become more abundant and discredit the traditional systems (Anokye, 2013). However, the author notes that these beliefs persist more strongly in rural communities.

Chiefs also play a role in current water resource management (Alhassan, 2009). District Assemblies deal with local governance and resource management but the chiefs are the starting points of these programs when they are local and represent bottom-up approaches to decision-making, planning, and implementation. Thus, water resource planning cannot be implemented without input from the Chief in the community.

6. Thesis Objectives

Previous studies have addressed why people choose to not use improved water sources or filtered water despite access to these water sources. Attributes such as taste, smell, look, and other aesthetic characteristics have come into play. However, no study has examined why people choose to not use these sources when they do not have complaints regarding the aesthetic characteristics of the water. Furthermore, these studies have no addressed the social or political contexts of water management in which these decisions are made, or thought about the role gender may play in this. The goal of this thesis is to understand why people are choosing to consistently use river water sources despite having access to borehole water of acceptable

quality. This will be done through understanding participant perceptions, attitudes, and beliefs around different water sources in the community. Social and political factors have also not been looked at in great detail in the literature, and thus this Thesis hopes to fill this gap as well. Furthermore, Chapter 2 contains information on the methodology used during the study period. Chapters 3-5 focus on the three major themes that emerged from this research: access and collection around water, perceptions on the quality of water, and the dynamic interactions between perception and access of water respectively. Chapter 6 gives conclusions and recommendations.

Chapter 2: Methods

1. Study Design Justification

I conducted a qualitative analysis and used grounded theory approach to better understand why people chose to use river water or both river and borehole water concurrently. Grounded theory is a method of analysis used when no specific theory on a particular topic exists or a theory exists that is too abstract to be tested (Cho et al, 2014). It involves applying descriptive codes to data through a series of coding cycles that ultimately lead to a theory "grounded" in the original data. It also is used to understand how topics work in context.

I conducted two studies; the first in May-June 2016 and the second in January-February 2017. I chose these two time periods to account for Ghana's two main rain-related seasons and the resulting differences in water use between the two seasons. The first study coincided with Ghana's rainy season while the second study coincided with Ghana's dry season.

In the initial study in May-June 2016, I conducted semi-structured in-depth one-on-one interviews. I chose to do this because I was looking to extract as much information as possible from participants on their daily behaviors and in-depth interviews are conducive to getting detailed information and exploring a topic in a greater depth than other alternative approaches (Frechtling, 1997). The objectives of this study were: 1) understand people's perceptions of "good" and "bad" water, 2) gain insight on what people's thoughts, attitudes, and beliefs of each water source in the community was 3) assess what water sources people were using and why and 4) understand differences of quantity and quality between each water source and between the dry

and the rainy season, 5) understand water use and water collection behaviors, and 6) investigate differences in gender on water-related activities such as bathing or swimming

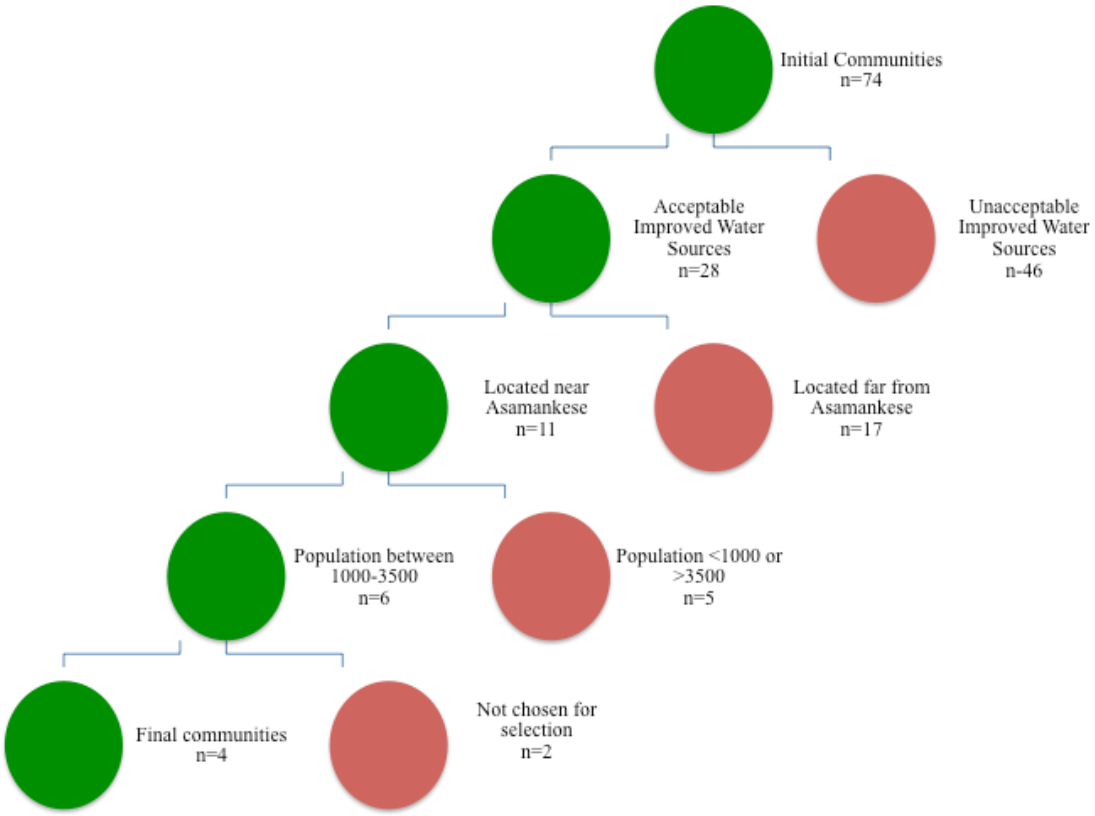
I returned to Ghana from January-February 2017 to provide context for previous participant responses. For example, I sought to understand how people used certain water sources, gain further insight on water use in households, and to see if stated answers matched observed behaviors. Self-reported data can sometimes be unreliable if participants cannot accurately recall, interviews "probing" answers that may color participant responses, or participants trying to give a "correct" answer to researchers (Frechtling, 1997).

2. Selection of Communities

Previous research conducted in the Eastern Region of Ghana categorized basic water access and water quality in seventy-four communities in the rural and agrarian Eastern Region (Kulinkina et al., 2017). Four of these communities were selected in which to conduct in-depth, semi-structured interviews and then to conduct field observations (Figure 4).

The first selection criterion was that the communities must have water sources with acceptable water attributes (e.g. color, scent, taste, absence of visible particles; n = 28; Kulinkina et al., 2017). This enabled me to explore reasons other than aesthetics for why people continued to use unimproved water sources when proximal acceptable improved water sources were present in the community.

Figure 4: Eastern Region Water Source Perception Community Selection Criteria



Notably, among the 28 communities that had acceptable improved water sources, the number of functional boreholes and perennial river access points varied. To determine if the number of boreholes versus river access points played a role in why people chose to get water from a certain water source versus another, a second selection criteria was that the four communities should each represent a different one of the following four scenarios: 1) at least two boreholes (+ for improved) and at least two perennial access points to a river or stream (+ for unimproved), 2) at least two boreholes (+ for improved) but fewer than two perennial access points to a river or stream (- for unimproved), 3) fewer than two boreholes or (- for improved) but at least two perennial access points to a river or stream (+ for unimproved), and 4) fewer than two one

boreholes (- for improved) and fewer than two perennial access points to a river or stream (- for unimproved). Two sources were used as a cutoff point because having one water source would cause an unnecessary burden of collection on the participants. Table 1 lists the number of communities in each category.

Within each category, I selected communities based on geographic considerations and population size (Figure 4). To ensure accessibility for research, all communities had to be within a one-hour drive from Asamankese and located in the West Akim, Upper West Akim, and Ayensuano districts (n = 11). To ensure comparability between communities, I only considered the remaining six communities with a population size between 1000 and 3500 people. Of these six communities, one community had a broken borehole in the past year and one lacked an improved water source and could not in the study. No other town nearby lacked both improved and unimproved water sources based on the selection criteria so I chose Town D as my final town due to its proximity to Town A.

Table 1: Access to Improved and Unimproved Water Sources for Communities in the Eastern Region

Improved	Unimproved	# of communities in each category from initial 28 with acceptable improved water sources	Name of selected community
+	+	7	Town A
+	-	9	Town B
-	+	6	Town C, Town D
-	-	6	--

3. Study Towns

Please see Table 2 for descriptive data on the study communities. Briefly, In Town B, I was not shown wells but I was able to find four wells, but there may be more in the community.

In Town C, eight access points were found on the Suppong River, which is the main river source. Nevertheless, three other small streams were mentioned during the January-February 2017 visits so more access points exist.

In Town D, during my May-June visit, there was only one borehole that was functional and four covered wells that were functional. When I returned in January, the community Assemblyman had worked to fix many of the already existing sites, including the community's borehole and covered well.

Table 2: Community Water Characteristics

Town	Population (2014)*	# of functional boreholes	# of perennial river access points	# of covered wells	# of uncovered wells
Town A	2035	3	2	0	0
Town B	3342	4	1	>2	>2
Town C	1909	1	>8	0	0
Town D	2439	1 (2)**	2	4 (5)**	1

*(Based on projections from Ghana Statistical Services, 2013)
**Additional functional sources were noted in January that were not functional in May.

Map 1 shows where communities are located in relation to one another. Location of water sources and participant homes are shown in Maps 1-5. Maps 4 and 5 show differences between visits for Town D between May and January. ArcGIS was used to plot all points. GPS coordinates were available for water sources while the location of participant homes was estimated since no GPS information was available.

It is important to note where water access points are located near clusters of households. In Towns A, B, and C, all boreholes were located near marketplaces or public spaces. In Town D, the Assemblyman stated that the boreholes were placed based on where ground water was and were not located near public spaces.

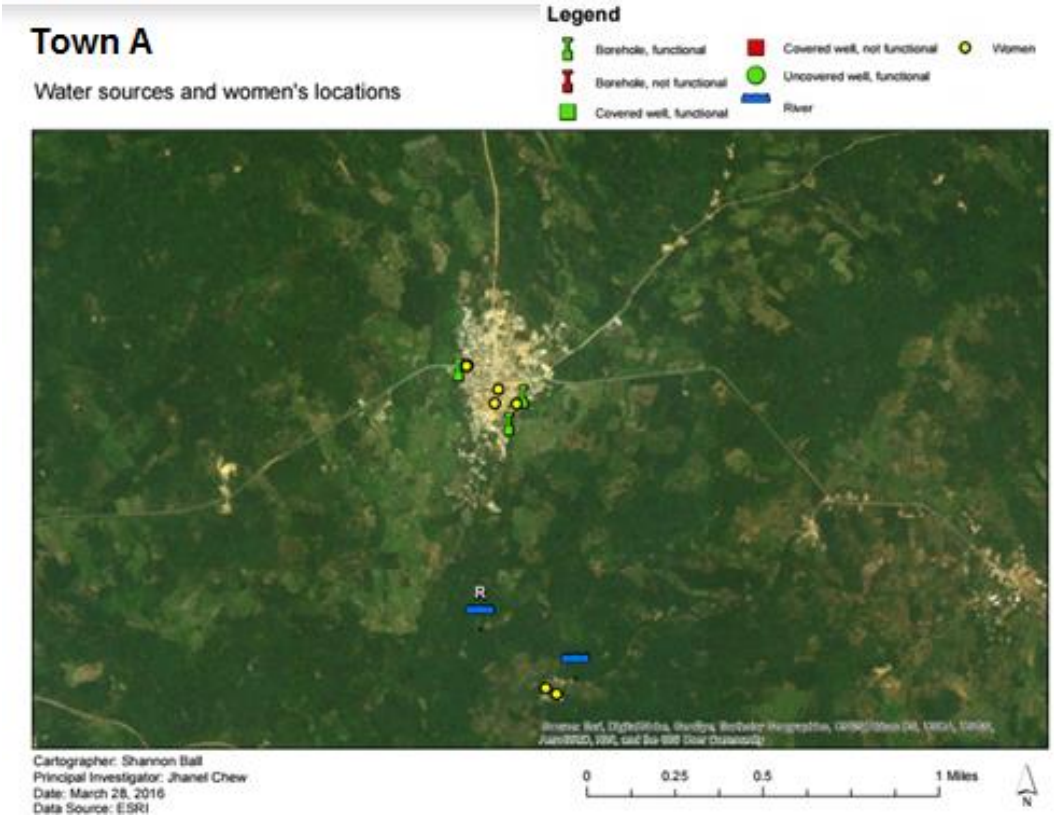
In Town A, the boreholes are located much closer to the center of the community than the rivers, which are approximately 1 km away from the marketplace. Thus, those who live by the river don't have as much access to boreholes as those who live by the marketplace.

Like Town A, in Town B, the river is located on the outskirts of the community and the boreholes and wells are located much closer to people's homes.

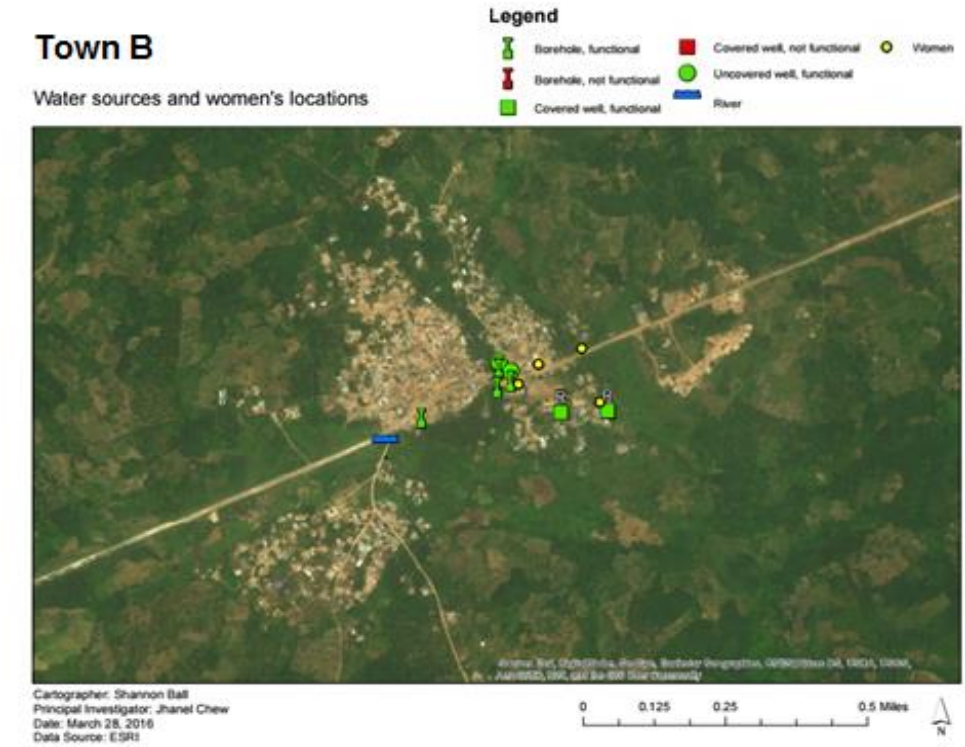
In Town C, there is only one functional borehole located in the center of town and many river access points alongside this. There are more houses located near rivers than near the borehole.

In Town D, the boreholes are located on the opposite sides of the community so that they can serve opposite sides of the community. The river is located in the middle of the clusters of houses.

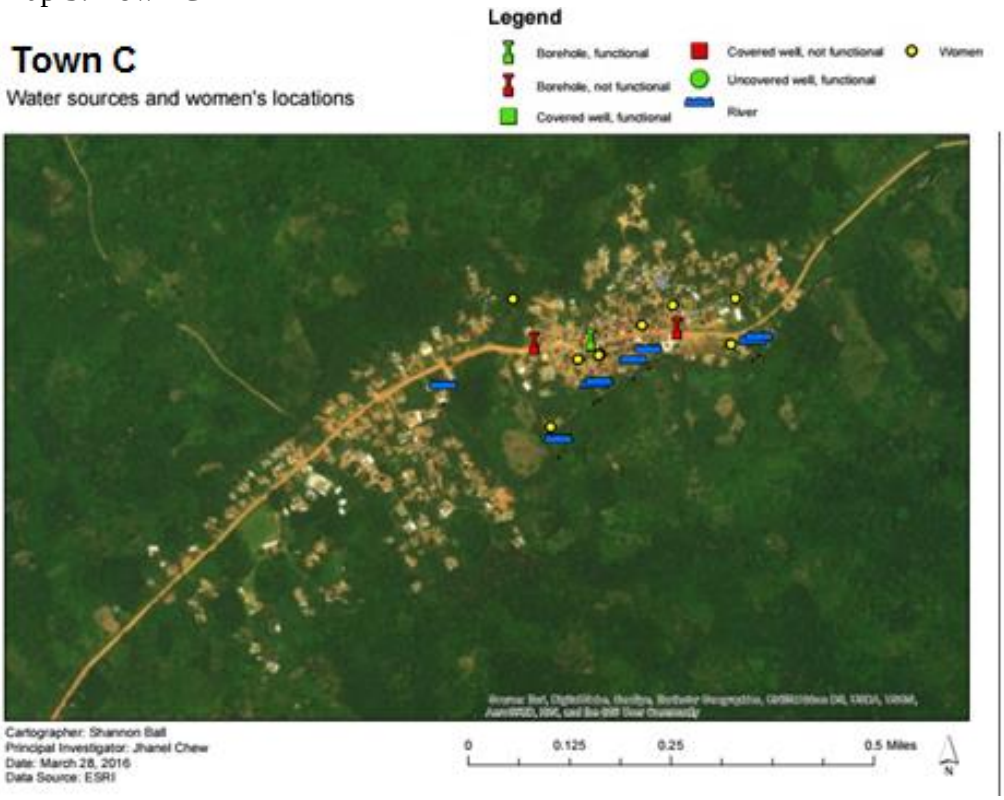
Map 1: Town A



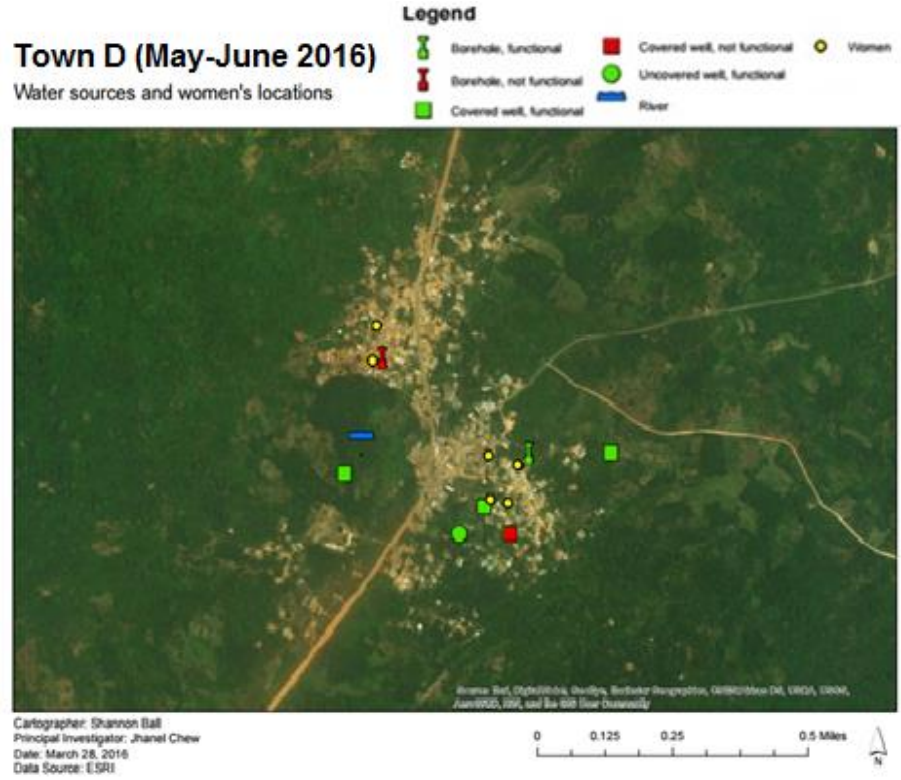
Map 2: Town B



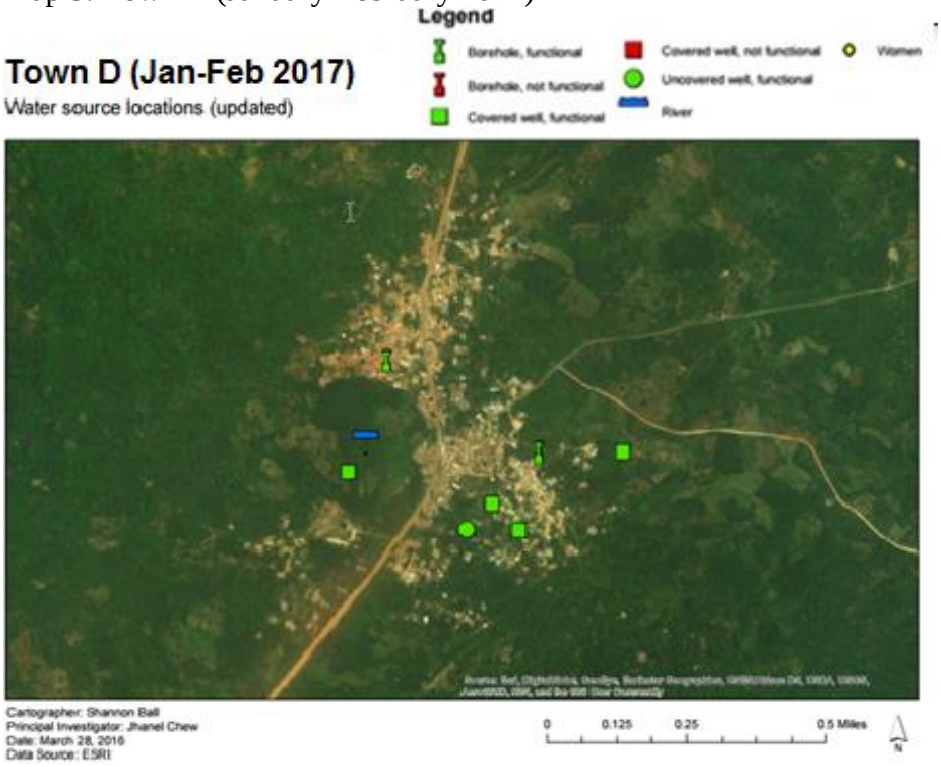
Map 3: Town C



Map 4: Town D (May-June 2016)



Map 5: Town D (January-February 2017)



4. May-June 2016 Site Observations

Before I conducted each interview, I contacted the community's Assemblyman and told him about the study. I asked his permission to interview the women and a Key Informant in the community. The Assemblyman then gave me a tour of the community and identified various water sources in the community, including river access points, nonfunctioning and functioning boreholes, uncovered and covered wells, and other water sources. I collected Global Positioning System (GPS) coordinates for each water source shown or found in the community using a Garmin eTrex GPS precise up to 10m.

Before I interviewed participants, I conducted non-obtrusive observations at each water source. I, accompanied by my translator, would stand several feet away from each water source site and

observe people at this location for a few minutes. We would also return to different water sources two or three times throughout our visits to make other observations. The purpose of these observations was to see what norms and behaviors were customary at each water source. This included what time of day people (mostly women) usually went to collect water from that source, what techniques and approaches were used to collect the water, if children were present at the water source, and if people were interacting with one another All field notes were recorded in a notebook or an iPhone 6 device.

5. Interviews with women collecting water

I recruited participants via convenience sampling. I approached women aged 18 years and older at various water sources in the community at dawn while fetching water or while waiting in line to fetch water. Two separate, but related, intervals of interviews were conducted. I interviewed a total of 25 women in May-June 2016 and one in February 2017. Of all the women that were approached, only two declined to be interviewed. When I was not able to find someone at a water source, I asked participants if they knew anyone else in the community who might be interested in participating in the survey.

6. Key Informant interviews

I interviewed a Key Informant in each community. I selected them based on previous or current membership on the community's Water Committee. In the absence of a member of the Water Committee, I asked the Assemblyman to make a recommendation by taking into consideration the person's knowledge of the community's attitudes, beliefs, and preferences regarding different water sources. In three towns, I interviewed current or previous members of the Water Committee. In the fourth town, I interviewed a former appointee in the Chief's Palace.

7. Informed consent

The Tufts University Social, Behavioral and Educational Institutional Review Board (IRB) classified the May –June 2016 and January –February fieldwork studies to be exempt (Protocols #1605022 and #1612034 respectively).This field work was also reviewed and found to be "acceptable to community norms" by Professor Kwabena Bosompem of the Noguchi Memorial Institute for Medical Research, Accra, who is also a member of the Noguchi IRB.

I obtained verbal consent from all participants who were interviewed. I did not seek written consent due to the prevailing illiteracy rate (35.8%, Ghana Statistical Service, 2013) as well as based on the previous experience of other Tufts research teams. When I first approached participants at the water sources, I asked if they wanted to participate in a study and if they were over 18 years of age. If they agreed, I told them that I was conducting a study on water perception and that we wanted to gain a better understanding of why they used one water source over another. I also asked for consent for my translator and me to walk with them from the water source to their home. Once arriving at the home, we reminded participants that they were free to stop participating at any time, their responses were confidential, and that they did not have to respond to any question that made them uncomfortable. We also told them that there would be no compensation for the interview. We also asked for consent so that the interview could be audio recorded.

I also obtained verbal consent for observations conducted in January to February 2017. My translator and I approached women at their homes and told them that they were eligible for another research study. We also told them that they were free to stop participating at any time,

they did not have to respond to any questions that made them uncomfortable, and their responses were confidential. We told them that compensation for their participation was a set of plastic bowls. Three of the four participants in the January-February 2017 fieldwork study participated in the May-June 2016 interviews.

8. May-June 2016 Field Work: One-on-One Interviews

I conducted fieldwork during the rainy season in Ghana. My translator and I followed women from the water sources to their homes during the normal time they gathered water either before or after the interview. This was done to gain a better understanding of the various routes that people use to obtain water. I took field notes on what time of day the women were fetching water, and if they brought her children, how they fetched her water, if the terrain was rough, how long the water collection process took, and anything else that seemed informative. The time from the water source to the home was recorded on a timer on an iPhone 6 device.

I conducted a semi-structured informal one-on-one interview with each participant. All interviews were audio recorded on an Olympus DS 3500 device that was password protected. All but one interview was conducted in Twi; the other was conducted in English. A translator trained in health services performed simultaneous translation.

The survey questions asked in the one-on-one interviews were selected and adapted from a previous research study (Kulinkina et al., 2016). The majority of questions were open-ended questions. The open-ended questions allowed participants to give more detailed answers as well as to allow for follow-up questions to be posed based on the answers given. Not all questions on the survey instrument were asked of each participant and the questions were not asked in a

specific order due to the open-ended nature of the questions. When appropriate, participants were prompted to explain more about their answers.

While each participant had a slightly different set of questions, the interview format was similar for each participant. First, I asked background questions regarding the person's age, years lived in the community, and water collection responsibilities. If the participant was not responsible for collecting water, I asked who in the household was usually responsible for collecting water. Questions focused on how many times a day the participant fetched water, where the water was collected from, and what time of day the water was collected. Additionally, I asked participants about their opinion and perceptions on the water obtained at specific sources. For example, they were asked about their personal definition of water in general, the differences between "good" and "bad" water, their general thoughts regarding each water source in the community, and their assessment of the differences in water quality and quantity that exist between the dry and rainy seasons. I also asked participants about water collection and water use behaviors. These questions assessed the ways different water sources were used in the households, what the water was used for (e.g. bathing or washing), and how participants viewed any social interactions that were associated with the fetching of water. Questions also probed for detail on how age and sex affected an individual's participation in water collection.

9. January- February 2017: Field Observations

I conducted a second field study in January through February 2017 during the dry season. I observed one woman previously interviewed in the May-June 2016 field work in each community. The second period of field work was to observe women conducting normal daily behaviors for up to four days in length. The goal of these observations was to gain insight into

how water was collected and utilized in the home as well as to see if reported behaviors corresponded to observed behaviors. I also conducted casual guided conversations throughout the observation period in order to 1) understand the differences between water use in the dry and rainy season, 2) gauge the utilization and perceptions of different water sources in the community, 3) understand methods of collection and how this may change for different water sources, 4) understand the role of gender in collection, management, storage, and use of water, and 5) gauge perceptions of water management in the community. I also explored issues concerning the role the Water Committee and that of the traditional government in water management. The four-day study period was chosen to elucidate trends in collecting and using water that might vary from day to day. Due to difficulty in finding a previously interviewed woman in Town B, one woman was interviewed in February and observed the following day for only one day.

10. Transcriptions

Participant answers were directly translated from Twi to English during the listening process. All but one interview was fully translated and transcribed by the translator. I assisted by typing translating. I transcribed the one interview that was conducted in English. A second translator who was not in the field at the time the interviews were conducted also independently translated and transcribed all interviews in order to minimize bias. For analysis, both translations were consulted.

11. Water Testing

Duplicate water samples were collected at all known water sources in each community using a 100-mL sterile sampling bag. They were then placed in a cooler bag with ice packs in order to

preserve the integrity of the sample. The sampling bags were refrigerated at 4 C within about four hours of the initial sample extraction. Colilert Presence/Absence tests were performed within 12 hours of water collection. Due to the limited amount of test kits available (n = 25), a random sample generator was used to choose approximately half of all samples collected (total samples n = 28, samples tested n= 17). Only 17 tests were done to account for possible contamination of samples. All water tests were conducted indoors on a flat table surface sterilized with 70% isopropyl rubbing alcohol. For each sample, 10 mL of water was pipetted in each tube containing Colilert medium. The test was shaken until the medium was completely mixed. The mixture was incubated in a waist belt incubator worn by the researchers to keep the mixture at 30-35 C. After 24 hours, if the tubes had turned yellow, they were positive for total coliform. If they turned yellow and fluoresced under ultraviolet light, they were interpreted as positive for fecal coliform.

12. Analysis Methods

I used a grounded theory approach to analyze the interviews (Cho et al., 2014). This approach led to memo-ing, or writing short notes about what is stated in the interview, of all interviews using both sets of transcriptions. From this memo-ing, I did a first set of coding by creating forty-six open codes as described by Saldana et al. (Saldana et al., 2009). Open coding involves comparing participant responses with other participant responses to find similarities and differences within their responses, giving contextual labels to these incidents through a word or phrase, and then grouping the concepts together.

The second round of coding involved collapsing open codes into axial codes, which explores the relationship among the codes. Eight axial codes were created: 1) good water, 2) bad water 3)

methods of collection, 4) outcomes of drinking water, 5) customs around drinking water/spirituality around drinking water, 6) comparisons of different water sources, 7) utilization of different water sources for different tasks and 8) health.

Once these axial codes were created, all interviews were further coded in NVivo 11. From this coding process, three themes emerged: 1) collection of and access to water, 2) perceptions on water quality and 3) interactions between first two themes. These three themes are presented in Chapter 3-5.

Chapter 3: Theme 1—Collection and Access Around Water

Case Study

Elizabeth is a 25-year-old primary school teacher who has lived in her community for twenty years. Her family initially moved to this community to find farmland. She lives with her five sisters, her brother, and her mother and father. She is unmarried and has no children. Church is an important part of her life and she has an active social life.

Since Elizabeth is a schoolteacher, she is college educated. Unlike the other women I interviewed, she speaks English fluently. She also has a good understanding of the health risks associated with drinking contaminated water, especially river water. She is horrified when I ask her if the river is a good source of water. "No," she says, shaking her head. "Anyone can defecate in it," showing that she has a clear understanding of disease transmission. The river is also on the other side of the community, which is a good deterrent for her and others in her family to not use the water.

Elizabeth works in the closest neighboring city. Because of this, she has to wake up at 4 AM to get ready for work so she can catch the local bus around 5:30AM to head to school. In this time, she fetches her bath water, washes her clothes, and gets dressed. When she comes back from school, she eats dinner with her family and plans her lesson for the next day.

Elizabeth shares the burden of collecting water with her sisters. Her brother and father do not do any of the water collection in the household. Where she and her sisters choose to get their water is strongly influenced by the season of the year. In the rainy season, she collects most of her water from the uncovered well behind her house. She uses this water for everything except for drinking. For drinking, she only uses the borehole water. In the dry season, she sometimes

fetches from the uncovered wells by the boreholes but mostly collects from the borehole. Elizabeth also collects rainwater during the rainy season, but since her brother and father don't like the taste, she will still fetch from the borehole to collect water for drinking for them.

Elizabeth has a low opinion of the quality of water from the well. The only reason Elizabeth chooses to use this source despite unfavorable opinions of it is because it is easily accessible. For the borehole in town, she has to walk to the source; she must pump the borehole, which sometimes makes a noise and she finds this task exhausting; she has to carry the water back to her home; she has to pay for the borehole water; and in the dry season, she has to wait in a queue. With the well in her backyard, she does not have to do any of this. It is closer, more affordable, and she doesn't have to wait in line and pump the water. Thus, even though the she perceives the well water quality as much worse than the borehole, her proximity and access to this water is much higher than that of the borehole so she uses it. Perhaps if the borehole were more accessible and convenient to Elizabeth, she and family might use this water source for everything instead of just drinking and not depend on the well at all.

Introduction

Elizabeth, like others in her community, considers the tradeoffs of collecting water from each source in her community. Factors include convenience, accessibility, and reliability of each source. For Elizabeth, the well water in her backyard is the most convenient and accessible water source. However, this water is not reliable, as it dries up during the dry season and thus she must go to the borehole, which is less convenient as it is further from her home.

The women that I interviewed have to make decisions like this every day. Ideally, one would collect water that is the most convenient, the most accessible, and the most reliable, but these factors do not always line up. Thus, the women must make intricate decision through the identification of which factor they deem to be the most important at the time.

Given the important role of seasonality, this chapter is separated into the rainy and the dry season. As previously mentioned, the rainy season in Ghana lasts from March to October while the dry season lasts from November to February. The rainy season represents the best-case scenario for the study communities—water is plentiful and participants have reliable access to water. I also review scenarios that are equally true in the rainy season and the dry season within this chapter. During the dry season, issues with collection begin to arise and thus, collection becomes more complicated as compared to the rainy season. This is because the dry season brings forward issues concerning water scarcity and how people live with and handle the perception of not having enough water.

The analysis section of this chapter will provide a broader context of water collection and use specifically by examining the role of gender dynamics in these communities and how this interacts with power and the traditional and civil systems of governance.

Collection and access around different water sources instructs us that an individual's reasons and desires for collecting the water as they do is quite complex. These women consider the tradeoffs regarding their time, energy, and resources to decide which water source is best to collect from. This calculus depends on heavily on what the individual deems to be most beneficial.

Results

Fifteen of the 26 women interviewed stated that they regularly use river water. Nine women use only borehole water. Six women interviewed use river water concurrently with borehole water (Table 3). Participants were more likely to use river water in Town C, which had at least eight river access points and only one borehole. In contrast, participants were more likely to use borehole water in Town B where there were four boreholes and only one river access point. Town A and Town D, which had three boreholes and two river access points and one borehole and two river access points fell in the middle in terms of river and borehole water use. It can be inferred that difference in improved versus unimproved sources in a community plays a role in what water source people choose to use.

Table 3: Use of Borehole and River Water by Participants

Town	Borehole Only	River only	Both	Total
Town A	2	2	3	7
Town B	4	0	0	4
Town C	1	5	2	8
Town D[1]	3	2	1	6
Total	10	9	6	25

[1] One woman is excluded due to only using a covered well

The number of people who stated they regularly used river water may be underreported. This is because I did not realize the large amount of time women spent on the farms, typically located outside of the communities the women live in. There, river water is accessible and participants may choose to drink this water even though they would drink borehole water in their community.

Collection during the rainy season

In general, people will choose to collect water in a way that is the most convenient, reliable, and accessible. In the rainy season, the most ideal water source is the rainwater.

Rainwater is typically collected by leaving barrels open or placing a large bucket on a stool in the yard. In fact, the rainwater is so easy to collect that it's not deemed a task at all, as other water sources require some type of physical labor as well as a time element. Thus, because of the perceived minimal effort expended no participant actually listed rainwater as a source they collected. I had to specifically ask each participant if they collect rainwater. Rivers will also flood and appear physically dirty after a rainstorm, and thus, participants typically don't collect water from this source until one or two days after a heavy rainfall only after when the banks become clear and the water looks clear again. It does not rain every day during the rainy season, however, thus demonstrating that although rainwater is easy to collect it is not always accessible or reliable. Thus, other sources must be used concurrently to supplement the rainwater so that participants are obtaining sufficient water for their daily needs.

Since water is heavy and requires participants to walk to and from the water source to their homes, distance plays a role in what water sources participants choose to use. Women will often fetch two to five times in a row in order to ensure there is enough water in the household for the day or for the task at hand. This can be tiring, so the women consider time and efficiency a factor when collecting their water. Afua, a 56-year-old housewife stated, "[the borehole] is far from my house and a river lies here. I will not go fetch that far." It is important to note that Afua believes the river and borehole are both equally viable options. She chooses not to go to the borehole, however, because the river is much closer to her home and she did not want to go too far to collect water.

When water sources are of relatively the same distance from one another, participants tend to use all of the water sources near them. Abena, a 26-year-old farmer, chooses to use three sources of water –two covered wells and a borehole—for different tasks in her home because they are within a five-minute walk from her house**.** Distance alone, however, does not tell the full story of what water sources people choose to use, as collection of the water source came up again and again in interviews. If the sources are not similar in ease of collection, people will choose to use the source that is the most convenient to collect.

By far the most cumbersome water sources are the borehole and the covered well, both improved water sources, which require participants to pump them by hand in order to get water. Yaa, a 30-year-old housewife, stated about the borehole, "after fetching [the borehole], you will be hungry. It is difficult to pump and you will get hungry by the time you finish… When my son is on my back and I carry a big [bucket], I will be tired." This shows how physically exhausting collecting borehole water can be. Yaa describes that after collecting it, she is "hungry" showing the great deal of energy required to collect the borehole water. Yaa also had an infant son at the time of the interview, and she would carry him on her back to fetch water like other young mothers in these communities. The physical weight of having to carry her son and the water back to her home after pumping for a lengthy amount of time makes her even more exhausted by the time she is done collecting the water. This task is so daunting for her, Yaa stated that she only collects water from the borehole once per day. This choice may be a decision other young mothers who have small infants may also make. Furthermore, collecting from the borehole only once has several health implications, as she lacks enough water to practice basic hygiene, increasing her and her family's chances of contracting diarrheal diseases (WHO, 2003).

People also complained about collecting water from the covered well. Akosua, a 56-year-old housewife stated about the experience, "Your dress gets wet when you pump it. It leaks when pumping for water and as I stand, you can see my dress is wet." At the time of the interview, Akosua had just collected the well water. She stood up to show me the bottom of her dress, which was quite damp. It is apparent that Akosua did not like that she was getting wet from pumping the covered well. Abena also mentioned that she disliked that the handle on this particular well was shaky. Thus, it can be shown that when pumps are not placed properly on boreholes and on covered wells, it can cause issues for the person pumping, which may discourage them from using that source.

Both the river water and the uncovered well, are unimproved water sources, yet are much easier and faster to collect compared to the borehole and covered well water due to not having to hand pump these water sources. If participants are close enough to an improved source and an unimproved source, they will sometimes choose the unimproved water source because of how much easier it is to collect.

Another barrier to collecting borehole water is that fees are often collected for this water source; this is not true for other water sources, including the covered well. Three of the four towns I observed collected money for borehole use. I observed refers to both non-obtrusive observations and field observations at women's homes as described in Chapter 2. Women are typically in charge of collecting fees as well as maintaining the borehole. This task generally involves sweeping and scrubbing the borehole when it gets dirty. It does not imply the repair of the

borehole. Mary, a 26-year-old housewife stated, "For the borehole, they take money. So, you can fetch the well for washing and bathing. They don't take money for the well." Since the borehole requires payment, if people don't have money, they will choose to use unimproved sources such as the uncovered well and river. Furthermore, since tasks that are water use heavy, such as washing and bathing as Mary noted, require many buckets of water, it is too expensive to collect water from the borehole to conduct these tasks. Thus, people will choose to use other sources, as it is more affordable. This was also reported by Elizabeth, who chose to collect from the uncovered well during the dry season for washing when she didn't have money to collect from the borehole.

Another barrier to borehole use is that it is sometimes is locked and thus, water cannot be collected from it. In two of the towns I observed, the women in charge had access to a lock and would open the boreholes at times of peak demand. This was done to allow the women to do daily tasks such as housework or farming so that they would not have to worry about collecting fees while they were away. Typically, the borehole would open around 5 AM and be locked around 9 AM when daily tasks such as going to church or to the farm predominated. The borehole re-opens around 3 or 4 PM and stays open until the evening around 7 PM. At times when the borehole is locked, participants chose to go to the next nearest water source, which can sometimes be an unimproved water source. During my observation periods, I saw people collecting water from rivers and streams near the borehole when the borehole was locked because they did not have access to the borehole at these times.

The river also presents issues of accessibility. There is a specific day once a week that participants are forbidden to use the river or go to the farm. Akua, a 40-year-old housewife stated, "the chief in the town says we shouldn't fetch water on Thursdays. All the other days we fetch." This quote shows that this is a rule mandated by the chief, and everyone in the community has to obey it. Akua did not know why the chief had mandated this rule, but followed it because this is what is culturally acceptable in her community. Afua stated, "our ancestors had that rule, so any chief that comes has to obey it," showing that the chief must follow the rules allocated by the ancestors of the community. Faith, a 63-year-old housewife, further explained this rule by stating,

> "Everybody has what he or she doesn't like. So, the river too has its day that it doesn't want the community to fetch water from it… So, if you go there with your intention, you will die because you are not supposed to go there on Fridays. So if you argue and you go, anything can happen to you."

This shows that the people viewed the river as a living entity and something that could have likes and dislikes. By going to the river on the day the community is not allowed to go, bad consequences can result, even death. Thus, this rule goes beyond the chief and the ways of their ancestors and demonstrates that participants believe negative consequences can occur if they upset the river.

Because the rules for what days' community members are allowed to go to the river are so stringent, this causes people to use different water sources. If there is more than one river or stream in the community, participants would choose to use them, as each river and stream has a different day that water collection is forbidden on. However, not every town has more than one river or stream and thus not every participant lives close enough to use this as an alternative source. In these cases the borehole is the other option to use.

Since the borehole is the alternative option instead of the river, long lines occur when many people go to the borehole at the same time on the very days when they are not allowed to go to the river. Afua stated that on Thursdays, when her community is not allowed to use the river water, they wait a long time at the borehole, approximating one hour and thirty minutes. This may be an exaggeration on Afua's part, as I did not observe anyone waiting this long at the borehole, but it shows how people perceive that the time spent at the borehole as wasteful.

Collection during the dry season

During the dry season, water sources in the community, such as covered and uncovered wells and smaller streams will dry up. Rainwater is also not available, eliminating a crucial water supply source for the people. Esther, a 55-year-old shopkeeper stated,

> "Water is scarce in this town in the dry season, but we get water in the rainy season. During the dry season, for here, the well can dry up… so it makes us grieve for water here. For the [borehole], it doesn't dry in the dry season. But all the others dry up. People from other communities come to fetch from the [borehole]."

During the dry season because the wells, rivers, and other sources will dry up, people will flock to the borehole. People from other communities will even come to use the borehole so that they can have water for use. This at first may seem like a positive thing, as people are using an improved source, but it soon becomes clear why this is an issue.

Yaa spoke of her frustration of outsiders coming to the community to use the borehole. She stated, "Why are they at the water? They bring all their [buckets]. Why are there many there? They don't allow us to fetch. When the place gets dirty, they don't clean." Yaa is frustrated that outsiders are contributing to long lines at the boreholes and thus, making it harder for local

residents to fetch their own water. Not only this, the outsiders don't contribute to the community labor, which requires all community members to organize every week to maintain the community through cleaning, sweeping, weeding, and other activities. Thus, Yaa thinks it's unfair for others to use the borehole if they are not from the community and do not contribute to its upkeep.

Because so many people are flocking to the borehole during the dry season, lines become increasingly long each day. I also observed people having to wait to collect water from the borehole, especially during peak times in the early morning and early evening. Magdalene, a 45-year-old housewife stated when she is waiting for the borehole, "We chat and sometimes fight. When we go there early and you think someone is fetching before you, it turns into a fight. No I came here before you, you came before me, this and that." This shows that their placement in line and maintaining order at the boreholes can be an issue. The participants and people don't want to wait in line longer than they have to, so they may cut in line, which can cause arguments.

The borehole also requires more strength to pump in the dry season as compared to the rainy season. This is due to that the water doesn't flow well (as there is less groundwater available) and that more people are pumping the water out. Abal, a 35-year-old housewife stated this about the borehole during the dry season: "You have to pump [the borehole] for a longer time before you get water so you need more energy for the pumping of the borehole…In the dry season, the borehole doesn't flow well so you would have to stand there for long before you can get water." This shows how much more strenuous it is to collect the borehole water during the dry season in comparison to the rainy season. Because the water doesn't flow well, people have to

continuously pump the water for longer periods of time. Furthermore, this contributes to long lines during the dry season because it is taking people longer to pump the water. This is a further deterrent for using the borehole, as people already dislike having to pump at the borehole.

Due to the various issues of having to pump at the borehole and having to wait in line, five participants chose to use the river instead of the borehole due to these collection issues. This includes Abal. On this matter, she stated, "if you are in a hurry, it will waste your time, so you would prefer going to Ayensu [river] to fetch… You have to pump [the borehole] for a longer time before you get water so you need more energy for the pumping of the borehole." Abal considers going to the borehole during the dry season a "waste of time." This is true despite that the borehole is much closer to her home than the river . In other words, Abal, like others in her community are considering the tradeoffs of time and energy spent versus getting water from an improved water source. In her case, along with the four other women who stated they went to the river instead, their time and energy was much more important.

During the dry season, issues with accessibility and the reliability of well water also arose. During the dry season, some of the uncovered well water, depending on its size will dry up. Covered well water will sometimes dry up, but at other times it will not flow as well. These occurrences made participants view both the covered and uncovered well water as unreliable sources, as they could not last through the dry season.

These issues with the covered well not flowing well were much more extreme than the borehole water. On the covered wells, Yaa stated, "The [covered well] water gets dried up and sometimes

there wouldn't be more [water] in it. So, when you pump it, [the water] wouldn't come…. But the water doesn't get finished. You will have to wait before you get water." Yaa explains that sometimes she goes to the well and no water is available. However, if she waits a few hours, the water will regenerate and eventually come from the pump. This is most likely because the well did not hit the water table or barely hits the water table and thus, will dry out relatively quickly, especially during the dry season, when there is no rain water to replenish it. Usually, participants would have to pump for one or two minutes to see if water will actually flow from the pump when there is no one there beforehand. This is because participants would not know if water is actually available in the well. Participants stated having to wake up as early as 4:30 in the morning to collect well water or having to wait for several hours for the well water to replenish, which is both inconvenient and time consuming. This shows the unreliability of the well water, as people can walk to the well and find no water.

Because of this issue, Dolores, a 44-year-old housewife stated, "…The whites built the [borehole] and it went deep to the ground. But the other ones, the well is not like that. But this one, they just put the pump on it just like that. It doesn't go deep." This shows that because the well is not as deep as the borehole, Dolores perceives this negatively. She wishes the well could be rebuilt so that it would be more reliable like the borehole during the dry season.

Analysis

Collection of water sources is a complex matter and is based on numerous factors such as the convenience of collecting the water, accessibility to the water source, and reliability of the water source from day to day and between the dry and the rainy season. In this thesis, "complex" refers to the intricate and connected parts of the social determinants and infrastructure barriers involved in the collection of water. As complex as this all sounds on paper, the participants and other

women have to navigate through these scenarios every day. Women try to delicately manage their time, energy, and resources in order to pick the optimal water source available.

Gender plays a large role in this theme. As previously mentioned, women are primarily responsible for collecting water in these communities and collection of water is seen as "women's work" (WHO/UNICEF, 2010; Sorenson et al., 2011; Harris et al., 2016). I also observed women as those primarily collecting water at the boreholes. I did observe children of both genders sharing a large burden of water collection. This makes sense, as women are the ones primarily responsible for taking care of the children. They are teach their children how to collect water through observational learning as a result of taking their children when they fetch water, especially when the children are infants.

Two of the participants stated that men also collect water but it is primarily young single men that are helping their mothers and sisters. Older men may collect water if they wish to collect their own bath water or if their wives are sick. In the case of Afua, a 56 year old housewife whom I observed, two of her sons (in their late teens/early twenties) collected the majority of the water for the household, while Afua typically only collected bath water for herself and her husband.

Men can also help with water-related chores. I observed men washing clothes and cooking meals, but overwhelmingly, it was the women who were doing these tasks. Men do collect water for their families, but usually only in specific situations whereas the expectation for women is to collect water throughout their lifetimes.

The findings relate closely to the Harris et al. (2016) study, which found no statistically significant difference between times men and women spent collecting water in Accra, Ghana. However, my findings found that men do collect water for their families, but usually only in specific situations whereas the expectation for women is to predominately collect water on a regular basis. These findings may agree better with Chen & UNDFW (2005), which found that women were four times as likely to perform unpaid labor compared to men. Thus, it can be seen that women have a more nuanced knowledge of the water sources present in the community, how they function, if they are functional, and what the quality of the water is like. Participants sometimes referenced friends that they would talk to and describe what water sources their friends would collect, showing that water collection is such an important part of these women's lives, that it is a knowledge base that is shared with their friends.

Water collection also had strong ties to the traditional system of governance. As described by Anokye (2013), traditionally, there are certain days that are taboo to use for water collection as well as beliefs that there are god/goddesses in the river that can cause assistance or harm based on its upkeep. In Town C, many of the women spoke of the river as a "good mother." Furthermore, as previously described, Faith described a scenario in which negative consequences can occur if one goes to the river on the day they are not supposed to. This rule was further enforced by the Chief. It is important to note that there are no such rules for the borehole. This shows that these communities still have strong ties to the Chief system, as noted by the Ghana Statistical Service (2013a). Furthermore, these views persist despite the pervasiveness of Christianity in the area.

Despite their sophisticated knowledge of the water sources in their community, women were often dissatisfied with the improved water sources in the community, especially regarding covered wells. This dissatisfaction may stem from the women not being as involved as men in decision-making processes related to water resource management (Boateng et al., 2013, ATPSN, 2007). Women complained about how the boreholes were inaccessible due to long lines, especially during the dry season. This was especially in true in Town D, where at the time of the interview period, only one borehole was functional. Participants also complained about the covered well, wishing that the pump would be fixed and that it was a borehole instead, as it would service more people and be more reliable. Since women were not heavily involved in such decision-making processes, these problems persisted in the communities adding to the frustration of the women.

Payment for the borehole was another issue that came up in regards to access of the borehole water. Women reported not having enough money to collect borehole water, and thus, chose to use an unimproved source instead. Men in these communities typically are the ones that earn money for their families while women do not often make money for themselves. Thus, they must rely on the sole incomes from their husbands, who may not see the benefits of collecting from the borehole water.

It is important to note that not all participants in every community talked about water scarcity. Participants in Town C were generally happy with the amount of water they had regardless of the season, which may be due to the prevalence of river access points in the community. Complaints

about water scarcity were most prevalent in Town D and Town B, which interestingly, are the only two study communities I visited that had access to covered and uncovered wells. This may have intensified why these participants believed water to be scarce during the dry season, as these sources tend to be unreliable during the dry season. The participants may heavily depend on these water sources during the rainy season and then will have to go elsewhere during the dry season, potentially travelling longer distances.

Chapter 4: Theme 2—Water Quality Perceptions

Case study:

Afua is a typical 56-year-old woman in her community. Her family has lived in the community for generations, dating back to her great grandparents, she states. She is one of fourteen children. Several of her siblings still live in the community and sometimes stop by her compound to say hello. She married a farmer, the son of an appointee in the Chief's Court and together, they have eight children. Most of her children are grown but she still lives with her two unmarried sons who are in their late teens/early twenties, her granddaughter who attends the local primary school, and her husband. Her husband, also from a large family, has lived in the community his whole life as well.

Afua is quite popular in the community. People frequently stop by her house to chat. As we walk through town together, she stops every few feet to say hello to someone and they quickly chat and laugh about a topic. She is a happy and joyful woman who deeply cares for those around her.

As we walk around town, she is very helpful and points out things such as how some people use the river, and some use the borehole. She points to a nurse's home and tells me that he only drinks the borehole water. Others that live by the market, she says, also only use the borehole. Others that live away from market, she states, use the river.

From what I observed, Afua spends most of her days at home doing domestic work. These include tasks like chopping firewood, cooking, washing clothes, scrubbing pots and pans, and cutting scraps of food for the farm animals. Some days, she walks to the farm about an hour away on the mountain nearby to collect food for the family. The first day I visit, she comes back

with a basket brimming with firewood; kontomire, a green leaf similar to spinach; cocoyam, a root vegetable; cassava; and okra. I see her cut down plantains from the trees in her yard using a machete. Sometimes people walk by and stop to help. And of course, Afua also collects water.

Afua shares the burden of collecting water with her two sons. Her sons usually collect water from the river to fill up the large storage container located inside the kitchen, outside of the compound. The river is so close to her house that schoolchildren will cut through her yard to get to the river. Afua also helps her sons collect water when they are busy, but mostly collects bath water for herself and her husband. Her granddaughter, like most children her age, fetches bath water for herself.

In Afua's mind, all the water in the community is good. If she could, she would use all the water sources in the community, but constraints like distance and her bad back, come into play. Because of this, she uses the river water for everything because the river is so close to her compound. She thinks the river is good because it comes from a rock high above on a mountain that's clean. She also believes the water is good because it flows, pushing all the dirt and debris out of the way.

Out of all the water sources in the community, though, the rainwater is her favorite as it comes directly from God. She collects rainwater every chance she gets. She uses the rainwater for everything except for bathing, as it makes her body "slippery".

Afua does have some understanding that germs can cause disease—she mentions that germs can cause you to get sick and are in the bad water. She doesn't, however, make the connection that the water she uses every day contains germs in it that can make her sick.

Even though Afua believes that the borehole water is a good source, she only collects this water on Thursdays, which is the day that community members are not allowed to go to the river. She likes the water, but it is too far from her house, as it is about a 10-minute walk on an unpaved, rocky road. When collecting firewood, she often stopped to rest. These factors stop her from collecting the borehole water in town.

About two years ago, the borehole by her house broke down. When the borehole was working, she fetched the water every day. Afua said this is because the government had told her the borehole was a good source of water and she should use it; she did not understand the health impact of using the borehole water over the river. Afua also notes that others in the community encouraged her to use the borehole including the chief, the leaders of the community, and nurses. She looks guilty as she says this, as she is afraid to admit this to me. She also believes that the borehole water is treated, and that's what makes the water clean. She states that she collected this water for everything except washing, as her bad back stopped her from collecting it for additional purposes. For washing, she chooses to use the river water. Afua also states that the borehole doesn't really lather with soap, so she prefers the river water for this task. After the borehole broke down, she continued her old patterns of collecting from the river as the other borehole source was too far from her home.

Introduction

Like many others in her community, Afua's perception of the quality of water in her community combines the physical, intellectual, emotional, and spiritual aspects of the water. Physically, she differentiates specific uses of different water sources, such as how the borehole water isn't good for washing since it doesn't lather with soap. Intellectually, she supplies justification for which sources are good and for what reasons. To her, the river is good because it's clean. She knows this because it comes from a rock on the mountains and it flows. The borehole is also good because she was told that it was a good source. Emotionally, she feels a connection to the water. She believes that all of the water in her community is good, even if she doesn't use all of the sources of water equally. Spiritually, she believes the rainwater is a good source because it comes directly from God.

In general, perceptions of water quality differed drastically between the water sources and sometimes between the women themselves. Although each woman had their unique perspective and there was no single overarching perception, some generalities did emerge. The women spoke about the health impacts of drinking "bad" water, aesthetic characteristics of the water, and how each water source is used in a specific context. Because each water source looked different in terms of design, the water from the source looked different, and the water from each source behaved a different way when used; all of this taken together impacted people's perceptions of the water. These ideas will be further explored in this chapter.

To illustrate these differences, I separate this chapter into sections based on each water source. I started with borehole and river water because they are the two most collected water sources in

the study area and each study community had access to both borehole and river water. These sections are combined, as they are so intertwined, it is virtually impossible to speak of one source without the other. The women often made contrasts between the two sources throughout the interview process.

The section on borehole and river water is followed by a section on rainwater, which is the most collected source of water during the rainy season and is collected by every participant interviewed. Perceptions of the rainwater were unique compared to other sources because participants emphasized the spiritual aspect of the water.

This chapter concludes with perceptions regarding well water. Both covered wells and uncovered well perceptions are combined. This is mainly due to the realization that perceptions on the quality of water are strongly tied to the quantity of the water, which is low during the dry season. However, people did have opinions on the quality of these water sources, which I will discuss further in this Chapter.

As in Chapter 3 the analysis section considers the implications of gender on perceptions on quality of water. I have done this to put the women's ideas and perceptions into context and provide a broader picture of how these elements affect behavior and beliefs.

Although the women may have contrasting opinions on their perceptions on the quality of water, their understanding of the different water sources in her community explain why looking at

perceptions on the quality of water is so important—it helps us better understand why people choose to use the water sources they choose.

Results

Perceptions of Borehole and River water

One of the main reasons the participants stated why they continued to drink the river water instead of the borehole water is because their ancestors had used the river. Mercy, a thirty-five-year-old housewife stated about the river water "… our great grandparents were using the river. I prefer using the river for everything. You can see Ayensu Ancient River, and the borehole is new so I prefer the Ayensu for everything." This belief likely has strong ties to the traditional system of governance that places emphasis on the rules handed down by the community's ancestors. As the participant states, the family has been using the river water for generations, and it can be assumed that she has been drinking this water her whole life. She is used to drinking the river water and does not wish to switch to another source. She has strong ties to the water that she has been drinking for a long time. She also calls the river an "ancient river." Many of the women interviewed mention the river being there for a long time, long before people were present, thus legitimizing the river as a good water source. This quote further implies that if their ancestors were healthy using the river water, they also will be healthy.

When the women spoke about the river, one can infer that they generally had a low perceived health risk of the water. When the boreholes were first constructed, the Ghanaian government had told the woman that the river was making them sick and that they should use the borehole water instead. Kessie, a 37-year-old farmer stated, "[Ghana Health Service] said there are germs

in the water, so when you boil it, they die…. You can be sick if you take the water with the germs." Kessie made an accurate statement about germs in the river water and how this leads to sickness. She also accurately stated how to successfully treat water. Despite this, she frequently collected water from the river and believed that boiling water was too cumbersome of a process. Her use of the term "Ghana Health Service said" implies that she does not fully believe them when they say the water could make her sick. Thus, it can be seen that the advice given by Ghana Health Service proved to be ineffective for this woman as she was advised to use the borehole, but chose not to do so.

Other women briefly mentioned "germs" in their interview when asked what bad water was, showing that they had some understanding of the health risk of taking bad water. It is important to note, however, that the word for germs in their local language, Twi, is also the same word for small animals so there may be confusion on what is in the water is harmful. A few women showed understanding as they knew that germs are microscopic. On the water itself, Afua stated, "The bad water has germs in it so you will be sick when you drink it." Despite her understanding that germs could make you sick, she still chose to drink from the river water. Afua also failed to mention germs again in their interview at all, especially when talking about river water or other unimproved water sources. This shows that the women truly do not understand that the "germs" are found in their water supply.

Several participants also stated that they did not get sick from the river water, reinforcing the low perceived health risk the women had of the river. Aba, a 51-year-old housewife stated, "Since we came to the town that is the water we have been using. We don't get sick from this water," thus

demonstrating the health risk of the river water is perceived as being low. Her use of the term "this water" is important, as it implies you may get sick from other water sources, but not from the river in her town. Gloria, a twenty-four-year-old stated, "a person may complain of headache and stomach cramps and that is attributed to the river. It is a common sickness everyone can experience." This quote shows that Gloria believes that illnesses related to the river are minor in nature and were quite common to all people, not just the participants.

Due to the low perceived health risk of the river water, treating this water source was very low. Four women, however, mentioned boiling or warming river water specifically for their children. Warming is typically done for bath water while boiling is saved for drinking. One participant, Adwoa, a 21-year-old cook, mentioned boiling river water for her children but not for herself. When I asked why she didn't boil for herself, she made a disgusted noise and said, "I don't like it. If I drink it, my stomach…." This shows that she perceived the water as tasting differently when the river water was boiled and liked the water much better when it was not boiled. She even had stomach pains when drinking the boiled water, which stopped her from boiling it for herself. She thought it was beneficial for her to children to drink the boiled water because it killed germs in the water, but found the taste of the water more of a concern for herself rather than potentially getting sick.

Some women mentioned "sieving" the water, typically by letting the dirt settle from the water and then pouring the water into a new container. One participant mentioned using a white lace cloth to sieve the water. Faith, a 63-year-old housewife stated, "the dirt is no good, so I have to sieve it," showing that because there was dirt, she perceived a health risk and needed to separate

it from the rest of the water. Once this dirt was separated from the water, the water would be good to use. This aesthetic characteristic of dirt played an important role in health perception, as some women stated that bad water contained dirt in it.

Because the participants did not understand that germs caused diseases, aesthetic characteristics, and not the source of water, became much more important to gauge water quality and thus, perceived health risk. For those that used the river water, they mentioned it as tasting good, being cool, having a "good" color that was "white" (there is not word for clear or colorless in Twi), having no scent, and no dirt. Since the water looked, and smelled appealing, this made it much harder for the women to perceive a health risk.

Other aspects of how the water could be used came up when speaking on quality of the water, such as lathering with soap. Kessie mentioned, "The river lathers with soap when you wash. But the borehole doesn't" and that she needs to use more soap for the borehole water. She did state that she liked the borehole, but couldn't use it for cleaning because of this lathering issue and preferred the river for this. This is most likely a water hardness issue—groundwater tends to be much harder than surface water and thus, does not lather with soap as easily. This physical aspect of the borehole water for lathering poorly compared to that of the river water was another reason why Kessie chose to go to the river.

Women perceived the flowing nature of the river as a positive, as it would free the river of all the dirt and debris that would cause illnesses. Nana, a 35-year-old housewife stated, "[The river's] not really that bad. Animals fall in it and then leaves too. There might be dirt on the leaves and

the water washes it." This is something that people can see with their own eyes. When it rains, one can see debris and trash float into the river, causing the river to become dirty and have a brownish color. Within a few days' time, the river will go back to looking clear. Thus, the women can perceive that if other things fall in the river, this will take time for the water to become clean as it washes the dirt, leaves, and animals away. Since bacteria are invisible to the naked eye, the respondents cannot see that the things in the water that can make them sick are still there and thus, may not see the river as an unhealthy or a "bad" source.

In contrast, for those who used the borehole water, perceived health risk of the river water was high. Five of the fifteen women who use the borehole water spoke of diseases in the river water as the reason they chose to use the borehole. Yaa, a 30-year-old housewife, stated about the river, "What I like is that … no one can step in. No one can spit saliva in [the borehole]." Thus, the borehole was the only viable option as no one could contaminate the water due to its structural barriers that provided cover. Akosua, a 56-year-old housewife stated, "You will be sick when you take bad water. Like the river. You will see blood in your urine when you swim or bathe. And there are other worms like thread which will also go into your body (points to her leg)." This participant is most likely mentioning the symptoms arising from schistosomiasis and guinea worm respectively. It is important to note that the participants do not mention the diseases by name but have a strong understanding of the disease's symptoms and what the vector of the disease is. Although guinea worm is not presently active in Ghana, the public education campaign is still strong and the information to report the disease are still prevalent. These women also understood that schistosomiasis could not be transmitted via drinking, but only through bathing, swimming, or collecting water immersed in the river. For these women, it did not matter

that the river was flowing or had positive aesthetic characteristics; the risks of contracting a disease was too high, and thus the borehole was the better option. These women were successfully able to disentangle aesthetic characteristics of the water from health.

The positive connotations of the borehole as disease free were shown when five participants stated that they thought the borehole was good because the water had been treated. This opinion was most prevalent in Town A and Town B, though one participant in Town C also stated this. Both of these towns' Water Committee members also stated that the borehole had been treated. One participant stated, "when they built the borehole, they put some medicine in it and it makes it clean." None of the participants who expressed this view knew what the borehole had been treated with and none had actually seen the borehole being treated—just the idea of hearing that the borehole had been treated was enough for people to believe that it was a good source. Typically, the borehole is treated with chlorine after construction before the pump is installed.

Another argument could be that people only perceive treated sources as "truly" clean once it hits the ground. It is important to note that those who used the river water did not perceive the borehole water as bad. On the contrary, they often did not have negative views of the borehole water at all. Three participants, including Afua, were unable to differentiate or rank the water sources at all. Faith stated, "it's not that I don't like [the borehole]. It's good water. But I don't use it." This shows that she didn't have a negative perception of the borehole water, she just perceived the river water as a superior option. Esther, a 55-year-old shopkeeper stated when asked the difference between good and bad water: "The [borehole] is good. Rainwater is good. The well is good. River too is good. Every water is created by God, so it's good. But when it's

there and it has dirt in it, it's bad." This quote shows the spiritual aspects of the water. The participant believes that all water is good because it comes from God. Yet, she still uses dirt as an indicator from something "bad" in the water.

One of the reasons why people viewed the borehole water as a viable source of drinking water was because they were told it was a good source of water. The women told me that when the Ghanaian government placed the boreholes, Ghana Health Service told them that it was a good source of water and they should use it. These women were also encouraged by non-governmental organizations, the Chief in the community, other leaders in the community, and nurses. The women did not note Ghana's Community Water and Sanitation Agency but this may be because they did not know the title of this agency. The women in these communities all trust these various stakeholders, as they believe that no one would purposefully put something bad into the community, and thus, believe the stakeholders when they are told that the borehole is good. Thus, people like Afua, before the borehole near her broke down, choose to use the borehole water because someone has told them to and not because of a perceived health risk.

Perceptions of Rainwater

> "The borehole is from the ground. The river is also from God. All is from the ground. So, the rainwater is better. The borehole is a ground water and the river is God's creation that flows on the ground as well so the rain water is much cleaner but does not fall always…. No leaves can fall into the rainwater. But for the river, any leaves can fall in it. The borehole too is also from the ground, so there can be dirt in it."

This quote from Aba, a 51-year-old housewife, demonstrates one of the prevailing perceptions about the rainwater common in participant responses: the rainwater was a good source because it comes from God. Other sources had a potential to be contaminated with dirt, leaves, germs, and other impurities but the rainwater did not. Faith stated, "the rainwater is from God so I know that I will not get any sickness when I drink it," showing that the strong link to religion and spirituality for these women made the women perceive the rainwater as a healthy source to drink from.

Eight women stated this same rationale when asked why they thought the rainwater was a good source—because it was from God, Heaven or "above." Fourteen out of the 26 women interviewed stated that the rainwater was their favorite source of water in the community. Others stated that they thought the rainwater was good because it was not contaminated with dirt, but did not state the religious connotation of coming from God, showing that many others thought the rainwater was much cleaner than other sources. Every single participant interviewed collected rainwater.

Despite viewing the rainwater as the best source in her community, Aba also had a complicated opinion regarding the ultimate cleanliness of the rainwater. She stated, "God created it. But when it falls on the roofing sheet, it washes the dirt off the roofing sheet and makes the rainwater dirty." She understood that there was a potential for the rainwater to be contaminated by external factors, although she still had a hard time choosing which water source she liked best as she felt that all the water in the community could be used for something. It is important to note that

others in the community may have this understanding, though due to small sample size, it is impossible to fully appreciate how widely shared this belief may be.

People preferred rainwater based on how well it performed in a variety of domestic tasks. Similar to river water, people liked the rainwater because it tasted good. Some mentioned that they thought the borehole tasted salty, and thus, the rainwater was a better source of drinking water for them. The rainwater also easily lathers with soap, and participants reported using considerably less soap to do household chores, especially compared to the borehole water, which tends to be harder water.

Almost all the women stated that there was nothing about the rainwater they did not like. Despite this, there were two main complaints about the rainwater that were brought up. The first was that because the rainwater was soft, it made one's body feel slippery after bathing with it. The women often didn't see this as an issue, as they could depend on other water sources for bath water. Another complaint was that worms would grow or dirt would accumulate after a few days of storage. Abena, a 26 year old farmer, stated, "if you keep [rainwater] in your room for long, you will see germs in it. So if I fetch it today, and after four days, and I see that it's becoming dirty, I throw it away and wash the bowl." Others would wait for the dirt to settle before pouring the water into another container and throwing away the water on the bottom of the original container.

Others stated that the rainwater was not as reliable as the other sources. One participant stated, "for the rain, it has a time it flows, so for the borehole it's always there." This explanation was

one of the main reasons others did not choose the rainwater as their first choice as it did not rain all the time and thus, you could not depend on it to always be there. This person chose the borehole as their favorite choice, but others chose the river for the same reason.

Perceptions of Well Water

Well water is available in both Town B and Town D. Four out of 11 participants in these towns use uncovered wells and four use covered wells. All but one participant has negative views of the well water. Three participants stated that the well water (two uncovered, one covered) is their least favorite source of water in the town. There are several reasons why the well water was found to be unpopular.

The main complaint for the uncovered well is that it was not covered, and thus, anything could fall into it. Abena stated, "the well I went to fetch, it's open. They have not covered it so for that, houseflies, leaves, and the other things have fallen into it and with that if you normally drink, it can affect you." This shows that the participant perceived a health risk of using the uncovered well because anything could fall into it.

This perceived health risk was present even when the water had pleasing aesthetic characteristics. When asked what she thought about the uncovered well water, Elizabeth, a 25-year-old schoolteacher stated, "Because it's from the ground, we can't say that it's clean… There are particles in it that you can't see. But as far as the color and the scent, it's fine. And there's no cover, so it's not safe." This shows that Elizabeth understood the health implications of drinking water that was not covered and that there were germs in it that she could not see that could make

her sick. Even though the aesthetic characteristics were good, she still perceived this source as bad because it had no cover and comes from the ground.

Although the covered well had a cover and a pump attached to it like the borehole and is considered an improved source, perceptions of this source were also negative. Dolores, a 44-year-old housewife stated, "[The covered well] is not clear, like how the [borehole] is. We don't see any dirt in the [borehole]." Dolores looked at the aesthetic characteristics of the water to make her judgements on what health impacts the water might have.

It is important to note that perceptions on well water largely focused on quantity and not quality. As mentioned previously in Chapter 3, major complaints about the well water focus on how there is not enough of it, especially in the dry season.

A summary of the above findings are shown on Table 4.

Table 4: Responses to Perceptions on the Quality of Water

Water Source	Views of Water	Perceived Health Risk	Relative Ease of Use
River Water	Positive	• Ancestors had used the river and did not get sick • Pleasing aesthetics • Flows and moves dirt/animals/debris away	• Lathers well with soap
	Negative	• Diseases in water	
Borehole Water	Positive	• Disease free • Treated/medicine in it • Pleasing aesthetics	
	Negative	Doesn't taste as good as river/tastes salty	• Doesn't lather well with soap
Rainwater	Positive	• From God • No dirt • Tastes good • Disease free/won't get sick from it	• Lathers well with soap
	Negative	• Will get dirt on roofing sheet • Worms will grow in it or dirt will settle after a few days	• Makes body slippery when bathing
Well Water	Positive		
	Negative	• Negative aesthetics • Anything can fall in (uncovered)	

Water Quality Test Results

A total of 17 water quality presence/absence Colilert tests were conducted to see if perceptions of water quality matched objective water quality. The results are summarized in Table 5.

Table 5: Water Quality Testing Results

Source	Number Tested	Presence/Absence of Total Coliform	Presence/Absence of Fecal Coliform
Borehole	6	Absent	Absent
River/Stream	6	Present	Present
Covered Well	3	Present	Present
Uncovered Well	2	Present	Present

All borehole water was found to contain <1 most probable number (MPN)/100 mL of both total coliform and fecal coliform, meaning this water source has no risk for being hazardous to human health. All rivers, covered wells, and uncovered wells were found to be positive for both total coliform and fecal coliform, which means they may be hazardous to human health.

(These results more closely align with the United Nations definition of improved versus unimproved water sources, with the notable exception of the covered wells, which are considered an improved source but all had fecal contamination in them. This is due in part to the United Nations definition focusing on the design and construction of the source and whether or not the design can separate fecal contamination from entering the water. Due to the design of the borehole and the covered well, this would be considered an improved water source while the river and uncovered well would be considered unimproved. Since the women view aesthetic characteristics as an indicator for perceived health risks, in general, they would consider both the river and the borehole to be “good” sources of water while the covered and uncovered well are “bad” sources of water.) Perhaps remove.

Analysis

Perceptions of water quality for participants in this study largely focused on aesthetic characteristics of the water. In general, perceived health risk of river water was low due to positive aesthetic characteristics of the water source, such as it looking clear, tasting good, and having no scent. Utilization of the river water for washing was also seen as superior in contrast to the borehole water. Some who used the borehole water did perceive a health risk of the river water, but this was only one-third of the women who used this as a water source, while others chose to use it due to closeness of the source, because they perceived it as being "treated" and therefore clean, and because they were told it was a good source to use. This reasoning explains why people don't use the borehole water, as the river water is seen as a comparable option.

Women's perceptions on the quality of water, however, is not as simple as stating that there is a low perceived health risk of the river water. The reasons for the low perceived health risk, as previously mentioned, combine intellectual, emotional, physical, and spiritual aspects of the water. The women intellectually believe the water is good because it is a flowing source of water that appears clean. Emotionally, some of the women believe the river to be a living entity, with the power to let negative things happen to you. They are also tied to their ancestors, and the traditional system of governance, who also drank the river water. As Esther stated, without water, they "grieve." Physically, the river is easier to use than the borehole water for lathering and also tastes better. And spiritually, it is a good source of water because all water comes from God, and thus, the river has to be a good source too. All these reasons don't necessarily negate the benefits of the borehole water, but amplify why the river water is a comparable, if not better, source.

A similar study in Sri Lanka found that aesthetic characteristics had a significant role in perceived health risk (Nauges and Van Den Berg, 2009). Francis et al. (2015 also found that people in Indian communities perceived treated water as clean, good for drinking, and safer for children. This is similar to those that saw the borehole water as a clean source of water because it was "treated." Thus, this idea may persist in these communities because treated water is seen as a positive. Kosinski et al. (2016) and Kulinkina et al. (2016) also found that how the water source was utilized played an important role in what water sources people used. Kosinski et al. (2016) similarly found that participants stated that they used the river because their ancestors had as one of the main reasons participants continued to use the river water.

Overall, definitions of good and bad water did not agree with the definitions of improved and unimproved water sources used by the Joint Monitoring Programme. (Joint Monitoring Programme, n.d.). WHO guidelines state that the goal for "minimal health risk" in drinking water is 0 MPN/ 100 mL (WHO, 2006). However, the WHO acknowledges that achieving this concentration may not be realistic in low-income countries, like Ghana, and thus, the target standard concentration recommended is less than 10 MPN/100 mL. .

One study in Uganda found that boreholes were the most microbiologically safe with a median concentration of 0 thermotolerant coliform (TTC)/100 mL while rivers were the least microbiologically safe with a median concentration of 1200 TTC/100 mL. Covered wells had a median concentration of 235 TTC/100 mL and uncovered wells had a median concentration of 1070 TTC/100 mL (Parker et al., 2010). Another study conducted in Sierra Leone calibrated these findings, as only 1 out of 13 boreholes, or 8%, had concentrations higher than 10

MPN/100 mL and 3 out of 31 covered wells, or 10%, had concentrations higher than 10 MPN/100 mL whereas 92% of covered wells had concentrations above the standard (Magrath, 2006). These findings suggest that the boreholes were the most microbiologically safe while the uncovered wells and the river water posed a greater threat to human health. The covered wells concentrations were in general lower than the uncovered well concentrations.

Generally speaking, the women defined the river water as a good source, despite being categorized as an unimproved water source. Their definition of the river water as a "good" source also did not match up with water testing. This is tied the women's subjective understandings of "good" water as having positive aesthetic characteristics rather than objective measures such as water quality testing. The borehole water was the only water source that measured at 0 MPN/100 ml, showing objectively to pose minimal health risk. The covered wells were perceived as a bad source of water, and was shown to have fecal contamination in the source. Due to the nature of the test, one cannot assess the magnitude of the harm to human health merely that one may exist. However, based on the findings of the aforementioned studies, covered well water quality was of much better quality compared to water from uncovered wells. This suggests that the women's definition of the covered well water as "bad" did not match water quality testing results. Subjective measures can be beneficial when water exhibits aesthetic problems but objective characterization id useful when no such aesthetic issues are present. Needs further thought.

Participants perceived uncovered wells as a bad source due to it not being covered, even though both the river and the uncovered well are uncovered. This may be because the well water is a stagnant source, and the river's flowing nature is seen as a positive. Thus, the well water would not push away all of the leaves and insects in it like the river would. Covered wells were seen as bad due to aesthetic characteristics such as color.

The participants also held beliefs that water was from God and especially rainwater was good because it comes directly from God. This shows strong ties to spirituality and a higher power who would protect them from diseases. Thus, it can be seen that spirituality is an important aspect of these women's lives. A study conducted in the Akwo Ibom state in Nigeria also had similar findings (Akpabio, 2011). Participants in the study had strong spiritual ties to the water, believing it to be a free gift from God, and were more likely to have these views if they lacked formal education. Traditional institutions, such as the chiefs, elders, and others were also more likely to hold this view.

Although rainwater is typically considered an improved water source, it must be collected properly in order for this definition to hold true. Thus, concerns about worms in the water after a few days may be due to improper collection and storage. During my observations, I observed that women would not cover their water sources despite access to a cover. This may be how worms get into the water supply although the women may not make this connection since they continue to leave their water sources uncovered.

As with issues around collection, gender matters here. The context in which we understand gender in terms of perceptions of water may not be as evident, but is still key in understanding what is reported by respondents. Previous studies in other resource poor countries have also

shown that education levels are tied to perceived health risk (Nauges and Van Den Berg, 2009; Francis et al., 2015; Onjala et al., 2014). This thesis cannot fully study the impact that educational levels had on perceived health risk as educational data were not obtained from participants. Census data, however, provides information on educational levels in the Region and attributing these levels may help to understand the low perceived health risk of the river water as reported by study participants.

Using literacy as a proxy, one can better understand educational levels of the women in these populations. In total, 21.2% of residents in the Eastern Region in all localities are illiterate in both English and a Ghanaian language (GSS, 2013a). However, when you separate this by gender, a much different picture emerges. Male residents who lived in rural settings had an illiteracy rate of 19.2% while female residents had an illiteracy rate of 34.0%, nearly twice as high as their male counterparts. 55% percent of males in a rural context are literate in an English and Ghanaian language as opposed to only 38% of women. Education levels were also found to be nearly twice as high in men as compared to women in all localities, with negligible differences for those that attended primary school. This may be why the participants interviewed did not perceive a health risk of the river water—because they never learned about germ theory formally.

Formal education may also affect women's understanding of specific diseases. Only one of the five participants who spoke about diseases in the river named the diseases by name. Despite this, some women were able to describe disease symptoms and transmission in detail. The women spoke about bloody urination as a symptom of schistosomiasis, and understand that this is contracted not through ingestion, but through swimming or bathing in the river. They also spoke about guinea worm coming from a parasite that can burst through the body, particularly the leg,

as well as general diseases related to the river such as stomach cramps. This shows that even though, in general, women are not as educated as their male counterparts, they can still have a foundational understanding of the diseases prevalent in their community. The women also had a good recall of things they had learned from governmental hospitals, which for some women encouraged them to use the borehole water. For others, they did not fully agree with their statements on the implication of their health on drinking and using river water. As previously mentioned, this may be becomes the women rationalize that their ancestors used the river water and did not get sick, so they too would not get sick. It is important to take what these women have to say seriously. Their understandings and perceptions of the water sources in their community are complex. As women are the main collectors of water in their community, and as the ones who pass this knowledge down on to their children, particularly their daughters, their voices need to be amplified so that the public health of their communities may be improved.

Chapter 5: Theme 3—Dynamic Interactions between Perceptions of Quality and Access to Water

Case study

Mawusi is a 32-year-old farmer, who was born in a country near Ghana. She and her husband moved to Ghana to find work. They rent a plot of land in a neighboring town about an hour's walk away from her home. Mawusi usually goes to the farm three to five days a week to assist her husband in collecting crops. Her best friend, a woman who lives a few houses down from her, also helps on the rented plot. While they work, they talk about a number of things such as the latest TV show, news in the town, and recipes. She always carries her infant child on her back, even when collecting crops and fetching water. Mawusi and her husband also have a three-year-old daughter, who stays with a neighbor when they are at the farm late.

During the rainy season, Mawusi used the borehole water exclusively.
When speaking of good water, Mawusi stated, "It's the taste and the color being white is what you have to consider. But if you're using it for washing, it doesn't matter. And if you're using it for cooking, you can't use any other water." This shows that the different aesthetic characteristics were helping her determine whether the water source was good or not. However, based on the aesthetics, she was able to differentiate the different water by use. In her mind, cooking needed to be reserved for good water while for washing, it didn't matter if the water was good or bad.

When I returned in January 2017, the Assemblyman decided to start collecting fees for this water source. Mawusi doesn't trust this at all—she recalls a time period of two years ago when the Assemblyman collected fees. When the borehole broke down, there was no money to fix it and it

remained broken for nearly a year and a half. Mawusi expressed her frustration by rhetorically asking, “Where did that money go?” When the borehole broke down again, since they were not collecting fees, it also stayed broken for a long time. This is why the Assemblyman decided to start collecting fees again. Not only does Mawusi dislike that fees are being collected again, she thinks the water is too expensive. It costs too much to fill up the barrel in her home. She’d rather pay a flat fee when the borehole breaks, she states, than pay per bucket. Now that the borehole is too expensive, Mawusi started to use well water from her friend’s private uncovered well, a source she typically only used during the dry season when the lines at the borehole were too long and she did not want to wait. She reserves the borehole for drinking and cooking, as she believes this water to be much cleaner than the well water. She only uses the well water for cooking when her friend puts “medicine” in the water, a white pill that Mawusi does not know the name of, but she states that it makes the water look clear and free of dirt. I observe Mawusi placing water from the two different sources in different buckets; she keeps the borehole water in her room, while she leaves the well water on the porch. I observe her using the well water to bathe her children and cook food with when the “medicine” was placed in the well.

Mawusi has some knowledge of germ theory. When I ask her what bad water is, she states that its water that needs to be boiled to kill the bad germs in it. She cannot tell me what water sources contain the germs, however, as the germs are so small you cannot see them. She does note that she boils the borehole water for her 3-year-old daughter to drink and also warms water for her two children when they bathe or they will start to cry.

Since Mawusi prefers to drink borehole water in her community, saying she finds it to be safer, I would have expected her to use borehole water at her farm. However, this was not the case. In fact, Mawusi continuously walks past a working borehole to collect water from a river located five minutes from the borehole. Mawusi and her friend typically collect water from the river over the borehole. They use this water for drinking and cooking on the farm. They only collect from the borehole when they are feeling too "lazy" to walk to the river. I ask if they perceive the water as good. Her friend states, "It's been here for a long time and we don't get sick from it." Mawusi adds that the river tastes better than the borehole and that the borehole water tasted salty. The borehole water in her home community tastes fine she states, it's just the borehole water in the town by her farm is that bad.

Introduction

Mawusi's story shows the dynamic interactions between her perception of water quality as well as collection and access to these sources. Due to the collection of fees, the borehole water has become inaccessible to her so she chooses to collect from her friend's private well. However, she still chooses to collect water from the borehole even though the water is expensive. This is because she perceives the quality of this water as much higher than that of the well. Thus, she differentiates use based on her perceptions of the water quality and her access to it

This story is no different than others in the community. Not all the women I interviewed found accessible water in their community that they perceived as good quality. This explains why people collect water from various sources and differentiate use for various tasks. Six participants collect from both borehole and river water, four collect from both the borehole and unimproved well, and three collect from the borehole and improved well.

In Chapter 3, I discussed the different barriers to accessibility. Distance is the main driver for accessibility. However, how water is collected plays a role in its accessibility. Rainwater is easy to collect, but is not accessible at all times throughout the year. River water is a reliable source and it is fast and easy to collect. Borehole access is impeded by fees, locking, long lines, and the physical act of pumping the water. Covered well water has similar access barriers to borehole water as well as the additional barrier of lack of reliability during dry season. Finally, uncovered well water is fast and easy to collect, but is unreliable in the dry season. In Chapter 4, I discussed how perceptions of water quality play a role in water collection. Perceived health risk, aesthetic characteristics, and utilization of the water source all played a role in how people perceived the quality of the water.

I separated this chapter into four case scenarios: 1) water quality perception is good and there is high accessibility, 2) water quality perception is good but there is low accessibility, 3) water quality perception is poor and there is high accessibility and 4) water quality perception is poor and there is low accessibility. These scenarios inform us what water sources people choose to use and for what purposes. As with the chapter on water quality perceptions, each women's opinions on these different scenarios differed, but general trends emerged. I will describe in general how people use the water, and then lay out specific examples of how people use this based on different water sources. These chapters will also speak specifically to borehole collection as this thesis is looking to address why people are choosing not to use the boreholes.

Results

Table 6 illustrates the different case scenarios of water quality perception and accessibility of different water sources, as well as how people use these water sources.

Table 6: Water Source Utilization as Related to Water Quality Perceptions and Accessibility of the Source

Perception	Accessibility	Utilization of Water Source
Good	High	Ideal situation; use one water source for everything
Good	Low	Save for specific tasks that the water is "good at"
Bad	High	Only use for one or two tasks, if used at all
Bad	Low	Worst case; usually not used at all

Good Water Quality Perception and High Accessibility

The ideal scenario for water selection for these women is that accessibility to a water source matches perceived quality of the water. People who use these ideal water sources typically only collect from these water sources and use this water source for every domestic task. Typically, these water sources are located very closely to participant homes.

For five participants, this water source was the borehole. In this scenario, for those who have a low health perception of the river water, distance is a much larger factor in the collection of the borehole water. Typically, these people live much closer to the borehole than to other sources. They do not mind having to wait in line or pumping the source because either the distance is so close, they can have someone save their spot for them, or they can come back at another time when it is less crowded. For those with a high-risk perception of the river water, the fact that they have to pump the borehole or wait on line is not a deterrent as they are grateful to have a safe water source close to their home.

For nine participants, the river is the preferred source. As previously noted, this water source is fast and easy to collect and does not require waiting in a queue to collect. These participants have a low perceived health risk of the river water and attribute its good quality to aesthetic characteristics. This describes Afua from Chapter 4's situation perfectly; she perceived the river water as a good source and it was so close to her home, she did not need to get water from anywhere else.

Good Water Quality and Low Accessibility

Based on what other water sources are available, there are two scenarios that can play out in this situation.

The first is that nearby water sources are more accessible but have lower perceived water quality. If this is the case, participants will use this water source since the other water source has a greater perceived health risk. However, the women will differentiate the water sources based on tasks. This is because the women must manage their time spent collecting water, as this is not their only domestic task for the day and water that is less accessible cannot be collected as frequently. Thus, the women will save the better perceived water for cooking and drinking.

This first scenario can also play out when boreholes are locked or participants do not have the disposable income to pay for the borehole at all times. Since the borehole water is less accessible, they will use other water sources nearby that are free since women need water to perform their daily domestic tasks. They will do this even if they perceive the other water sources as "bad."

The second scenario is that other sources nearby have similar perceived high water quality but are easier to access. In this scenario, it's not worth collecting the water source with low access. For instance, many perceived the borehole as a good source because they were told it was, but also perceived the river as a good source. Thus, they never went to the borehole because it was too far away.

A key example of this scenario is rainwater. Rainwater is extremely easy to collect and many people perceive this as one of the best water sources in the community due to its close ties with God or Heaven. Since it doesn't rain every day, rainwater is seen as a "treat," something that should be saved and used carefully for special purposes. Women mentioned saving the rainwater for drinking, as this water source tasted the best, or for washing, as it lathered with soap the best.

Poor Water Quality and High Accessibility

Despite the fact that this water source has a high-perceived health risk due to its low quality or it cannot be utilized as well as other sources, women will still collect from these sources because it's highly accessible. Since the women have many tasks to do outside of water collection, they must take into consideration the amount of time it takes to collect the water from the source and how they want to use the water. Women will collect from a low-quality but highly accessible source if they are in a rush or if they have many tasks do that day. They will typically not use the water for drinking, however.

For example, Adwoa, a 21 year old cook finds borehole water highly accessible as her shop is right next to the borehole. However, she perceives this water source negatively, as it hurts her stomach when she drinks it. Thus, she only uses this water source for washing pots and pans.

This scenario is also true of well water for many women. Well water is typically used for any task except cooking and drinking because there's dirt in the water, and thus, the water is of bad perceived quality.

Poor Water Quality and Low Accessibility

This case scenario leads to the least use of a given water source. Women will not typically collect poorly perceived water that is not accessible because it is not worth the time and resources. In this scenario, the accessibility concerns are usually more important than the perception concerns given that women will collect water they perceive as low quality if it is geographically close to their homes.

There is, however, one scenario in which this water is collected. I have seen people collecting water from wells, even though the water sources were not reliable or convenient to collect, when the well was close to their homes. Women mentioned waiting for the well water to regenerate before collecting water. They would then use this water for specific tasks that did not involve ingestion.

Analysis

In the dynamic relationships between perceptions of water quality and access to sources, it is apparent that women decide on different water sources for different purposes. Decisions involve balancing factors such as collection time, labor, availability, and water quality perception.

Overall, accessibility, especially distance to the source, is much more important than water quality. Consistently, women collect from the sources that are closest to them regardless of water quality because they must balance their other daily tasks with water collection. It does not matter

how poor the water quality is, the women will typically find a use for it. This explains why so many women complained about the well water—four out of 11 participants who used well water listed this as their least favorite source in the community—yet still used it. This is mainly because the concern of not having enough water for daily tasks is so high. Thus, women must use all the water sources around them. Francis et al. (2015) also found that distance played a large role in use of water distribution centers in India, as compliant families lived closer to the distribution center compared to non-compliant families. Similarly, Kosinski et al. (2016) also found that those who lived closer to boreholes were more likely to use them, while those who lived equidistant from a borehole and a river chose to use the river water.

Expectations of balancing paid and unpaid work also affect water source decisions. Women carry a disproportionate share of unpaid labor in their communities (Food and Agriculture Organization of the UN, 2010; Sepulveda, M., 2013). However, a 2005 study found that unpaid labor only accounts for 23% of Ghanaian women's work (Chen & UNDFW, 2005). This is because many women typically help out on their family farms or have small business enterprises (Food and Agriculture Organization of the UN, 2010, GSS, 2014d). Women were more likely to be employed if they were married, and employment increased the more living children a woman has (GSS, 2014d).

Thus, women must carry a "double burden" of paid and unpaid labor (Food and Agriculture Organization of the UN, 2010). Comparatively, water collection is a small part of women's many daily tasks, especially since many tasks require several buckets of water, requiring women to walk back and forth carrying heavy buckets of water. As the primary people responsible for

collecting water in their communities, women have to navigate spaces where the closest and most convenient water source to them might not be the best quality. Despite this, they may feel as they have no choice but to use this water as they cannot spend too much of their time and energy on water collection. .

Given this dynamic, it is understandable why women decide to collect water from many different water sources, even ones they consider "bad." Through differentiation of tasks based on "good" and "bad" water, women feel as if they are protecting their and their children's health by only ingesting the "good" water. By saving their time and energy during water collection, they can focus on paid labor that can best support their families via farming or small business enterprises.

Chapter 6: Conclusion and Recommendations

Case Study

Magya's huge compound is overflowing with women—her mother, her grandmother, so many sisters I lose count, nieces, cousins, and friends. Everywhere you turn, there is a woman performing a task: they make brooms from palm leaves to sell; cook porridge, stew, and other traditional Ghanaian meals; pound fufu; make palm oil; wash laundry; cut scraps for the farm animals; bathe their children. Women sit under the tree outside of the compound talking and laughing as they wait in line to collect water from the borehole located only a few feet away, their laughter as ubiquitous as the red dirt beneath their feet. Magya's home is full of women and I am instantly enthralled.

Inside the compound, I hear the heavy creak of the borehole, located a couple hundred feet from Magya's room. Laundry hangs everywhere to dry—the kids get themselves too dirty to not do laundry every day, one of Magya's sisters tells me. Outside, the children are playing. They find an old tire and push themselves around in it. When there is no one at the borehole, they sometimes try to play with it, but Magya shoos them away. Once, Magya falls asleep under the tree, and her 2-year-old daughter places a small cup under the spigot, stretches her hand up high so that it just reaches the handle, and wiggles her fingers *just* enough to get the tiniest bit of water to come out. When Magya wakes up, and sees her daughter holding the cup, she laughs while admonishing her. Perhaps this is a behavior her daughter learned sitting with her mother under the tree by the borehole and watching women crank the handle of the borehole so that water can come out.

The borehole is so close and accessible to Magya and her family, there is no reason why they would collect water from another source. Magya recalls a time when she was younger and there was no borehole there. “First when there wasn’t any [borehole] here, there is a river down there and you have to walk a long distance before getting it,” she states. The distance to the river is approximately a 30-minute walk from her home, a far cry from the several feet that the borehole is from her house. The borehole is so reliable for her, she barely collects rainwater during the rainy season, but likes that the rainwater lathers better with soap than the borehole water.

She and her family also have a high perception of the borehole water. Her sister lives in a city nearby and tells me the borehole in the town is much better quality than the piped water she gets in the city. “When you put the borehole water down and let it settle, you don’t see any dirt,” she says. “But for the piped water, if you let it settle, you will see dirt.” Here, dirt is an indicator of something harmful in the water.

Magya plays a key role in water management in her community. Ever since her elder sister left the community two years ago, she has been tasked with collecting money from people who are fetching water from the borehole outside of her home. This requires Magya to sit in front of the borehole all day to ensure that people are paying their fees. There are so many people at the borehole, I don’t know how she keeps all the people straight and remembers who pays and who hasn’t, but yet, she always knows when to ask for payment from someone who isn’t complying with the rules. She also sweeps and scrubs the borehole once a week late at night after everyone is done collecting water. At the end of the month, she gives the money she collected to a member

of the water committee. She doesn't know what the money is for and doesn't want to disturb the men by asking. She notes that when the borehole breaks, they do use this money to fix it and usually the borehole is fixed within two days. She compares this to an earlier time when they did not collect money and it took a long time to repair the borehole, whereas now, the borehole usually gets fixed right away. Magya is good at her job too; she notes that if she does not collect the money, the men will take her job away. She keeps the money stored in a container in her room and sits under the tree a few feet from the borehole collecting money from everyone. When she is inside cooking, she sometimes pokes her head out to make sure people have paid. This job also comes with another benefit—she and her family do not pay for the water from the borehole as opposed to the other members of her community.

Magya also gets paid one-third of the money she collects. Magya doesn't think it's that much money, especially during the rainy season when people aren't using the borehole as much as a result of collecting rainwater. She notes that men would never do this task, as they would never make enough money to support their family. Still, she is happy to bring in some supplemental income for her family in order to provide more food for her children. She supplements this income by going to farm once or twice a week and has her sister or mother oversee the borehole while she is gone.

Magya has some power and agency in water management in her community, but overall she still has little say in how her community manages the water. When I visit the community in January, I heard the women in her compound talk of a new borehole that was built a short time beforehand. They were not sure where it was located, but noted it is on the other side of the town. I decided

to locate the borehole and I was told that it's at the end of the road in a large compound where the Assemblyman lives. This borehole was built just a month prior to my visit. The Assemblyman keeps it locked so that children do not play with it and break it but does say he allows others to fetch water from it for free.

When I tell Magya about the new borehole, she is unhappy. "If it's really for the community, it'd be in the town," she states, implying that she thinks the new borehole was placed in the Assemblyman's compound for ulterior reasons. She believes that the Assemblyman did not do a good job placing the borehole in his compound because people who lived in the town needed the extra borehole. She notes that some people will go to the river instead of waiting in the queue for the borehole because they don't want to wait for a long time. She didn't even know the new borehole was being built. A few weeks beforehand, the children of the Assemblyman came to the queue to tell people to go use the borehole instead of waiting on the long line. As a woman who both collects water for her family and manages the payment of water, Magya had no say in where and when new boreholes were built and actually heard about the new borehole from third party sources. It seems as if the power lies with the Assemblyman and is information is infrequently shared or provided transparently to other members of the community.

Conclusions and Recommendations

Magya's story informs us about how power, and water use, management, and access are all deeply gendered. Her social world involves the navigation of gender defined spaces and interactions which create rich and vibrant intimacies around work and water collection. We learn that women dominate water collection and water use in these communities. As I observed Magya, I witnessed countless women doing a myriad of tasks day in and day out. Through

observation, her child learned how to collect water and was able to do so while her mother slept. Magya also collects water that she judges to be the most accessible and the best quality. For her, this is the borehole. She doesn't think it's worth it to walk to the river since it is so far away. Since Magya manages her borehole, she gets extra privileges that make the borehole even more accessible and attractive to her—she doesn't have to pay or wait in line. Despite her responsibilities at the borehole, she still has no say in her community on where and when water resources are placed. If she were able to choose a location, the new borehole would not have been at the Assemblyman's house. As she stated, it would be in the town where it's accessible for those who truly need it the most.

It is evident that Magya displays concern for her fellow women in the community because she understands that they don't want to wait in the queue and often choose to go to the river instead. Most importantly, Magya understands the daily struggles and complexities of water collection which are influenced by perceptions of both water quality and access.

By observing and interviewing women in four communities of the Eastern Region, Ghana, this thesis addresses reasons why people choose to continue to use unimproved water sources in the presence of acceptable improved water sources. Furthermore, this thesis describes the social and political dynamics that are at play with water collection in these communities. Previously, these relationships have not been prominently addressed in the literature for this region or elsewhere. It is important to note that a few women did complain about aesthetic characteristics of the boreholes such as salty taste and minor health complaints such as stomach cramps, but they were not nearly as common as positive or neutral perceptions of the borehole water.

I found that traditional ideas and the accompanying forms of governance are still pervasive in the Eastern region. Women described rules which forbid the fetching of water on certain days because of a norm dictated by the Chief, negative outcomes when one used the river on this day, and beliefs which held that since their ancestors had used the river, it was fine for them to use the river as well. These traditional ideas have strong ties to the use of river water, as these social norms and beliefs do not exist to the same degree for the improved water sources, such water obtained from boreholes.

Another factor that influenced use of river water was its low perceived health risk. Aesthetic characteristics of water sources were tied to subjective measures of perceived health risk. Since river water had similar aesthetic characteristics to the borehole water, but also had the added benefit of tasting better and lathering better, river water was seen as a comparable or superior option. These low perceived health risks were likely due to low education levels, as most participants did not understand that use of river water would increase risk of contracting water-borne diseases. Thus, the implementation of educational programs that provide information on water quality and the link to infectious diseases should be implemented in these communities. These programs should be led by women, as women are the ones primarily responsible for collecting water, and already spend time talking about the quality of various water sources in their community. It is encouraging to note that 43% of women on WATSAN committees in Ghana already lead hygiene education programs (ATPSN, 2007). Thus, it seems plausible that the women could also teach about water quality and infectious diseases. One study found that households were more likely to practice proper hygiene, such as handwashing before eating and after defecation, when women reported the practice (Cairncross et al., 2005). Previous research

in India found that by informing households that they were drinking "dirty" water, they were 11 percentage points more likely to treat or safely store the water than those who had not been informed that they had "dirty" water (Jalan and Somanthan, 2008). However, this result was found after eight weeks after the initial information was given, and thus, does not necessarily indicate long term behavior changes.

The most important factor it seemed for river use, however, was access to and collection of water. Since women in these communities have to balance many daily tasks inside and outside of the home and need to use water for many of these tasks, the best water source for them is one that is convenient, reliable, and accessible. As improved sources, such as boreholes, require pumping, which is strenuous and tiring, and waiting in line, especially during the dry season, unimproved sources are perceived as faster and easier to use. Requiring payment and the locking of boreholes at certain hours present additional challenges to access this source. Thus, despite a recent study that showed a large number of Eastern Region communities had achieved "basic access" to improved water sources, the women interacted with in this thesis often did not avail themselves of these improved sources of water (Kulinkina et al., 2017). In order to combat issues around collection of the borehole, improved water sources would benefit from mechanization via solar power or electricity when economically and logistically possible.

Due to the women's need of balancing their time, energy, and resources regarding water collection, women tend to choose water sources that are the closest to them as their main water source, regardless of their perceived water quality. Water that is perceived as having poor quality, yet is conveniently located for the women to collect, is usually used for domestic tasks.

Women will often choose to use water of better quality more sparingly as it is harder to access. Thus, they begin to choose their water sources carefully and they frequently differentiate the water sources based upon task. This is similar to findings in Asamama, Ghana in which 53.8% of households reported the regular use of both river and borehole water (Kosinski et al., 2016).

Women in this thesis stated that they believed the borehole water was a good source of water, but chose not to use it. Many of these issues arise because women are not in charge of decision-making processes that involve the selection of the location of water infrastructure or in planning these projects. Since women are the ones that bear the primary responsibility of collecting water, they have the most intimate knowledge of how these water sources work and where they should be located to improve access for the community. Furthermore, they have more at stake if an improved water source is not properly maintained and operated, as this affects their daily lives, causing them to have to walk further to collect water (Anokye & Gupta, 2011; Mjoli, 1998). Strategies that attend to downstream challenges of water collection could be better solved with more proactive participatory processes and dialogues that allow women to play a much larger role in water resource management. Increasing the role women have in WATSAN committees could increase access to boreholes and create more affordable pricing, reducing many of the challenges around water collection.

Research, however, has described that cultural barriers which discourage women being appointed to WATSAN committees (Boateng et al., 2013; Opare et al., 2005). One study found that balancing household chores and paid labor was challenging, women were fearful and concerned about being mocked by others, and receiving criticism from other women were all

reasons why women chose not to fully participate in WATSAN committees (Boateng et al., 2013a). Another study found that a prevailing cultural belief is that men are natural leaders and that women are handicapped by low levels of education which often conspire to negatively affect women's self-image. A central reason for this is that reading and writing is essential to discharging the responsibilities of key positions such as chairperson and secretary which often entail the reading of minutes, and the creation of agendas (Opare. 2005). This study also found that the burden of performing both unpaid and paid labor kept the women too busy to participate in WATSAN Committee activities.

In order to address these challenges, women should be encouraged to prolong their education in order to increase literacy rates. This would allow the women to have greater comfort in the roles of the WATSAN committee. Such attainment would also allow these women to gain more confidence in themselves and their ability to handle these jobs. One study found that women who had a secondary education were 13 times more likely to participate in decision-making and planning, eight times more likely to participate in project construction, and three times more likely to participate in monitoring and evaluation (Boateng et al., 2013b).

Suggestions have also been to increase women's confidence in their leadership abilities (Opare, 2005). One method was to enable women to achieve increased economic power through the use of microfinancing. Lacking such a resource, women are often financially dependent on men, which is another form of subjugation. By promoting the financial independence of women they would gain increased ability to make decisions independent of men. The author of the study also

recommended the strategic selection of capable women leaders to participate in development programs focused on improving their leadership abilities.

The use of horizontal interventions, such as giving women a right in making decisions around water use management, are more long-term but tend to have a lasting impact as compared to vertical interventions, which only address short term solutions (El-Sayed & Galea, 2017). Engineering strategies and approaches also align with this method of thinking.

Strengths and Limitations of Study

From this thesis, one can see the benefits of conducting qualitative research. By conducting a qualitative study, one can better visualize the challenges presented by the use, access, collection, and perception of improved water sources. Thus, these difficulties can be directly addressed in order to increase improved water source use.

A principal strength of this thesis was found in the combined use of both in-depth interviews and field observations. This mixed methods approach was beneficial in that it captured detailed participant answers in their own words coupled with comprehensive information about the participant's daily behaviors obtained through direct observation. These observations also provided context for participant responses elicited during the interview process. In general, the participant answers as obtained through the surveys were closely matched by observed behaviors. Another strength of the research protocol was that data were obtained in both the wet and dry seasons. The importance of this is found in the reality that behavior may markedly change in communities subjected to either abundance or shortages of water.

This study also had its limitations. It only looked at perceptions of 26 women and 4 Key Informants in four communities in the Eastern Region. It is possible that participants may have changed their behavior during the observation period to better match what they thought I wanted to observe. Furthermore, behaviors observed from the four women may have been atypical to others in the community. The limited sample size, short observation period, and convenience sampling limits the generalizability of the findings. It should be noted that generalizability is not a primary objective of the grounded theory methodology of qualitative research. The goal of this type of research is to deduce emergent themes common across the group of respondents. A set of such themes were successfully identified and it can be inferred that saturation was reached. Thus, we were able to draw a set of conclusions from the information extracted during the conducting of the thesis.

Issues with generalizability arose during the observation period of four women, which lasted for one to four days. This was beneficial in providing context and adding detail and nuance to water collection in these households. It was also concluded that participant answers as obtained through the survey portion of the research very closely matched their observed behaviors. However, the observation period was short, and thus, participants may have changed their behavior during the observation period to better match what they thought I wanted to observe. Furthermore, behaviors observed from the four women may have been atypical to others in the community. Thus, it is recommended that longer observation periods are employed to better understand water collection and use in the Eastern Region.

The UN Economic and Social Consul (2003) states that, “the human right to water entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses.” No one should be using contaminated water for drinking and domestic purposes, especially when non-contaminated drinking water exists in their communities. By amplifying the voices of these women and allowing them to play a more active role in their own daily lives, women can make informed decisions about their own health and better assess this basic human right.

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