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Jacqueline Chan Date

"Assessing the Relationship Between Water-fetching Distance and Equitable Access to and Use of Improved Water Sources in Rural Ethiopia"

By

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Master of Public Health

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"Assessing the Relationship Between Water-fetching Distance and Equitable Access to and Use of Improved Water Sources in Rural Ethiopia"

By

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B.S. Microbiology, California Polytechnic State University, San Luis Obispo, 2009

Faculty Thesis Advisors: Matthew Freeman, MPH, PhD

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I would like to express my deepest love and gratitude to my family and close friends for their love and support during the completion of my degree.

ABSTRACT

Lack of access to safe drinking water is experienced most by those living in poverty, making them vulnerable targets to water-related adverse health effects. This study aimed to increase understanding of the barriers and mediators to safe drinking water access in rural communities and identify subpopulations which are missed by a constructed improved water supply intervention. Mixed research methods, including community mapping, interviews, focus group discussions, household surveys, and GPS data collection were used to explore factors impacting water access in four rural communities in Oromia, Ethiopia. This study focuses on the quantitative results from household survey analysis. We utilized data from 161 households in 4 communities to assess the relationship between water collection travel time and a household's choice of using an improved water source exclusively for drinking and cooking purposes. Households which did not exclusively use an improved drinking water source traveled relatively farther to collect water from the improved water source compared to households which did exclusively use an improved drinking water source. Our logistic regression model indicated that households traveling further than 15 minutes were less likely to exclusively use an improved drinking water source; however, the odds ratio confidence intervals were wide and we did not find evidence that they were significantly different. A higher proportion of households which did not exclusively use an improved drinking water source were with an illiterate female heads of household, a disabled member of the households, higher water collection container capacity, higher storage capacity, and collected water for income generation or livelihood uses. Household water quantity was relatively higher among households which did not exclusively use the improved water source for drinking; however, there was no clear correlation between proximity to improved water source and household water quantity. Overall, our results indicate that proximity to an improved water source has a moderate effect on households' exclusive use of an improved drinking water source.

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CHAPTER I: BACKGROUND/LITERATURE REVIEW

Global Impact of Water Access

Water is a human right and one of the essential elements needed for human health and dignity. Yet an estimated 884 million people do not have access to improved sources of drinking water and nearly 1.5 million children die each year from diarrheal disease (1). The health disparities caused by the lack of access to water are experienced most by those living in poverty, making them vulnerable targets to waterborne infectious diseases (2). The global community has dedicated considerable resources to improving water access and the UNICEF/WHO Joint Monitoring Program has announced achievement of the Millennium Development Goal drinking water target - to reduce by half the proportion of people without sustainable access to an improved source of water (3). Despite the recent increases in access, great disparities still exist with improvements among the rural and the poorest populations being slower in many parts of the world (3). If the most marginalized in a community are not served by these improvements to access, the health and development impact of water improvements will not be fully realized by those who need it most.

Water Access in Rural Ethiopia

Ethiopia remains one of the world's poorest countries with 38.9% of the population living below the international poverty line (4). Only 38% of the population in Ethiopia have access

to an improved water source, among the lowest in the world (5). Progress has been slow in rural areas where only 26% of the population have access to an improved water source (6). Ethiopia's DHS survey indicates that 44% of rural households collect water from unimproved sources, primarily surface water, which may be contaminated from runoffs and unsafe for consumption (4). Over half of the rural population spend over 30 minutes for one trip to fetch drinking water; these people are primarily female (4). Prevalence of diarrhea in rural Ethiopia is especially high in children under 5 years old (4).

Challenges in Measuring Water Access

The WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP) measures use of an improved drinking water source (e.g. borehole, rainwater, protected spring or well, or a piped supply) as an indicator for access to safe water and measures overall progress towards the MDGs through national or regional averages(7). The Federal Democratic Republic of Ethiopia measures drinking water access as use of an improved water source and being within 1.5 kilometer of an improved water source (8). These measurements are designed for evaluation of large programs and do not capture the disparities of water access that happen at the local level. Few studies have thoroughly ascertained whether standard water access coverage metrics are truly accurate (9). Safe drinking water access involves many dimensions such as proximity, water source choice, water quantity, water quality, and household characteristics. Thus, improvements of safe water access through installation of an improved water source may be overestimated if evaluation measures only consider use or proximity.

Studies suggest that difference in proximity to water source affects the amount of water collected and types of water sources used. A study in rural Mozambique demonstrated that, following construction of a new improved water system, there was a reduction in collection times from 5 hours to 10 minutes, and water consumption in the village increased by a factor of 2.7 (10). Cairncross (1987) found that water access is significantly decreased if a water source is more than 1.5 kilometer or 30 minutes from a household (11). Similarly, a study summarized the different levels of water service and their estimated gains in health and water quantity; no access to water was measured as being more than 1 kilometer or 30 minutes total water collection time. However, the relationship between distance and water access is not always consistent, and there are factors besides proximity which impact use of an improved water source (12, 13). Studies have identified additional factors besides proximity that influence household water quantity such as perceived water quality, water service level, socio-economic status, household size, education level, geography, and number of women in the household (9, 14-17). Results of a multiple regression analysis showed that additional water collection capacity and having a bicycle were associated with an increased amount of household water quantity; water-fetching distance was not as a significant factor influencing household water quantity (18). These findings suggest that in order to accurately assess access, and to understand who might be missed by community water source improvements, water access measures should also consider demographic composition, socio-economic makeup, and other household characteristics in addition to usage and proximity.

Understanding factors influencing a household water sources choice would provide further insights into key barriers and determinants of safe water access. Studies have found the following factors to influence water source choice: water collection time, distance to water source, price of water, perceived quality of water, quantity of water available, wealth, head of household's education level, female education level, and the number of women in a household to be influential factors (15, 19) (20-22). Only a few studies have explored the impact of factors influencing rural households' choice water sources specifically for drinking. A study in urban Pakistan found perceived water quality to be a significant factor influencing household drinking water source choice(2). A similar study in rural Philippines analyzed household's drinking water sources among networked and non-networked systems and found collection time to be an important determinant (10). Although there is overlap in findings, the identified factors within each study were varied suggesting that determinants may vary depending on the context. Multiple conclusions from these studies signify a need to further clarify determinants of safe drinking water access. Our study focuses on exploring determinants of a household's use of an improved water source for drinking and cooking.

Research Study Sites

The research study was conducted in four purposively selected rural research sites in Oromia Region where MWP-E partner Living Water International (LWI) and its local partner, the Ethiopian Kale Heywet Church (EKHC), have recently installed a new improved water source (e.g. borehole well, spring public tap). Each study site had one recently constructed improved water source and at least one other alternative unimproved water source that the

community currently uses. The characteristics of the four research sites are described in Table 1.

Table 1. Characteristics of Research Sites and Study Population

	Korke Research Site	**Chirati Research Site**	**Yaleman Research Site**	**Turfe 2 Research Site**
Improved Water Sources[1]	Protected hand well pump, Rainwater	Protected hand well pump, Rainwater	Protected hand well pump, Rainwater	Public tap from protected spring, Rainwater
Unimproved Water Sources[1]	River, Pond	River, Lake	River, Stream	River
Population[2]	210	91	60	227
Villages	Misreta, Fursa, Gara	Chirati	Yaleman	Turfe 2
Approximate Sq. Km.	2 sq. km.	0.5 sq. km.	0.5 sq. km.	3 sq. km.
District Area	Ada Woreda, Korke Kebele	Ada Woreda, Hidi Hora Kebele	Ada Woreda, Hidi Hora Kebele	Shashamane Woreda, Turfe 2 Kebele

1: WHO/UNICEF JMP defines an "improved water source" as public taps or standpipes, boreholes or tubewells, protected dug wells, protected springs, and rainwater collection.

2: Population of research site refers to the number of households residing in villages served by the newly constructed improved water source.

The local governing water committee for each respective EKHC-constructed water source provided a list of villages, usually within close proximity to the water source, who are understood to be beneficiaries of the EKHC-constructed water source. A household is eligible to become a registered user of the improved water source if they reside in one of the

named villages. These criteria allowed us to examine the choices people make about their water sources when they have unimproved options available alongside an improved source option. The research sites were located in rural areas of Ada and Shashamane woredas within the Oromia region of Ethiopia. People in the region are generally poor and collect water from shared water points; only a few households collect rainwater (n=13). There are no piped water supply networks or private wells in the study area.

Formative research activities were conducted to inform on qualitative aspects of each research site's water sources. Participatory community mapping was employed to generate a community map for group discussion on water access issues and georeference waterpoints. Methods were adapted from a WaterAid guide and previous studies (23-26). The community mapping process was facilitated by translators and colored paper shapes symbolizing community landmarks. Maps were used to direct researchers to georeference water sources using Global Positioning System (GPS) portable units. Observations and semi-structured interviews with water management committee members were conducted at all water sources within each research site.

Project Objectives

Since 2004, a consortium of nongovernmental organizations (NGOs) led by the Millennium Water Program – Ethiopia (MWP-E) have been working to increase sustainable access to safe water for vulnerable populations through advocacy and direct action(27). Emory

University's Center for Global Safe Water (CGSW) has collaborated with the MWP-E to explore equity of water access. This thesis study is a component of a broader study to investigate specific factors that may prevent equitable access to safe water in sufficient quantity and quality.

The thesis study objectives of the water access equity study are:

(1) To understand the extent to which EKHC-constructed improved water sources provide drinking water access in the local communities.
    a. To identify vulnerable populations who may be at risk of decreased safe water access.
    b. To identify factors which increase or decrease likelihood of choosing to use the newly constructed improved water source for drinking and cooking

(2) To support MWP-E's mission to understanding sustainability of intervention impact with focus on ensuring equitable access to water for vulnerable populations.

The thesis study aims to address the following research questions: What is the relationship between reported water collection travel time and household's exclusive use of an improved water source for drinking and cooking purposes? How is this relationship modified or confounded by household characteristics? How is household water quantity affected by proximity to improved water source?

This study aims to identify subpopulations at risk of being marginalized from the benefits of an improved water source and identify mediators of water access. We hypothesize that shorter collection time, shorter water-fetching distance, shorter queue time, presence of animal or bicycles to assist with water collection, higher number of water collectors, higher education level, higher wealth, and lower vulnerability will be associated with a higher likelihood of exclusively using an improved water source for drinking and cooking. We utilize data from household surveys to construct a multivariable logistic model to assess whether proximity to improved water source significantly influences exclusive use of an improved water source for drinking and cooking, controlling for effect modification and confounding of household characteristics. In this report, we outline the methods of data collection and analysis, discuss findings from regression analysis, and present maps visualizing water access trends. We conclude with a discussion of the public health implications of our findings and areas for future research.

CHAPTER II: MANUSCRIPT

Title: "Assessing the Relationship Between Water-fetching Distance and Equitable Access to and Use of Improved Water Sources in Rural Ethiopia"

INTRODUCTION

The WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP) measures use of an improved drinking water source (e.g. borehole, rainwater, protected spring or well, or a piped supply) as an indicator for access to safe water and measures overall progress towards the MDGs through national or regional averages(7). These measurements are designed for evaluation of large programs and do not capture the disparities of water access that happen at the local level. Few studies have thoroughly ascertained whether standard water access coverage metrics are truly accurate (9). Thus, improvements of safe water access through installation of improved water source may be overestimated if evaluation measures only consider use or proximity.

Studies suggest that difference in proximity to water source affects the amount of water collected and types of water sources used. Cairncross (1987) found that water access is significantly decreased if a water source is more than 1.5 kilometers or 30 minutes from a household(12). However, the relationship between distance and water access is not always consistent, and there are factors besides proximity which impact use of an improved water source (12). Studies have identified additional factors besides proximity that influence

household water quantity such as perceived water quality, water service level, water collection capacity, using a bicycle for water collection, socio-economic status, household size, education level, geography, and number of women in the household (9, 14-18). These findings suggest that in order to understand the extent of improved water supply benefits, water access measures should also consider demographic composition, socio-economic makeup, and other household characteristics in addition to usage and proximity.

Understanding factors influencing a household water sources choice would provide further insights into key barriers and determinants of safe water access. Studies have found the following factors to influence water source choice: water collection time, distance to water source, price of water, perceived quality of water, quantity of water available, wealth, head of household's education level, female education level, and the number of women in a household(15, 19) (20-22). Conclusions varied widely across these studies, suggesting site-specific effects and limited understanding of factors influencing water source selection. Only a few studies have explored the impact of factors influencing rural households' choice water sources specifically for drinking. A study in urban Pakistan found perceived water quality to be a significant factor influencing household drinking water source choice(2). In rural Philippines, a household's drinking water source selection among networked and non-networked systems was significantly influenced by water collection time (10). Although there is overlap in findings, the identified factors within each study were varied, suggesting that determinants may vary depending on the context. Multiple conclusions from these studies signify a need to further clarify determinants of safe drinking water access. Our study

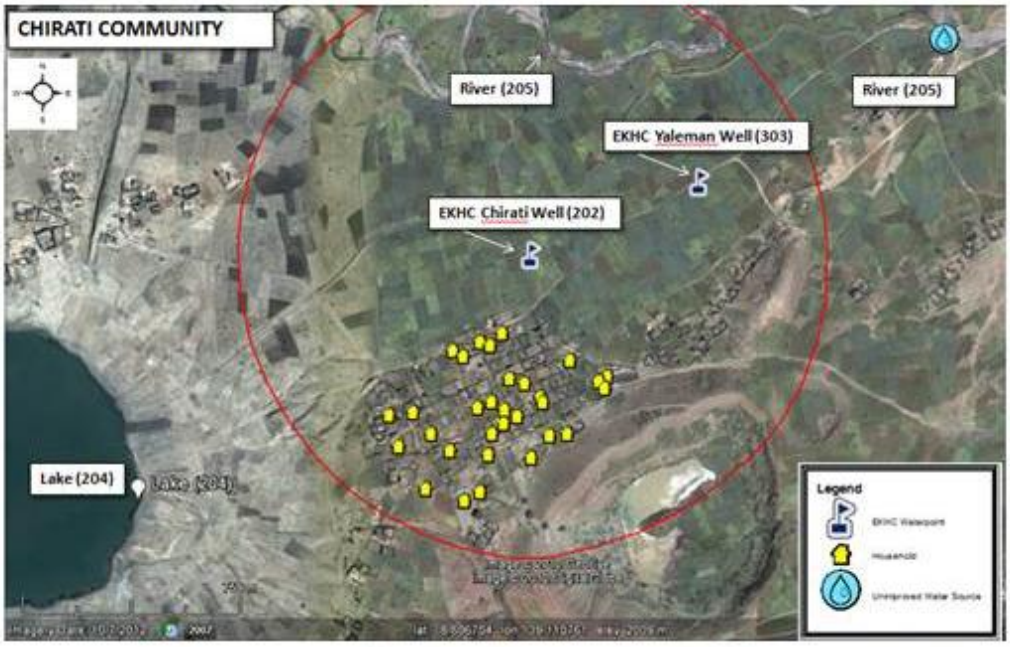
focuses on exploring determinants of a household's use of an improved water source for drinking and cooking.

This study aimed to increase understanding of the barriers and mediators to safe water access in rural communities and identify subpopulations which are missed by improved water supply interventions. Specifically, we aim to evaluate the association between water collection distance and a household's exclusive use of drinking water source.

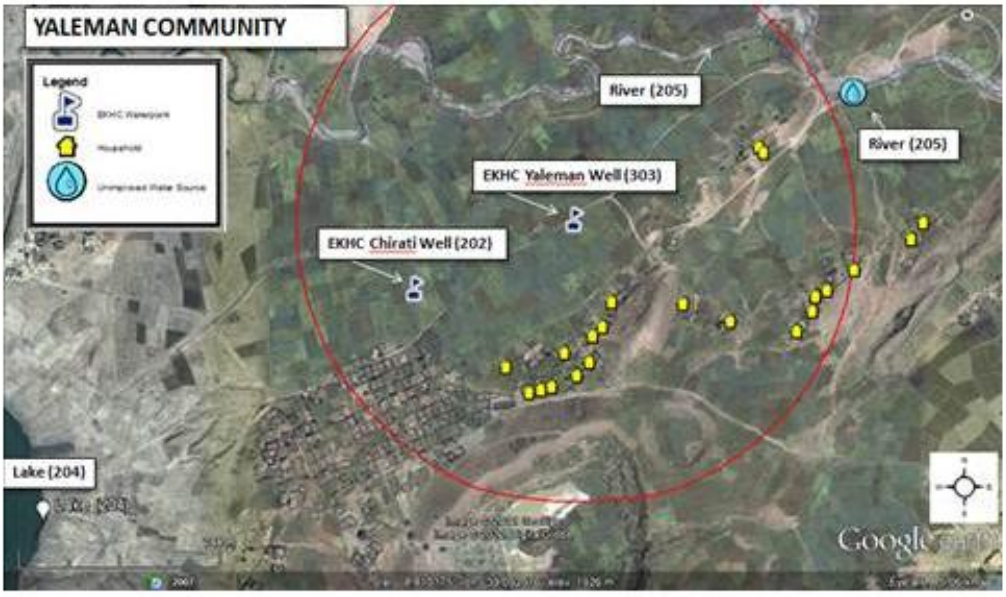
METHODS

Study sites

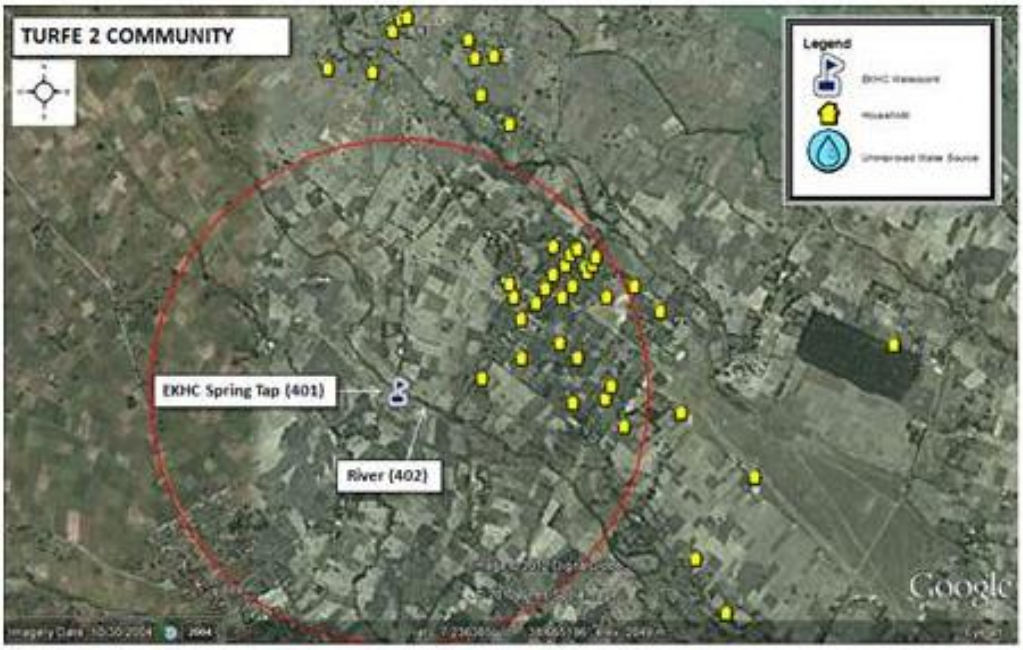
The research study was conducted in four purposively selected rural research sites in Oromia Region where MWP-E partner Living Water International (LWI) and its local partner, the Ethiopian Kale Heywet Church (EKHC), have recently installed a new improved water source (e.g. borehole well, spring public tap). People in the region are generally poor and collect water from shared water points. Each study site had one recently constructed improved water source and at least one other alternative unimproved water sources that the community currently uses. Satellite image maps of the selected research sites are shown in Figure 1.


CHIRATI COMMUNITY
River (205)
River (205)
EKHC Yaleman Well (303)
EKHC Chirati Well (202)
Lake (204)
Legend

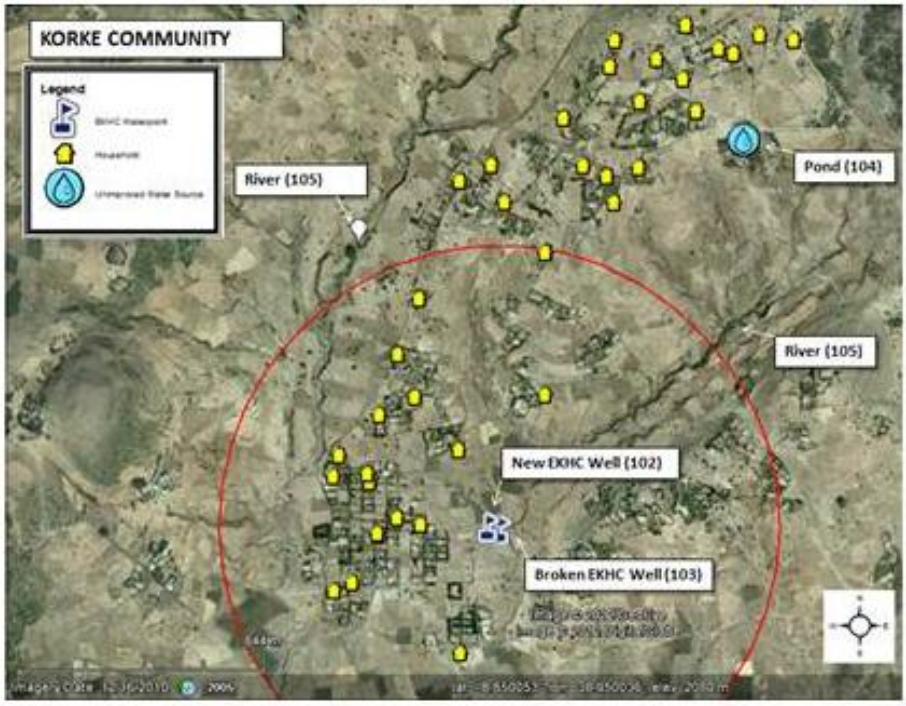
a)


YALEMAN COMMUNITY
Legend
River (205)
River (205)
EKHC Yaleman Well (303)
EKHC Chirati Well (202)
Lake (204)

b)



c)



d)

Figure 1. Satellite maps of water points and households at (a) Chirati, (b) Yaleman, (c) Turfe, and (d) Korke research sites. (Red circle indicates a one kilometer radius surrounding the constructed improved water source.)

The local governing water committee for each respective EKHC-constructed water source provided a list of villages, usually within close proximity to the water source, who are understood to be beneficiaries of the EKHC-constructed water source. A household is eligible to become a registered user of the improved water source if they reside in one of the named villages. These criteria allowed us to examine the choices people make about their water sources when they have unimproved options available alongside an improved source option.

Partner Organizations

Since 2004, a consortium of nongovernmental organizations (NGOs) led by the Millennium Water Program – Ethiopia (MWP-E) have been working to increase sustainable access to safe water for vulnerable populations through advocacy and direct action (27). Emory University's Center for Global Safe Water (CGSW) has collaborated with the MWP-E to explore equity of water access. This thesis study is a component of a broader study to investigate specific factors that may prevent equitable access to safe water in sufficient quantity and quality.

Study Design

We used a mixed methods approach to investigate the factors associated with a household's drinking water source in rural Ethiopia in the context of a newly constructed improved water source. We conducted a cross-sectional survey in four communities in Oromia Province during the rainy season between June and August 2012. Data were collected at both the household and community level to gain information on water access conditions and research site characteristics. Data collection methods included community mapping, interviews with water source management committee, focus group discussions, household surveys, and GPS georeferencing.

Participatory community mapping was conducted in each research site to explore distribution of community landmarks, households, and water sources. The map was utilized in a group discussion with community mapping activity participants focusing on water access conditions. The map was digitally reproduced to aid household survey participants in identifying water sources they utilize. Focus group discussions were held with a small group of female heads of household to explore barriers and conditions of water access in each research site. Semi-structured interviews were conducted with the local water management committee in each research site to understand governance, scope of villages served by the water source, history, and management difficulties in improved and unimproved water sources. Findings from interviews and focus group discussions informed of explanatory factors that should be included in the scope of the household survey.

The criteria for selecting research sites included: having an improved water source constructed by the MWP-E partner organization within the past year, presence of only one improved water source and at least one other unimproved water source used by the community, and site accessibility from main roads. The sampling frame included all households residing in villages served by the newly constructed improved water source. We employed simple random sample within each research site, and selected households from kebele government lists. A total of 126 households were determined as the minimum number needed to detect a difference of 15 minutes for water collection from an improved water source (results from OpenEpi, Version 3). We used the effect difference from a two-sample test comparing two means (binary outcome of exclusive use of improved drinking water source) with a 95% two-sided confidence interval and 80% power to detect a difference. Based on limited information from in-country partner organizations, we assumed a variance of 30 minutes amongst households' reported water collection time and an equal ratio between households which do or do not exclusively use the constructed improved water source for drinking and cooking.

In anticipation that some targeted subjects would be unavailable (e.g. not home, no desire to participate), the list of selected households were sampled in excess of approximately 60 households. If the selected household had no response, enumerators were instructed to visit the closest neighbor to conduct the survey. If no closest neighbor was available, the enumerator was instructed to proceed to the next selected household. After the target sample size was reached, no further samples were taken; thus, not every sampled household

was approached. A summary of the study population and sampled households is given in Table 2.

Table 2. Research Sites, Household Population, and Household Sample Sizes

Research Site	Population	Sampled	Surveyed
Korke	210	50	43
Chirati	91	50	41
Yaleman	60	30	26
Turfe 2	227	60	51
TOTAL	588	190	161

Household surveys were utilized as the primary data collection tool to obtain quantifiable data relating to household characteristics and water source choices. The household survey was refined during the pilot study, reviewed by local partners, and translated into the local Amharic and Oromifa languages. Targeted subjects for the household survey were the female heads of household who were usually the primary persons responsible for water collection duties. The household survey was conducted in Amharic or Oromifa language by trained female enumerators who held a college degree. Language was selected based on preference of the respondent. After verbal consent was obtained, research assistants conducted a structured survey which took approximately 30 minutes. The survey included questions on basic demographics, household assets, social capital, perceptions of water sources, distance and collection time to water source, water usage for domestic or productive purposes, effort to collect water, and vulnerability characteristics of the household (e.g.

presence of persons who were disabled or orphans in the household). A copy of the household survey is located in Appendix C. A copy of the informal oral consent read to respondents is located in Appendix B. After oral consent was obtained, we collected geospatial data on household and water source locations using portable GPS units. The GPS units generally had an accuracy range of approximately 10 meters.

Study methods were approved by the Institutional Review Board (IRB) at Emory University, and Jimma University approved the study. Due to low literacy rates, data collection was conducted through face-to-face questionnaires and oral consent rather than written consent.

Data Analysis Methods

We utilized data from 161 households to explore factors which influence the outcome of exclusive use of improved water source for drinking and cooking. All survey data were transferred from paper to Microsoft Excel. Data cleaning and analysis were conducted using SAS 9.3 statistical software.

The outcome of interest was whether or not a household reported exclusive use of the newly-constructed improved water source for drinking and cooking purposes. Current use was defined as a household collecting water from the water source within the past week or month. Secondary questions of interest included assessing the association between

household characteristics and household's exclusive use of improved drinking water source, and assessing the association between proximity to improved water source and household water quantity.

The effects of a stratified sample design with varied household sampling weights were included our data analysis. We treated each of the four research sites as a stratum in our analysis. Descriptive univariate analysis and bivariate chi-square tests of association considered household sampling weights and stratified study design. Bivariate two-sample t-test considered household sampling weights but did not include adjustment for stratified study design Linear regression analysis and multivariable logistic regression analysis considered sampling weights and stratified study design.

A descriptive univariate analysis was performed using SAS 9.3 statistical software to describe trends in household characteristics and water collection activities. Households that exclusively used or did not use the newly-constructed improved water source for consumption were compared across household characteristics, using the chi-square test of proportions. Continuous variables were compared using two-sample t-tests. Bivariate analysis was conducted for the following variables: household size, wealth, education level, having a female head of household, vulnerability factor (e.g. vulnerable household either has no adult males, does not own land, or has member who is disabled, an orphan, or chronically ill), reported water collection distance, reported water collection time, waiting time at the improved water source, household water quantity collected daily, number of daily water

collection trips, water collectors in household, use of an animal or bicycle to aid in water collection, water collection container capacity, water storage capacity, water sharing with neighbors, and water collection for income generation and livelihood uses. Approximate daily water quantity collected was calculated by averaging the number of liters collected from all water sources in the prior two days; the majority of water came from improved water sources. Linear regression analysis was applied to explore associations between water quantity and proximity to the newly-constructed improved water source; trends were visualized with a trend line and dot plots.

We built a multivariable logistic regression model to test the effect of reported travel time to the improved source on whether a household exclusively uses an improved drinking water source. Due to right-skewed distribution and to produce a more meaningful indicator, reported travel time to improved water source was divided into four categories (< 15 minutes, 15-29 minutes, 30-44 minutes, and 45 minutes or more). Categorical levels were determined by examining distribution and producing a representative number of households in each category level. In addition, the 15 minute intervals provide a practical and meaningful measure of change to assess change in proximity. Reported travel time was considered a better measure of proximity than reported distance since time takes pathways and time burden into account. Similarly, euclidian distance from GPS measurements would not take pathways and travel time into account. Thus, reported one-way travel time to collect water from the improved water source was chosen as the main predictor in the model.

The model outcome was household's exclusive use of an improved water source for drinking or cooking. The variables included in the initial multivariable logistic regression model were selected if there was plausible association with the outcomes based on review of published literature and input from topic experts. The following covariates were included in our initial logistic regression model: household size, number of water collectors in household, education level, wealth, vulnerability factors, head of household is female, number of water collectors in households, average daily water collection trips, water storage capacity, water collection container capacity, use of animal or cart for water collection, water collection time, queue time at water source, collection of water for income generation or livelihood uses, and sharing of water resources between households. Wealth was measured through a principle component analysis to derive a wealth asset score from variables indicating ownership of land, housing material, latrine, electricity, animals, households items (e.g. mobile phone, radio, TV, refrigerator, furniture), and transportation (e.g. bicycle, motorcycle, car). The wealth index was divided into terciles due to the right skewed distribution and to highlight the impact of being very poor within the lower third tercile.

Collinearity of variables in the multivariable logistic regression model was assessed by examining condition indices and variance decomposition proportions. Effect modification of model variables was assessed by comparing stratum-specific odds ratios; selection of interaction variables was conducted using backwards stepwise elimination. Confounding from household characteristics was assessed by comparing adjusted and unadjusted odds ratios in the presence or absence of the potential confounder in the model (difference of at least 10% change in effect estimate was indicative of confounding); selection of model

variables was conducted through change-in-estimate backwards elimination. Model fit was assessed by the Hosmer-Lemeshow goodness of fit test (using 0.05 significance level). Using logistic regression analysis, odds ratios were calculated with 95% confidence intervals as a measure of association between water-fetching travel time and exclusive use of the newly-constructed improved water source for drinking, controlling for confounding and effect modification.

Geospatial data from portable GPS units were converted from GPX file format to CSV file format using DNR Garmin 6.0.0.11 software. A total of 133 households were included in the spatial analysis to explore water access trends, particularly focusing on factors which influence the outcome of exclusive use of improved water source for drinking and cooking. A total of 28 households (range of 5-9 households in each research site) did not have spatial data available due to error in GPS data collection. The dataset was imported into SAS 9.3 statistical software for removal of duplicated or unidentified waypoints. The spatial dataset was merged with household survey data using SAS and then imported into a geodatabase in ESRI ArcGIS Desktop 10.0. The household layer was overlaid onto the water sources layer. The geodatabase dataset is projected in WGS 1984 and uses UTM measurements. Digital maps were created through ESRI ArcGIS Desktop 10.0 to visualize patterns relating to households' exclusive use of the newly constructed improved water source for drinking or cooking.

RESULTS

Univariate Analysis

A total of 161 households were surveyed at four research sites. Respondents consisted of 131 (82%) female adults with median age of 38 (range 18-86). A total of 114 (72%) were available and sampled upon the first visit; 42 (26%) households were not home when visited and 3 (2%) households refused to participate. The 26% of vacant households were substituted with the nearest neighboring household.

Results describing water source selection and drinking water access are shown in Table 3. Although 124 (70%) households relied on the newly constructed improved water point as their main source for drinking and cooking, a smaller proportion of 101 (55%) households relied on it exclusively for drinking and cooking. Maps showing spatial distribution of households' exclusive use of an improved drinking water source are located in Appendix B. Thus, 60 households (45%) were utilizing unimproved water sources for drinking and cooking purposes. Rain water is typically considered an improved water source (28); however, only 13 (8%) households harvested rain water. Of the households which exclusively used the constructed water source as their drinking source, 83 households (89%) reported water quality and health as the main reason for choosing their main drinking water source.

Table 3. Descriptive analysis of water source selection & accessibility (N=161)

Water Source Selection & Accessibility	**Mean (StDev), Median (Range), or N(%)**
Uses newly constructed waterpoint as main source for drinking/cooking	124 (70.1%)
Exclusively uses improved sources for drinking (including constructed improved water source and rainwater harvesting)	101 (54.8%)
Exclusively uses constructed improved water source for drinking	98 (53.3%)
Main reason for choosing main drinking water source:	
Only source available	4 (5.3%)
Health/quality	83 (88.5%)
Taste	5 (3.4%)
Convenient distance/path	3 (2.8%)
Ever went to alternative source because could not collect from constructed waterpoint	34 (21.1%)
Reasons why they were not able to collect water from constructed waterpoint:	
Not enough water at source	5 (3.1%)
Not functioning	13 (8.1%)
Water management committee limits amount	16 (9.9%)
Queue too long	15 (9.3%)
Household feels they cannot collect sufficient water for their family	105 (65.2%)
Reasons why household cannot collect sufficient water:	
Not enough at source	4 (2.5%)
Water source management committee limits amount	17 (10.6%)
Too far	16 (9.9%)
Not enough person-power to collect	9 (5.6%)
Not enough time	2 (1.2%)
Bad quality	2 (1.2%)

A total of 34 households (21%) have reportedly gone to an alternative unimproved water source because they were unable to collect water from the newly constructed water point. A total of 105 households (65%) reported feeling that their household water quantity is insufficient for the needs of their family; households reportedly could not collect sufficient

water mainly because of water quantity limits set by the water source management committee (17 households, 11%) or the water source is too far (16 households, 10%).

Bivariate Analysis

We compared household characteristics associated with whether or not households exclusively use the constructed water source for drinking and cooking. Comparative analysis was conducted across variables relating to household characteristics and water collection. Results of the bivariate analysis are shown below for household characteristics in Table 4.

Bivariate analysis indicated that households which did not exclusively use the constructed drinking water source were associated with having an illiterate female head of household (n=50 households, 82.9%, p-value = 0.07) and with at least one vulnerability factor (e.g. household either has no adult males, does not own land, or has member who is disabled, orphan, chronically ill) (n=21, 33.7%, p-value = 0.34). Households which did not exclusively use the constructed water source for drinking was associated with having a disabled person (n=7, 12.3%, p-value = 0.09) and having an orphan member of household (n=10, 17.2%, p-value = 0.12). Average household size was relatively similar amongst households exclusively using an improved drinking water source compared to households not exclusively using an improved drinking water source, 5.7 (SD=2.4) and 5.4 (SD=2.3) respectively.

Table 4. Bivariate analysis of household characteristics related to households' exclusive use of an improved water source for drinking and cooking

			Uses Constructed Improved Water Source		
			Yes (N=98)	**No (N=63)**	
Household (HH) characteristics		**Mean (StDev), or N(%)**	**Mean (StDev), or N(%)**	**Mean (StDev), or N(%)**	**Test of Association p-value[3]**
	Household Size	5.5 (2.3)	5.7 (2.4)	5.4 (2.3)	0.34
	HH in poorest third of study population	53 (32.9%)	34 (29.1%)	19 (32.8%)	0.64
	Illiterate male head of HH[1]	53 (32.9%)	35 (39.6%)	18 (43.1%)	0.73
	Illiterate female head of HH	119 (73.9%)	69 (67.9%)	50 (82.9%)	0.07
	Female-headed HH	40 (24.8%)	20 (24.5%)	20 (31.4%)	0.40
	HH is vulnerable[2]	45 (28.0%)	24 (26.0%)	21 (33.7%)	0.34
	No adult males in HH at all	12 (7.5%)	6 (8.2%)	6 (8.7%)	0.92
	HH has members who are disabled	11 (6.8%)	4 (4.3%)	7 (12.3%)	0.09
	HH has chronically ill person	7 (4.4%)	4 (5.9%)	3 (5.5%)	0.93
	HH has members who are orphans	16 (9.9%)	6 (7.8%)	10 (17.2%)	0.12
	HH does not own land	11 (6.8%)	9 (6.0%)	2 (2.4%)	0.22

1: $\geq$ 10% missing data.
2: Vulnerable household either has no adult males, does not own land, or has member who is disabled, orphan, chronically ill.
3: Two-sample t-test or chi-square test.

Bivariate analysis results for water collection factors are shown in Table 5. Households' exclusive use of an improved drinking water source was significantly associated with having relatively lower water quantity collected, collecting water more than 7 times per week, using an animal or cart to carry water, having lower water collection capacity, and having lower water storage capacity.

Table 5. Bivariate analysis of water collection factors related to households' exclusive use of an improved water source for drinking and cooking

			Exclusively Uses Improved Drinking Water Source?		
			Yes (N=98)	No (N=63)	
Water quantity and collection		**Mean (StDev), or N(%)**	**Mean (StDev), or N(%)**	**Mean (StDev), or N(%)**	**Test of Association p-value[3]**
	Mean reported distance in meters to EKHC waterpoint	613.3 (851.2)	728.7 (978.4)	433.7 (564.0)	0.017[4]
	Mean reported time in minutes to travel to EKHC waterpoint	25.7 (22.0)	25.1 (19.6)	26.8 (25.3)	0.65[4]
	Mean reported waiting time in minutes at EKHC waterpoint	74.0 (59.7)	64.7 (55.5)	88.5 (63.5)	0.013
	Total liters collected daily per HH, all sources (2-day average)	55.7 (34.8)	45.5 (39.2)	57.3 (54.5)	0.022[4]
	Total water collection trips taken daily (2-day average)	1.4 (0.7)	1.4 (0.6)	1.4 (0.9)	0.76[4]
	HH collects water more than 7 times/week	135 (83.9%)	82 (83.2%)	53 (84.4%)	0.86
	HH collects at least 15 l/person/day	38 (23.6%)	21 (21.4%)	17 (27.0%)	0.28
	Total water collectors in HH	2.1 (0.8)	2.2 (0.8)	2.1 (0.8)	0.66
	HH uses animals, bicycle, or cart to carry water	104 (64.6%)	61 (57.8%)	43 (67.1%)	0.29
	Mean water collection container capacity in liters	71.9 (40.7)	67.0 (35.6)	79.8 (46.9)	0.051
	Mean water storage capacity in liters	92.5 (72.3)	78.0 (53.0)	114.9 (90.9)	0.004[4]
	HH engages in water exchange with neighbors through selling, borrowing, or lending	130 (80.8%)	76 (80.3%)	54 (88.3%)	0.18
	HH collects water for income generation or livelihood uses	31 (19.3%)	14 (14.30%)	17 (25.6%)	0.02[4]

1: $\geq$ 10% missing data.
2: Vulnerable household either has no adult males, does not own land, or has member who is disabled, orphan, chronically ill.
3: Two-Sample T-Test or Rao-Scott Chi-Square Test.
4: Comparison groups had unequal variances with F-test at 5% significance level.

Households which exclusively used the improved drinking water had shorter reported waiting time at the constructed water points with 64.7 minutes (standard deviation = 55.5) compared to 88.5 minutes (standard deviation = 63.5) amongst households which did not exclusively use the constructed water source (p-value = 0.013).

Average water storage capacity was lower among households which exclusively used the constructed water source for drinking compared to households which did not, 71.9 liters (SD = 40.7) and 92.5 liters (SD = 72.3) respectively (p-value = 0.004). Households which did not exclusively use an improved drinking water source tended to collect water for income generation or livelihood uses (n=17 households, 26%, p=0.02).

Overall, households reported a median of 250 meters (range 25-6,500) and mean of 613 meters (standard deviation = 851.2) to travel to the constructed improved water source. Households which exclusively used the constructed water source for drinking had higher mean water-fetching distance of 728.7 meters (standard deviation 978.4) compared to households which did not exclusively use the constructed water source which reported mean distance of 433.7 meters (standard deviation 564.0) (p-value = 0.017). Distribution of reported distance to improved water sources are shown in Figure 2.

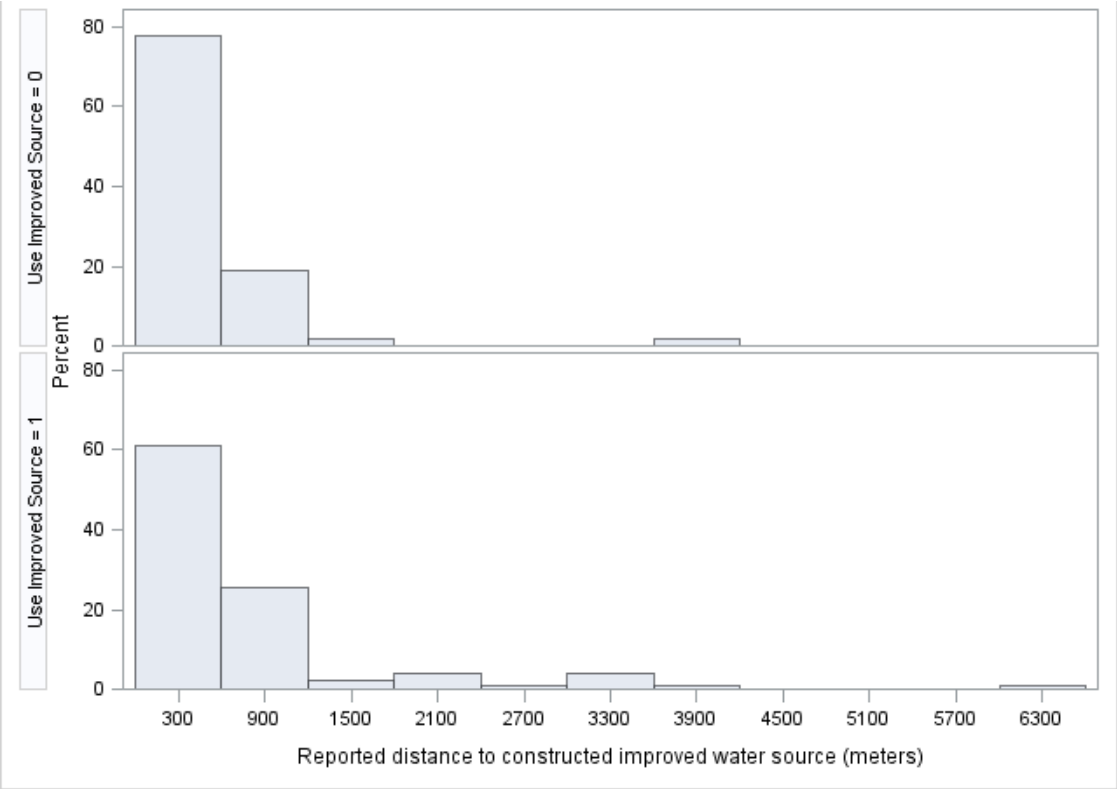


Figure 2. Reported distance, in meters, to constructed improved water source stratified by whether or not they exclusively use the improved water source for drinking and cooking (Yes = 1, No = 0).

Overall, households reported a median of 17.5 minutes (range 5-120) and mean of 25.7 minutes (standard deviation = 22.0) to travel to the improved water source. Households which exclusively used the improved water drinking source had relatively similar reported travel time with 25.1 minutes (standard deviation = 19.6) compared to households which did not exclusively used the improved water drinking source with mean reported travel time of 26.8 minutes (standard deviation = 25.3) (p-value = 0.65). Distribution of reported travel time to improved water sources are shown in Figure 3.

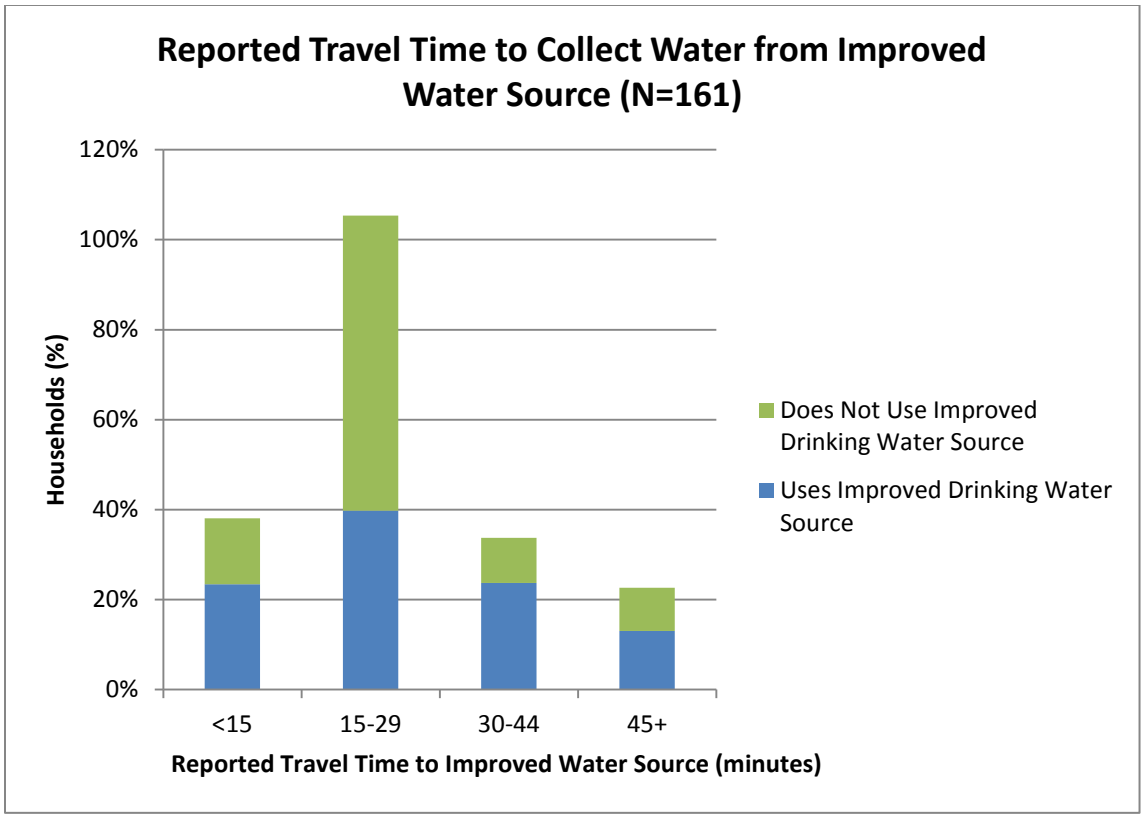
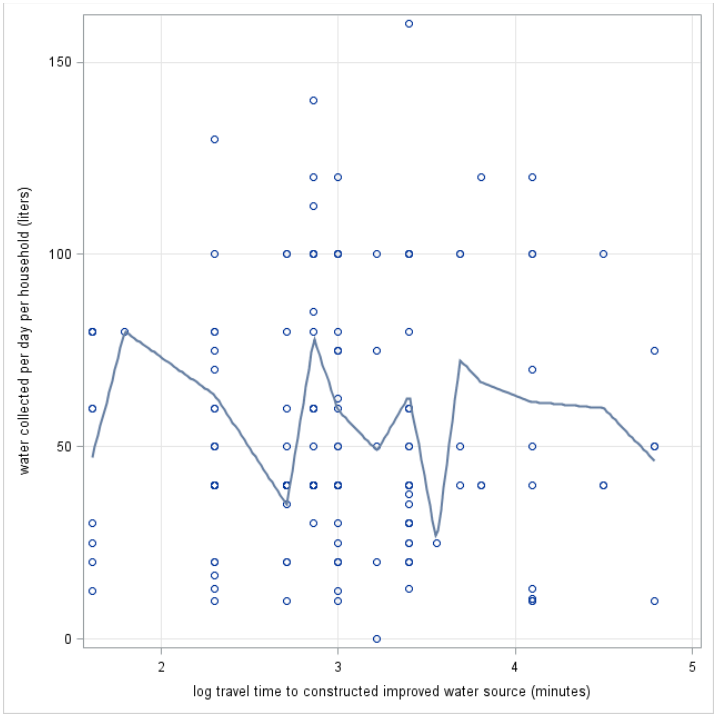


Figure 3. Reported travel time, in minutes, to constructed improved water source stratified by whether or not they exclusive use the improved water source for drinking and cooking.

Household Water Quantity Analysis

Trend plotting of household water quantity and log transformed proximity to improved water source is shown in Figure 4. Due to skewed distribution, water collection travel time and collection time were log transformed to normalize distribution.

a)



b)

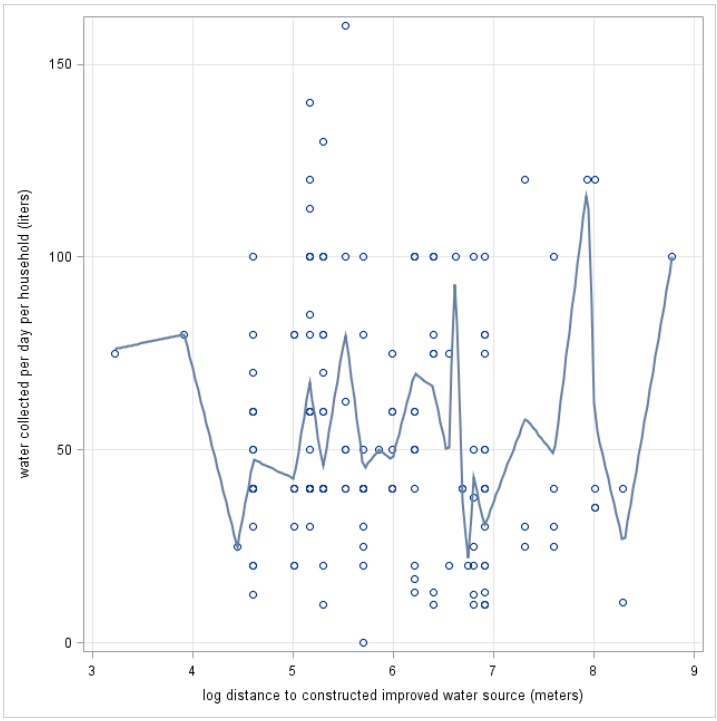


Figure 4. Trend plots between household water quantity and each of the following factors: (a) log reported water collection travel time, in minutes, to the improved water source and (b) log reported distance, in meters, to improved water source.

Trend plots for non-transformed water collection distance and time are located in Appendix A. The correlation pattern is scattered and the trend is not strong. Linear regression analysis detected a significant association between households water quantity and log water-fetching distance (linear regression beta coefficient =-4.76, p-value = 0.010). There was no significant association found between household water quantity and log water-fetching travel time (linear regression beta coefficient = -0.78, p-value = 0.78).

Multivariate Analysis

A multivariable logistic regression model was applied to test the association between travel time to improved water source and households' exclusive use of an improved drinking water source, controlling for effect modification and confounding from household characteristics. Results of the logistic regression analysis are shown in Table 6. The main exposure variable is reported one-way travel time to the constructed improved water source categorized into four levels (< 15 minutes, 15-29 minutes, 30-44 minutes, and 45 minutes or more) with the reference group as < 15 minutes. After using hierarchical stepwise backwards elimination, the following variables remained in the final model: female head of household is illiterate and male head of household is illiterate. There was no significant effect modification detected. Using the Hosmer and Lemeshow Goodness-of-Fit Test, the model was found to be a good fit with the dataset at a significance level of 0.05 ($R^2 = 0.26$, $X^2 = 6.3$, degrees of freedom = 6, p-value = 0.39).

Table 6. Multivariate logistic regression analysis results for factors associated with households using improved water source for drinking and cooking.

	Exclusively Uses Improved Drinking Water Source?		**Adjusted Estimates**		**Crude Estimates**	
Determinant Factors	**Yes (N=98)**	**No (N=63)**	**Odds Ratio**	**95% CI[2]**	**Odds Ratio**	**95% CI[2]**
	N(%)	**N(%)**				
Main Predictors						
Travels 0-15 minutes to collect water from improved water source[1]	25 (23.4%)	9 (14.7%)	-	-	-	-
Travels 15-29 minutes to collect water from improved water source	37 (39.8%)	38 (65.6%)	0.28	(0.11, 0.70)	0.38	(0.19, 0.79)
Travels 30-44 minutes to collect water from improved water source	24 (23.7%)	8 (10.0%)	1.29	(0.39, 4.31)	1.49	(0.59, 3.73)
Travels 45 minutes or more to collect water from improved water source	12 (13.0%)	8 (9.6%)	0.49	(0.14, 1.71)	0.85	(0.32, 2.23)
Confounding Variables						
female head of household is illiterate	-	-	1.46	(0.69, 3.11)	-	-
male head of household is illiterate	-	-	0.31	(0.13, 0.74)	-	-

1: Category level 'Household travels 0-15 minutes to collect water from improved water source' is treated as the reference group for comparison with other levels in this variable.

2: 95% CI = 95% Confidence Intervals for Odds Ratio Estimate

The odds of exclusively using an improved drinking water source appear to decrease as reported travel time from improved water source increases. Households which travel 15-30 minutes to the improved water source have lower odds of exclusively using the improved water source for drinking compared to households which travel less than 15 minutes (OR =

0.30, 95% CI = (0.10, 0.93). Households traveling more than 30 minutes similarly have lower odds of exclusively using the improved water source for drinking; however; this association does not appear to be very strong.

DISCUSSION

Our study explores the effects of proximity to improved water source and household characteristics on households' exclusive use of an improved drinking water source, and the association between proximity to improved water source and household water quantity. Our results indicate that proximity does not seem to be meaningfully associated with households' exclusive use of an improved drinking water source. In this discussion, we summarize key findings of the household survey data analysis, evaluate the strengths and limitations of methods, and discuss opportunities for future research.

Summary of Key Findings

Although most of the households were within 1.5 kilometers of the improved water source, the range in which the local government would consider as having access to safe drinking water, only a portion of the surveyed households exclusively used the improved water source for drinking or cooking. In bivariate analysis results, households which exclusively used an improved drinking water source traveled relatively farther to collect water from the improved water source compared to households which did not exclusively use an improved

drinking water source. This contradicts our hypothesis that distance would pose a physical barrier to improved drinking water access. Our multivariable logistic regression model indicated that households traveling further than 15 minutes were less likely to exclusively use an improved drinking water source; however, the odds ratio confidence intervals were wide and we did not find evidence that they were significantly different. Our findings are consistent with previous studies which indicated an association between proximity to water source and water source selection (15, 20, 21). The majority of households reportedly select their main drinking water source because of health and water quality, suggesting that they are aware of the health benefits from using an improved drinking water source. Distance to water source was not among the top reported reasons for choosing a drinking water source. This finding suggests that both perceived drinking water quality and proximity may influence drinking water source selection. Overall, our results indicate that water-collection distance and travel time only has a moderate effect on households' exclusive use of an improved drinking water source.

Households which did not exclusively use an improved drinking water source were associated with having an illiterate female head of household and having a disabled person in the household. These characteristics may be indicative of more stressed households that are less able to walk to further sources or wait in line. Lower education level may be attributed to households with lower awareness of the health benefits from improved drinking water sources. Findings are consistent with a previous study which found household wealth and education level to be influential in household water source selection (19). Although households which did not exclusively use an improved drinking water source were relatively

poorer, the difference was not found to be significant. Our results indicated that a greater proportion of households not exclusively using an improved drinking water source had at least one vulnerability factor (e.g. household has no adult males, does not own land, or has member who is disabled, orphan, chronically ill) with the strongest effect detected in households with a disabled member. The mechanism of association may be related to the number of people available in the household to collect water or socioeconomic factors which may decrease water access. Few studies have explored these particular factors which could indicate vulnerability of decreased safe drinking water access.

Households which did not exclusively use an improved drinking water source tended to travel longer distances and wait longer queue times, suggesting that higher time burden from water collection activities is an influential factor affecting exclusive use of an improved drinking water source. Households which did not exclusively use an improved water source had higher water collection container capacity, higher storage capacity, and collected water for income generation or livelihood uses. High water storage capacity may indicate a higher water demand in the household, which may be related with using multiple drinking water sources to meet this demand.

Many households reportedly collected insufficient water to support the needs of their family, mainly due to quantity limitations from the water source management committee or the water source is too far. This finding suggests that adequate household water quantity, for domestic and consumption purposes, is limited by distance as well as quantity available for

collection at the improved water source. Household water quantity was higher among households which did not exclusively use the improved water source for drinking; however, this effect was not very large and there was a wide range of household water quantity amongst households. Although water quantity appears to slightly decrease as either travel distance or travel time increases, the correlation pattern was generally weak. This finding indicates a need to further investigate whether distance and travel time is a meaningful predictor of household water quantity. A study in rural Kenya found a similar pattern in which household water quantity remained at approximately similar levels as collection time increased (12). Although previous studies indicated a clear trend where water quantity decreases as travel time increases (11, 14, 17, 29), our findings indicate that the trend is not clear and consistent. More research is needed to ascertain the relationship between household water quantity and proximity to improved water source.

Strengths and Limitations

This study is data-driven and rigorous compared to related published literature and we explore a broad range of explanatory variables. This is a cross sectional study so we cannot infer causality between proximity to improved water source and exclusive use of an improved drinking water source. Since the outcome of exclusive use of an improved drinking water source was not rare, the odds ratio may not approximate the relative risk very well. Due to field logistical constraints, sample size was limited and data was only collected during the rainy season. Most households were located relatively closer to the improved

water source and within approximately 1 kilometer range. The small range of travel times between the households and improved water source limited our ability to detect the effect of proximity on exclusive use of improved drinking water source. Reported distance may not be an appropriate measure to assess accessibility since it is a crudely estimate of proximity and may not account for pathways and terrain. We only consider proximity to the improved water sources and ignore proximity to unimproved water source, ignoring the potential impact of distance to unimproved water sources on households' exclusive use of an improved drinking water source. Both improved and unimproved water sources were relatively similar distances in the research sites so we expected household characteristics to be more influential in drinking water source selection.

Future Research

Future research assessing proximity should consider selecting research sites with broader proximity rangers in order to increase the ability to detect effect of proximity to improved water source on exclusive use of improved drinking water sources. To explore the effect of seasonality, this study may be repeated in the dry season. Our findings indicate that household characteristics may be playing a role in mediating access to safe drinking water. Thus, future research can further explore the impact of household characteristics in safe drinking water access. Our findings indicate that more research is needed to ascertain the relationship between household water quantity and proximity to improved water source. Households reported that water quantity limitations set by water management committee

were a barrier to accessing the improved water source; thus, future research may investigate the degree to which waterpoint-level characteristics influence safe drinking water access. Spatial mapping was a useful tool in visualizing water access trends and providing site-specific context. Future research may further explore the application of spatial analysis, such as cluster analysis, to detect global and local spatial trends. Future studies may apply similar study design and methods to explore determinants of household water quantity, allocation of water resources, drinking water quality, and water source selection.

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CHAPTER III:

PUBLIC HEALTH IMPLICATIONS & FUTURE DIRECTIONS

Public Health Implications

Improved understanding of factors associated with exclusively using the constructed improved water for drinking can inform intervention designs that may increase uptake of a water source, thereby decreasing the burden of disease associated with drinking from unimproved water sources. Identifying household-level characteristics associated with exclusive use of an improved drinking water source may allow intervention programs to specifically target these characteristics to improved safe water access.

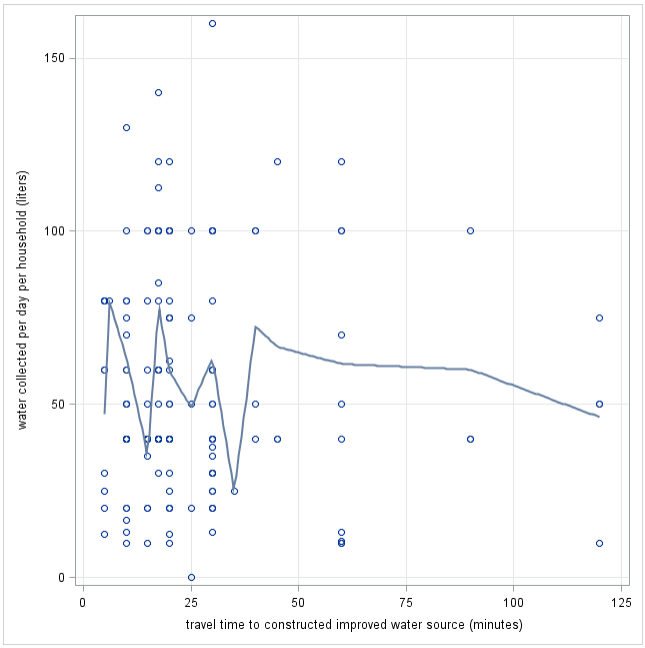
The local scale of this investigation provides insights into the degree to which broad indicators of safe water access may overestimate access levels in rural areas.Although most of the households were within 1.5 kilometers, the range in which the local government would consider as having access to safe drinking water, only a portion of the surveyed households exclusively used the improved water source for drinking or cooking. Thus, using distance between households and improved water sources may not be an effective measure of safe drinking water access in rural areas.

Future Research

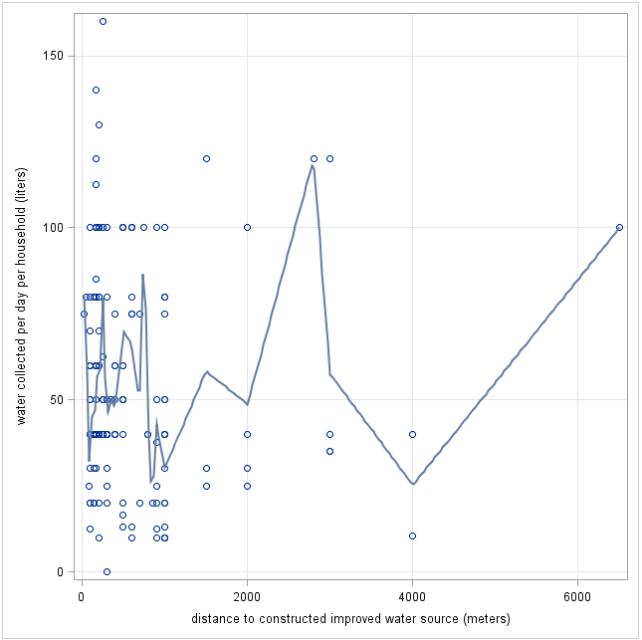
To explore the effect of seasonality, this study may be repeated in the dry season. Future research assessing proximity should consider selecting research sites with broader proximity rangers in order to increase the ability to detect effect from spatial proximity to improved water source. There is potential for the applications of spatial mapping and analysis in future research relating to water access. Spatial analysis methods could be applied to further explore the impact of proximity on household water quantity and use of improved drinking water source. Our findings indicate that household characteristics may be playing a role in mediating access to safe drinking water. Thus, future research can further explore the impact of household characteristics in safe drinking water access. Our findings indicate that more research is needed to ascertain the relationship between household water quantity and proximity to improved water source. Households reported that water quantity limitations set by water management committee were a barrier to accessing the improved water source; thus, future research may investigate the degree to which waterpoint-level characteristics influence safe drinking water access. Future studies may apply similar study design and methods to explore determinants of household water quantity, domestic versus consumption allocation of water resources, drinking water quality, and water source selection.

APPENDICES

APPENDIX A. Trend plots of household water quantity and each of the following factors: (a) reported water collection travel time, in minutes, to the improved water source and (b) reported distance, in meters, to improved water source. a)

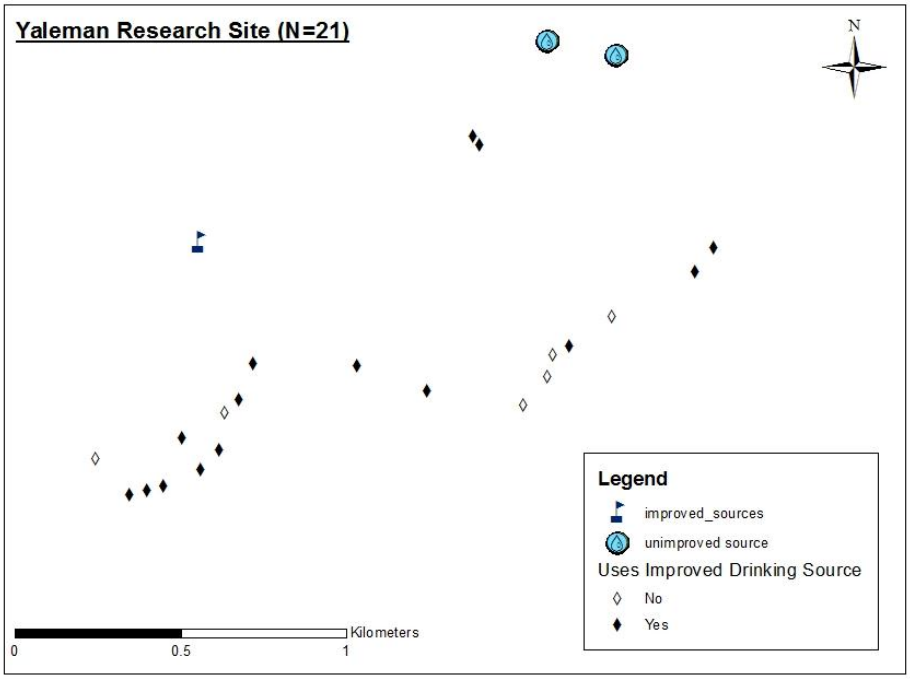


b)



APPENDIX B. Maps showing spatial distribution of households' exclusive use of an improved drinking water source

a)



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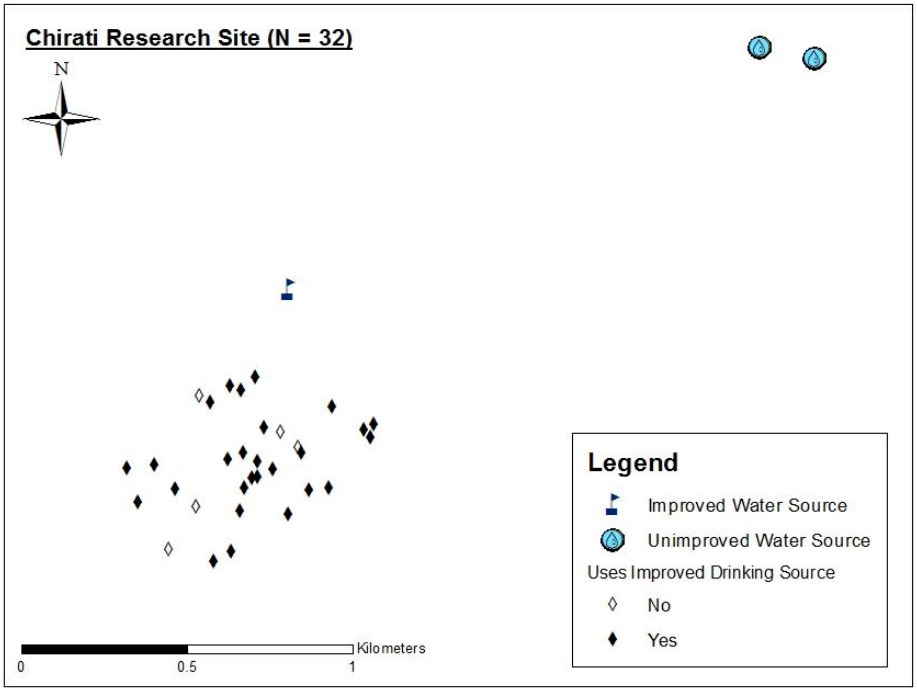

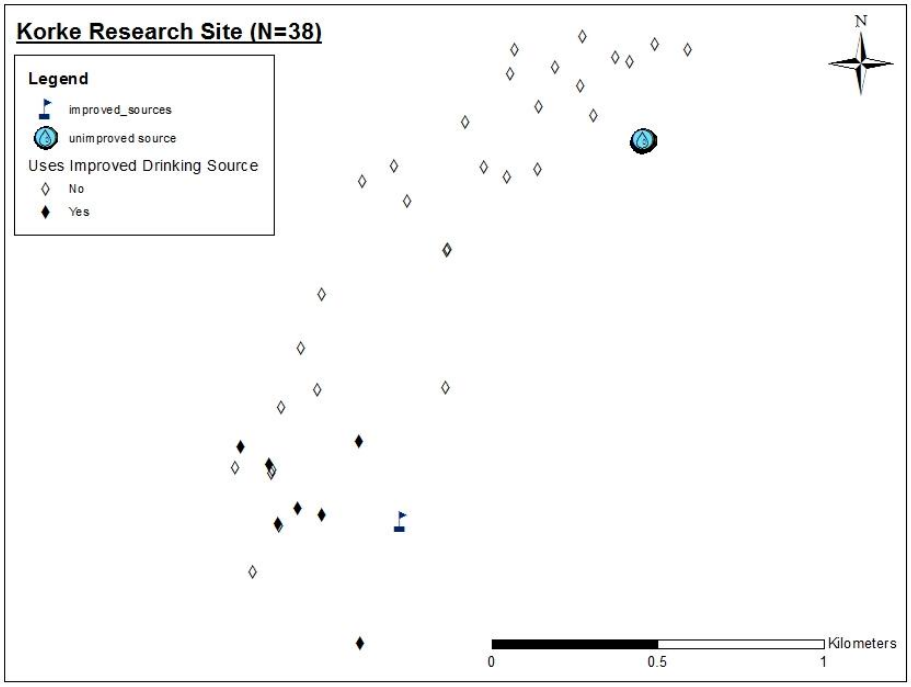
Korke Research Site (N=38)
Legend
improved_sources
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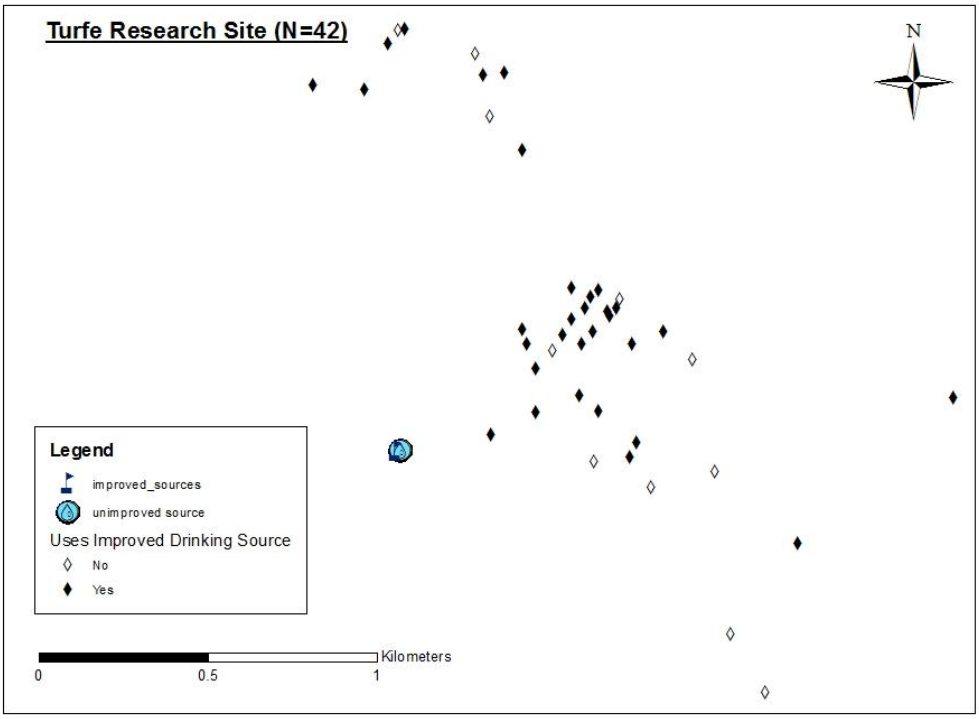
c)


Turfe Research Site (N=42)
Legend
improved_sources
unimproved source
Uses Improved Drinking Source
No
Yes
N
Kilometers
0
0.5
1

d)

APPENDIX C. Consent Form

Emory University, Rollins School of Public Health
Research leaders: Matthew Freeman, Michael Kramer, Leslie Greene
Sponsor: Conrad N. Hilton Foundation

Water Access Equity in Rural Ethiopia

Prior Informed Consent Script: *Household Surveys*

Introduction: Good morning/Good afternoon! My name is _____ and I am working with Millennium Water Program and Emory University in the United States. I am conducting this survey as part of a research project to understand the ways in which people collect water for their household. Your household has been randomly chosen to be asked to volunteer to participate in this research. This research is being conducted by Jimma University, Ethiopian Kale Heywet Church, and Emory University, from the USA.

Procedures: Today, we would like to ask you some questions relating to your water supply, the ways you collect water, and general questions about your household. At the end of our interview, we may take a sample of your water to test for contamination. These questions will take approximately 30 minutes to complete. We would also like to record the location of your household to use in creating a map of the local area.

In order to understand the ways in which you collect water for your household, you may also be asked to carry a GPS device during the daytime for a period of approximately 2-5 days. If you choose to do this activity, someone will visit you at the end of each day to check the device and answer questions. These visits would only take about 15 minutes. The device is designed to be comfortable and small so it should not interfere with your everyday activities.

In order to better understand how people decide on how much water to collect, we may also ask you to participate in another activity in which a researcher will visit your household each day for 2-5 days. They will ask you questions and record how much water you collected for different purposes during those days. If you choose to participate in this activity, each visit will take approximately 20 minutes of your time each day for 2-5 days.

We will use the information gathered to help EKHC and the Millennium Water Program – Ethiopia to better understand ways to improve water access conditions in this region. Your participation in any of these activities is voluntary. You can choose to participate in none, or only one, or if at any time during the survey you feel uncomfortable you are free to stop and ask the researcher to leave. You are also free to stay silent if you don't want to answer a specific question. If you change your mind, you are also free to later ask that information collected from you not be used for this study.

Confidentiality: Our research team will only use the information you share for research purposes only, and we will not tell other people what you said during the household survey. Even though the questions we ask should not be considered sensitive, we will still keep that information confidential. Your name will not be displayed anywhere. The GPS device will record the location of your house but your name or identifying information will not be collected. The GPS devices are programmed with a password lock and only our research team will be able to access this information.

Risks/Compensation: We do not think there are any risks associated with participating in this study to your or your family other than the amount of time it takes to participate. If you are asked to carry a GPS device, there is a slight risk of having the GPS device stolen or broken; however, you will not be responsible for the cost of repair or loss. Following the return of the device, you will receive a small gift of household soaps to express our appreciation for your participation. If you participate in the extra visits about water quantity, you would also receive a bar of soap to thank you for the extra time that you contributed. There are no other direct benefits to you for participating. Your participation may benefit this and other communities by helping us find the best ways to improve water interventions. The survey is a confidential exercise and your name will not be disclosed anywhere.

Contacts: If you have any concerns or questions about this research or your rights as a participant, even after this is finished, you may contact:

Yohannes Demessie
Program Manager
Ethiopian Kale Heywet Church
Telephone: +251 911 448619

Emory University Institutional
Review Board
1599 Clifton Road, NE
5th Floor East
Atlanta, GA 30322, USA
001+404-712-0720

Entitlement: If you would like to keep a written copy of the information I just told you, please ask and I will be happy to give it to you to take home. Do you have any questions?

Do you wish to participate in the questionnaire? [Circle their verbal response]
Yes **No**
Do you wish to participate in carrying a GPS device? [Circle their verbal response]
Yes **No**
Do you with to participate in follow-up visits to discuss water quantity?
Yes **No**

APPENDIX D. Household Survey (English Version)

Household ID number: ___ ___ ___ ___

Language: 1. Amharic 0. Oromifa

Got : _____ Village: _____ Kebele: _____
Woreda:_____

Date of interview (dd/mm/yyyy) |___|___|/|___|___|/|_2_|_0_| _1_|_2 | *(Use European calendar!)*

Enumerator name _____ Enumerator CODE: |___|___|

Checked by/ _____

➡ IMPORTANT NOTE TO ENUMERATOR: The desired and preferred respondents are the female most responsible for household or another person most responsible for taking care of the household's **water collection needs.**

➡ IMPORTANT NOTE TO ENUMERATOR: Read through and get CONSENT BEFORE you start filling in the questionnaire!

Did they give consent? *(circle):* 0) No → **mark on ID TRACKING FORM and move to next house indicated**

1) Yes

1. RESPONDENT: **"I would like to first learn about you."**		
1.01	*OBSERVE:* **Gender of respondent**	1 = Male 2 = Female
1.02	**Age of respondent** *(If age is unknown, approximate through past events)*	|___|___| years
1.03	**Who is the head of this household?**	1. Myself 2. Husband or Father 3. Wife or Mother 4. Another man

		5. Another woman
1.04	**What is the marital status of the head of this household?**	1. Married 2. Single 3. Widowed 4. Divorced/ separated 5. Other 99. Don't know

2. HOUSHOLD COMPOSITION

"I would like to ask you about the people most responsible in this household. Both male and female."

	MALE most responsible in household		**FEMALE most responsible in household**
2.01	**What is the age of the MALE head of this household?** |__|__| Years *(00 = dead/; 98 = n/a; 99= don't know)* *(If dead or n/a, → skip to 2.04)*	**2.04**	**What is the age of the FEMALE most responsible for this household?** |__|__| Years *(00 = dead/; 98 = n/a; 99= don't know)* *(If dead or n/a, → skip to 2.07)*
2.02	**What is the level of education of the MALE head of this household?** 1. Can't read or write 2. Read & write only, *(no formal education)* 3. Grade 1-6 4. Grade 7-8 5. Grade 9-10 6. Grade 11-12 7. > Grade 12	**2.05**	**What is the level of education of the FEMALE most responsible for this household?** 1. Can't read or write 2. Read & write only, *(no formal education)* 3. Grade 1-6 4. Grade 7-8 5. Grade 9-10 6. Grade 11-12 7. > Grade 12
2.03	**What is the profession of the MALE head of household?** *(circle only one response)* 1. Agriculture/ livestock 2. Skilled labor 3. Unskilled labor 4. Merchant 5. Teacher, other requiring higher	**2.06**	**What is the profession of the FEMALE head of household?** *(circle only one response)* 1. Agriculture/ livestock 2. Skilled labor 3. Unskilled labor 4. Merchant 5. Teacher, other requiring higher

	education 6. Unemployed 7. Other: _____		education 6. Unemployed 7. Other: _____
2.07	**How many males 18 years or older usually live in this household, including the head of household?**	Adult males: |___|___|	
2.08	**How many females 18 years or older ususally live in this household, including the female most responsible.**	Adult females: |___|___|	
2.09	**How many children age 5-17 years old usually** **live in this household?**	Children 5-17: |___|___|	
2.10	**How many children under 5 years old usually** **live in this household?**	Children < 5: |___|___|	
2.11	**How many children in your household attend school?**	Children in school: |___|___|	
3. WATER COLLECTION: **"Now, I would like to ask you about the ways that your household collects water."**			
3.01	**Who is the main person who usually collects water for your household?**	*(Only one answer is allowed!)* 1. Adult woman in household 2. Adult man in household 3. Girl child in household 4. Boy child in household 5. Outside person 6. Other: _____	
3.02	**How many other people in the household typically help that person to fetch water?**	[_____] people	
3.03	**Who usually helps fetch water?** *Probe:* **Is there anyone else?**	*(Multiple choices possible)* 1. Adult woman in household 2. Adult man in household 3. Girl child in household 4. Boy child in household 5. Outside person 6. Other: _____ 7. No person helps	
3.04	**Do you usually use animals, a bicycle, or a cart to carry water that you collect for the household?**	0. No 1. Yes	

"Will you show me all the containers you have available to use to collect water from outside the household?"		
3.05	**How many of each of these containers do you have?**	*Calculate total capacity by adding together the size of each container (how many liters it carries) times the number of containers* Total capacity of water collection containers: [_____] liters
3.06	**How often does someone usually go to collect water for this household in a typical week?**	*(Only one answer is allowed!)* 1. More than 7 times per week (more than once per day) 2. 6-7 times per week (once every day) 3. 3-5 times per week 4. 1-2 times per week 5. No water collection (has household tap)
3.07	**Will you show me any containers you use to STORE water at this household, which are DIFFERENT from the containers used to collect water?** *(do not include rainwater tank)*	Total capacity of storage containers: [_____] liters *(do not include collection containers counted in question 3.05)* *9999 = No other containers to store water*
3.08	**Does this household have a functional rainwater storage tank?**	0. No → SKIP to 4.01 1. Yes
3.09	*If yes, OBSERVE: What is the capacity of this tank?*	[_____] liters

ENUMERATOR: Write the code for each source, and go back to answer the questions for each one

4. WATER SOURCE INVENTORY								
"Now can you please tell me about ALL the different sources you have used for ANY PURPOSE in the past 12 MONTHS. Let's start with the main one you use…"								
		Source 1	**Source 2**	**Source 3**	**Source 4**	**Source 5**	**Source 6**	**Source 7**
4.01	**…What type of source is this?** 1. Open water bodies (river, lake, dam, stream, irrigation canal, drainage ditch, etc) 2. Unprotected hand dug well 3. Unprotected spring 4. Protected hand dug well 5. Protected well with hand pump 6. Protected spring 7. Rainwater tank 8. Household tap (piped to house) 9. Piped water to yard/plot of the house 10. Public tap/standpipe 11. Water vendor/ Sold from cart 96. Other *(describe)*	[____]	[____]	[____]	[____]	[____]	[____]	[____]
4.02	**I have a map that community members made. Can you show me which source this is on the community map?** *Write the code for this source from the map*	Source code: |__|__|	Source code: |__|__|	Source code: |__|__|	Source code: |__|__|	Source code: |__|__|	Source code: |__|__|	Source code: |__|__|

	Household tap = code [88] *Can't find on map = code [99]*							
4.03	**How far do you travel to this source, one-way?** *(Write in **meters!** 1 km = 1,000 meters)*	[_____] meters	[_____] meters	[_____] meters	[_____] meters	[_____] meters	[_____] meters	[_____] meters
4.04	**How much time does it take you to travel to this source, one-way, to get water?** *(Write in **minutes!** 1 hour = 60 minutes)*	[_____] minutes	[_____] minutes	[_____] minutes	[_____] minutes	[_____] minutes	[_____] minutes	[_____] minutes
4.05	**How long do you usually have to wait at this source before you can get water?** *(Write in **minutes!** 1 hour = 60 minutes)*	[_____] minutes	[_____] minutes	[_____] minutes	[_____] minutes	[_____] minutes	[_____] minutes	[_____] minutes
4.06	**Do you usually use this source during the rainy season, dry season, or both?** 1. Rainy 2. Dry 3. Both	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]

Continued questions about each source on next page…

	…Continued from above	**Source 1**	**Source 2**	**Source 3**	**Source 4**	**Source 5**	**Source 6**	**Source 7**
4.07	**Are there ever times that you want to use this source but it is not functioning?** 0. No 1. Yes	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]
4.08	**For how many months out of the year is this source NOT functional?**	[_____] months	[_____] months	[_____] months	[_____] months	[_____] months	[_____] months	[_____] months
4.09	**Do you ever use this source for DRINKING and COOKING?** 0. No 1. Yes	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]
4.10	**For how many months out of the year do you rely on this source for some of your DRINKING and COOKING water?**	[_____] months	[_____] months	[_____] months	[_____] months	[_____] months	[_____] months	[_____] months
4.11	**Do you have to pay for this source?** 0. No 1. Yes	[_____] If 0. No → SKIP to 4.13	[_____] If 0. No → SKIP to 4.13	[_____] If 0. No → SKIP to 4.13	[_____] If 0. No → SKIP to 4.13	[_____] If 0. No → SKIP to 4.13	[_____] If 0. No → SKIP to 4.13	[_____] If 0. No → SKIP to 4.13
4.12	***If yes,* How much do you have to pay?**	[_____] birr *Circle whether*	[_____] birr *Circle*	[_____] birr *Circle*	[_____] birr *Circle*	[_____] birr *Circle*	[_____] birr *Circle whether it is per:* Jerrycan	[_____] birr *Circle whether*

		it is per: Jerrycan / liter / week / month / year /	*whether it is per:* Jerrycan / liter / week / month / year /	*whether it is per:* Jerrycan / liter / week / month / year /	*whether it is per:* Jerrycan / liter / week / month / year /	*whether it is per:* Jerrycan / liter / week / month / year /	/ liter / week / month / year /	*it is per:* Jerrycan / liter / week / month / year /
4.13	**Do you ever treat this water to make it safe for drinking?** 0. No 1. Yes	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]
4.14	**When was the last time someone collected water from this source for your household?** 1. Within this week 2. Within this month 3. More than 1 month ago	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]	[_____]
4.15	**Are there any other sources you use for any purpose any time throughout the year?**	0) No → Move to #4.16 1) Yes → Fill out next column from 4.01	0) No → Move to #4.16 1) Yes → Fill out next column from 4.01	0) No → Move to #4.16 1) Yes → Fill out next column from 4.01	0) No → Move to #4.16 1) Yes → Fill out next column from 4.01	0) No → Move to #4.16 1) Yes → Fill out next column from 4.01	0) No → Move to #4.16 1) Yes → Fill out next column from 4.01	0) No → Move to #4.16 1) Yes → Fill out next column from 4.01

4.16	**Which of these water sources you told me is the MAIN source you CURRENTLY use for DRINKING and COOKING?** *Record reference number of water source from the map.*	*(Only one answer is allowed!)* Water Source: |___|___|___| *If can't find on map, write type of source:*
4.17	**What are all the reasons that you use this source as your main source for drinking and cooking instead of another?** *PROBE:* **Are there any other reasons?**	*(Multiple answers possible. Do not read options!)* 1. It is the only source available 2. It is the source assigned to this village 3. Quality 4. Health 5. Taste 6. Cost 7. Distance/time required to get to source 8. Time waiting in queue 9. Easy path to travel to source 10. Easy to collect water at source 11. Like the way it is managed 12. Trough or other facilities for convenient multiple usage 13. Other: _____
4.18	**Of the things you told me, which of those is the ONE MOST IMPORTANT reason that you use this as the main source for drinking and cooking instead of another?**	*(Only one answer is allowed!)* 1. It is the only source available 2. It is the source assigned to this village 3. Quality 4. Health 5. Taste 6. Cost 7. Distance/time required to get to source 8. Time waiting in queue 9. Easy path to travel to source 10. Easy to collect water at source 11. Like the way it is managed 12. Trough or other facilities for convenient multiple usage 13. Other: _____
4.19	**Which of these water sources you told me is the MAIN source you use for DRINKING and COOKING in the DRY SEASON?**	*(Only one answer is allowed!)* Water Source: |___|___|___| *Write 999 and describe type of source if can't find on map:*

EKHC WATER POINT QUESTIONS: Now I would like to talk about this water point: *(describe it by name and point to it on map)*

4.20	*ENUMERATOR: Point to the source with star on the map and tell the name.* **Are you a registered user of this water point?**	0. No 1. Yes 2. No registration required
4.21	**Have you ever gone to collect water from this source, but you were not able to collect the water you wanted for some reason?**	0. No → **Skip to 4.24** 1. Yes 99. Don't know → **Skip to 4.24**
4.22	**Why weren't you able to collect the water you wanted?** *Probe:* **Are there any other reasons?**	*(Multiple responses possible. Do not read options.)* 1. Not enough at source 2. Source was not functioning 3. WASHCOM limits amount 4. Queue was too long 5. Other: _____
4.23	**When you couldn't get water there, did you go to another source instead?**	0. No 1. Yes 99. Don't know
4.24	*ENUMERATOR: Did they say this source is their MAIN source for DRINKING and COOKING in question **4.16**?*	0. No 1. Yes → **Skip to 5.01**
4.25	*If they do NOT use this source as the main, ask:* **What are all the reasons you do NOT currently use this as your MAIN source for DRINKING and COOKING?** *(refer again to the selected source)* *Probe:* **Are there any other reasons?**	*(Multiple responses possible. Do not read options.)* 1. It is not/not always functional 2. My village is not allowed to use it 3. Not a registered user 4. Quality 5. Health 6. Taste 7. Cost 8. Distance/time required to get to source 9. Time waiting in queue 10. Difficult path to travel to source 11. Difficult to collect water at source 12. Don't like the way it is managed/conflict over water? 13. No trough or other facilities for multiple usage 14. Other: _____

5. WATER QUANTITY INVENTORY
"Please tell me all of the different water points that were visited <u>YESTERDAY</u> by your household

members, to collect water for ANY purpose."

5.01 ***Which day of the week was yesterday?***	#	**a) Which water points were visited on this day for ANY purpose?** *(use code from map)* *If not found on map, write 999 and describe:*	**b) How many liters total were collected in containers from each water point on this day?**	**c) On this day how many total trips were made to collect from this water point?**
(Circle):	**5.02**	1st Water point code: |___|___|___|	[_____] liters	[_____] trips
Monday	**5.03**	2nd Water point code: |___|___|___|	[_____] liters	[_____] trips
Tuesday	**5.04**	3rd Water point code: |___|___|___|	[_____] liters	[_____] trips
Wednesday	**5.05**	4th Water point code: |___|___|___|	[_____] liters	[_____] trips
Thursday	**5.06**	5th Water point code: |___|___|___|	[_____] liters	[_____] trips
Friday	**5.07**	**On this day did anyone in this household bathe or wash clothes or utensils in a lake or river?**		*Circle:* No Yes
Saturday				
Sunday				

Please tell me all of the different water points that were visited on the <u>DAY BEFORE YESTERDAY</u> by your household members, to collect water for ALL purposes."

5.08 ***Which day of the week was the day before yesterday?***	#	**a) Which water points were visited on this day for ANY purpose?** *(use code from map)* *If not found on map, write 999 and describe:*	**b) How many liters total were collected in containers from each water point on this day?**	**c) On this day how many total trips were made to collect from this water point?**
(Circle):	**5.09**	1st Water point code: |___|___|___|	[_____] liters	[_____] trips
Monday	**5.10**	2nd Water point code: |___|___|___|	[_____] liters	[_____] trips
Tuesday	**5.11**	3rd Water point code: |___|___|___|	[_____] liters	[_____] trips

Wednesday Thursday Friday Saturday Sunday	**5.12**	4th Water point code: |__|__|__|	[_____] liters	[_____] trips
	5.13	5th Water point code: |__|__|__|	[_____] liters	[_____] trips
	5.14	**On this day did anyone in this household bathe or wash clothes or utensils in a lake or river?**		*Circle:* No Yes

5.15	**Do you feel the water quantity you use for this household for all purposes is sufficient for the needs of your family?**	0. No 1. Yes → **Skip to 5.17** 99 Don't know
5.16	*If no,* **What is the main reason you can't get sufficient water?**	*(Only one answer is allowed!)* 1. Not enough at source 2. Source is not functioning 3. WASHCOM limits amount 4. Source is too far (too much time) 5. Not enough manpower to collect enough 6. Not enough time to collect 7. Sources have bad quality 8. Drought 88. Other: _____
5.17	**Do your neighbors ever take or buy water from your household?**	0. No 1. Yes 99. Don't know
5.18	**Does your household ever take or buy water from neighbors?**	0. No 1. Yes 99. Don't know

6. USAGE OF WATER		
6.01	**Apart from water for drinking, cooking, washing, cleaning and bathing, Does your household collect water for activities for income generation or livelihood uses?** *(DO NOT READ the list aloud for the respondents, LISTEN, keep probing what else)*	*(Multiple responses possible. Do not read options.)* 1. Irrigation 2. Fish farming 3. Livestock/Watering animals 4. Brick making 5. Beer brewing 6. Vegetable garden 7. Fruit trees 8. Other trees 9. Selling water 88. Other _____ 0. None

	PROBE: **Are there any other activities?**	
6.02	**How often do adults in this household wash their bodies?**	*(Only one answer is allowed!)* 1. More than once per week 2. Once per week 3. 1 – 3 times per month 4. Not even 1 time per month (< 1/month)
6.03	***How often are children under 5 bathed?***	*(Only one answer is allowed!)* 1. More than once per week 2. Once per week 3. 1 – 3 times per month 4. Not even 1 time per month (< 1/month) 5. Not applicable (do not have children <5)
6.04	**How often do you or others wash clothes?**	*(Only one answer is allowed!)* 1. More than once per week 2. Once per week 3. 1 – 3 times per month 4. Not even 1 time per month (< 1/month)

7. OTHER HOUSEHOLD CHARACTERISTICS		
7.01	**Has any child under 5 years old in this household had diarrhea in the past 2 weeks? Diarrhea means 3 or more loose or watery stools in one day.**	0. No 1. Yes 96. Not applicable (no children <5) 98. Don't know
7.02	**Are any members of these household persons who are disabled (such as physical movement disability, blind, deaf, or mental disability)?**	0. No 1. Yes 98. Unwilling to say 99. Don't know
7.03	**Have any of your family members been chronically ill or bedridden? (this means frequently and/or continuously ill for 3 or 4 months in the past 12 months?)**	0. No 1. Yes 98. Unwilling to say 99. Don't know

7.04	**In this household are there persons under 18 years who have lost one or both parents (orphans)?**	0. No 1. Yes 98. Unwilling to say 99. Don't know		
7.05	**Does this household own this house and the land it is on?**	0. No 1. Yes 98. Unwilling to say 99. Don't know		
7.06	**What type of fuel does your household MAINLY use for cooking?**	*(Only one answer is allowed!)* 1. Electricity 2. Gas/biogas 3. Parafin/ Kerosene 4. Charcoal from wood/ coal 5. Firewood/ straw/ Dung 96. Other_____		
7.07	**How many of the following does the household own?** *(Write the number owned next to each asset.* *Read each one SENSITIVELY.)*		**Type of animal** ***(read each one)***	**Number owned**
		7.07a	**Chickens**	
		7.07b	**Cow**	
		7.07c	**Oxen**	
		7.07d	**Goats**	
		7.07e	**Sheep**	
		7.07f	**Camels**	
		7.07g	**Donkeys or Mules**	
		7.07h	**Horses**	
7.08	**Which of the following items does the household have in working order?** *(Read each one SENSITIVELY.)*		**Household ítems**	**Yes or No?**
		7.08a	**Electricity**	0) No 1) Yes
		7.08b	**Solar power**	0) No 1) Yes
		7.08c	**Mobile phone**	0) No 1) Yes

		7.08d	**Bicycle**	0) No 1) Yes
		7.08e	**Radio**	0) No 1) Yes
		7.08f	**TV**	0) No 1) Yes
		7.08g	**Refrigerator**	0) No 1) Yes
		7.08h	**Motorcycle / scooter**	0) No 1) Yes
		7.08i	**Vehicle**	0) No 1) Yes
		7.08j	**Electric mitads**	0) No 1) Yes
		7.08k	**Kerosene or pressure lamps**	0) No 1) Yes
		7.08l	**Furniture (Bed, tables, cabinet, chairs)**	0) No 1) Yes
7.09	*OBSERVE: (Type of roof on the main house):* *If mixed record the predominate one*	*(circle only one)* 1. Thatched roof 2. Corrugated metal roof 3. Wood and mud 4. Tiles 96. Other _____ 99. Don't know		
7.10	*OBSERVE: (Type of floor in the main house:)* *If mixed record the predominate one*	*(circle only one)* 1. Earth/mud/ dung 2. Cement 3. Wood plank 96. Other _____ 99. Don't know		
7.11	**Does this household have its own latrine with a slab and house?**	0. No 1. Yes		
7.12	**Does anyone in this household currently participate in a community organization or committee?**	0. No → **Skip to 7.14** 1. Yes 98. Unwilling to say → **Skip to 7.14** 99. Don't know → **Skip to 7.14**		

7.13	**If yes, what type of community organization or committee do they belong to?** *PROBE:* **Are there any other groups?**	*(Multiple responses possible. Do not read options.)* 1. Church Committee 2. Youth Association 3. Government Committtee 4. School Committee 5. Women's Association 6. Idir 7. Water Committee 8. Development Committee 9. Security Committee 96. Other/ _____ 99. Don't know/
***ASK:* "Do you have a place where you wash your hands after defecation? If so, can I please see it?"** *OBSERVE conditions of the handwashing station:*		
7.14	*OBSERVE: Is there a place for handwashing?*	0. No → **Skip to section 8** 1. Yes 99. Refused to show → **Skip to section 8**
7.15	*OBSERVE: Is there currently water at this location?*	0. No 1. Yes
7.16	*OBSERVE: Is there soap at this location?*	0. No 1. Yes

8. GPS WAYPOINT

We are almost done. I would like to record the location of your household to use in creating a map of the local area.

Do I have your permission? **1. Yes**

0. No → SKIP to 9.01

8.01	**GPS Unit ID**	Emory #[_____]
8.02	**Waypoint Number**	[___|___|___]
8.03	**Latitude**	**N.** |___|___|. |___|___||___|___|___|
8.04	**Longitude**	**E.** |___|___|___|. |___|___||___|___|___|
8.05	**Elevation**	**[_____]** meters

9. WATER SAMPLE COLLECTION

Finally, I would like to take some water from your drinking water supply to test the quality. **Do I have your permission?**

1. Yes

0. No →

SKIP to 9.09

Can you please give me some water for drinking?

Instructions to enumerator: First label the bag with the HOUSEHOLD ID number. Then ask the respondent to pour the water into the bag as if they were giving you water in a cup to drink. That means, using whatever method they use to serve water for drinking (dipping a cup in, pouring, etc). Seal the bag and place it in the cold box.

9.01	*ENUMERATOR: Was a sample collected?*	*1. Yes, water sample collected* *2. No sample collected due to not enough water →* ***Skip to 9.20*** *3. No sample collected due to refusal →* ***Skip to 9.20***
9.02	*OBSERVE: What type of container is it?*	1. Clay pot 2. Jerrycan 3. Metal container 96. Other: _____
9.03	*OBSERVE: What type of opening does the container have?*	1. Wide neck (can fit a hand inside) 2. Narrow neck (cannot fit a hand inside)
9.04	*OBSERVE: How did they give the sample?*	1. Poured directly from container into bag 2. Dipped cup in container 3. Dipped long-handled cup or spoon in container 96. Other: _____
9.05	**Where did this water come from?** *(Identify source on the map)*	Source number: |__|__|__| If not on map, write 999 and describe:
9.06	**When was this water fetched?**	1. Today 2. Yesterday 3. Before yesterday
9.07	**Did you treat this water to make it safe to drink?**	0. No → SKIP to 9.09 1. Yes 99. Don't know → SKIP to 9.09

9.08	*If yes,* **What method did you use?** *(Note – DO NOT READ the list aloud for the respondents, LISTEN and record corresponding code.*	1. Boil 2. Bishangari/Wuha Agar/PUR/ bleach/chlorine 3. Strain it through a cloth 4. Use water filter (ceramic, sand, etc.) 5. Let it stand and settle 6. Three pot system 7. Solar disinfection 8. Moringa seeds or other herbs 9. Alum 96. Other (specify)/_____ 99. Don't Know

We have reached the end of the household survey! Thank you very much for your time and patience.

9.09. Do you have any questions or comments for me?

_____

10.01 *ENUMERATOR: Was this household selected for* ***Water Quantity Follow-Up****? (Check ID Tracking Form)*

0. No → **Skip to 11.01**
1. Yes → Read consent script below:

<u>Consent script:</u> "You have been randomly selected to voluntarily participate in an additional activity. We would like to get a more detailed understanding of how people in this community use water throughout the week. We have recruited a member of your community to visit people two more times this week to very briefly ask a few follow-up questions. Each visit should only last about 10 minutes. There are no risks to participating in this and no benefits. Participation is completely voluntary, and there is no penalty for refusing."

10.02 Would you be willing to participate in these follow-up visits?

0. No → Record response in ID Tracking Form and go to 11.01
1. Yes → Record response in ID Tracking Form and go to 11.01

11.01 *ENUMERATOR: Was this household selected for **GPS Tracking Follow-Up**? (Check ID Tracking Form)*

0. No → End survey and leave.
1. Yes → Read consent script below:

Consent script: "You have been randomly selected to voluntarily participate in an additional activity. In order to understand the ways in which people in this community collect water, we request that you carry this special device for the rest of today (show the device). This device will mark a pattern on a map to show us the path you travel to the water sources you collect from. This information will not be linked to your name, and we will hold it confidential for our own learning purposes. I will return to your house later today to collect the device again and ask some follow-up questions that will last about 10 minutes. There are no benefits and no risks to participating in this activity other than the extra time for the follow-up visit. We ask that you very carefully protect this device. It has no value on its own without the other attachments that only we have to download data. In the unlikely event that something happens to damage this device, you will not be responsible for it."

11.02 Do you plan to collect water for your household today?

0. No, or already collected it → Record in ID Tracking Form that GPS tracking NOT done and end survey.
1. Yes

11.03 Will you normally return from collecting water by 4:30pm (10:30 Ethiopian time) today?

0. No → Record in ID Tracking Form that GPS tracking NOT done and end survey.
1. Yes

11.04 Would you be willing to participate in this activity?

0. No → Record in ID Tracking Form that GPS tracking NOT done and end survey.
1. Yes

ENUMERATOR: If all three YES responses were circled, give instructions for the Data Logger GPS device and fill out the following:

11.05	*ENUMERATOR: Record the ID for the GPS tracking device*	Emory #[_____]
11.06	*ENUMERATOR: Record current time.*	Start Time: _____ (use European time)

12. ONLY FILL OUT THE FOLLOWING SECTION AT THE END OF THE DAY AFTER COLLECTING TRACKING DEVICE:

12.01	*ENUMERATOR: What is the current time when you collected the device?*	End Time: _____ (use European time)
12.02	**Did you collect water for your household today?**	0. No → End survey 1. Yes

"Please tell me which water points you visited today to collect water while wearing the device."

		Source 1	**Source 2**	**Source 3**	**Source 4**	**Source 5**
12.03	**Which source did you visit?** *(Write the code for this source from the map)* *Household tap = code [999]*	Source: |__|__|__|	Source: |__|__|__|	Source: |__|__|__|	Source: |__|__|__|	Source: |__|__|__|
12.04	**When did you collect water from this source while wearing the device? Morning, midday, or afternoon?** 1. Morning 2. Midday 3. Afternoon 4. Don't Know 5. Forgot to wear device	[____]	[____]	[____]	[____]	[____]
12.05	**Is there any other water point you travelled to for any purpose?**	0. No → End survey. 1. Yes → Fill out next column from 12.03	0. No → End survey. 1. Yes → Fill out next column from 12.03	0. No → End survey. 1. Yes → Fill out next column from 12.03	0. No → End survey. 1. Yes → Fill out next column from 12.03	0. No → End survey. 1. Yes → Fill out next

						column from 12.03

Thank you for participating!

APPENDIX E: Community Water Mapping Questionnaire

Name of person collecting data: _____

For each water source, answer the following questions:

Community name: _____ Date: _____

Source code: |___|___|

1.	**What type of source is this?**	1. River 2. Stream 3. Lake 4. Dam 5. Irrigation canal 6. UNprotected hand dug well 7. UNprotected spring 8. Protected hand dug well 9. Protected well with hand pump 10. Protected spring 11. Rainwater tank 12. Piped water into house 13. Piped water to yard/plot of the house 14. Public tap/standpipe 15. Water vendor (sold from cart or drum) 16. Other: _____
2	**When did this source first become available?**	(mm/yyyy) |____|____|/|__|__|__|__|
3	**Is this source currently functional?**	0. No 1. Yes 2. Don't know
4	**Is this source functional all year?**	0. No 1. Yes → Skip to 6 2. Don't know

5	**If not, when is it usually not functional?**	*Describe:*
6	**What are the purposes that people use this source for?** *PROBE for all uses. Multiple choices possible.*	1. Drinking 2. Cooking/ making coffee 3. Bathing/ washing face, legs 4. Handwashing 5. Cleaning house/ washing clothes 6. Animals/farming 7. Other income generation 8. Other: _____
7	**Do people pay for this source?**	0. No → Skip to 9 1. Yes 2. Don't know
8	**If yes, how much does each household pay?**	[_____] birr *Circle whether it is per:* jerrycan / liter / week / month / year / other: _____ Note other costs for livestock:

9	**Are there specific times that the water point is available for water collection? If so, what are the times?**	Hours it is open: _____ *(Use European Time)*
10	**Would you say the quality of this source for drinking is very good, good, bad, or very bad?** *If people disagree, try to get consensus, but it's OK to circle the range of answers*	1. Very good 2. Good 3. Bad 4. Very bad
11	**Who is allowed to use this source?**	*Describe:*

	PROBE: Are there only certain villages that can use it?	
12	**Are there any people who do not use this source even if they are allowed to? Who?** *PROBE.*	1. Everyone uses 2. Some people do not use *(describe who):*
13	**Why don't they use this source?** *PROBE.*	*Describe:*
14	**What are the advantages to using this source?** *PROBE.*	*Describe:*
15	**What are the disadvantages to using this source?** *PROBE.*	*Describe:*
16	***[Only if this is the new EKHC source, ask:]*** What was the main source people used before this source was available?	*Describe:*

APPENDIX F: Waterpoint Observation & Interview Questionnaire

MWP-Ethiopia Waterpoint Observation Form

Instructions: *Fill out this form as instructed. Observations are to be done by data collector. Questions are to be asked of those who know most about this water point. For managed water points, gather 2-3 members of the WASHCOM, and/or a caretaker. For non-managed points such as rivers and lakes, ask a person collecting water at the source.*

1.01 Name of person collecting data:
_____

1.02 Common name of water point:
_____

1.03 Water point code (refer to map): |____| - |____|____|

1.04 Date visited: *(dd/mm/yyyy)* |____|____|/|____|____|/|_2_|_0_|_1_|_2_| *(use European calendar!)*

1.05 Time of visit: _____ *(use European time)*

1.06 Village:_____ 1.07 Got: _____

1.08 Kebele: _____ 1.09 Woreda: _____

1.10 GPS Unit ID: Emory #[_____]

1.11 Waypoint Number: [____|____|____]

1.12 Latitude: N |____|____|. |____|____||____|____|____|

1.13 **Longitude:** **E** |____|____|____|. |____|____||____|____|____|

1.14 **Elevation:** _____ meters

If water point is a well or spring tap, only take 1 GPS measurement. ***→ SKIP to 1.24***

If water point is a river, pond, lake, or other open water body*, take 2 additional GPS measurements at other locations where people typically collect water:*

1.15 **GPS Unit ID: Emory #**[_____]

1.16 **Waypoint Number:** [____|____|____]

1.17 **Latitude:** **N** |____|____|.
|____|____||____|____|____|

1.18 **Longitude:** **E** |____|____|____|.
|____|____||____|____|____|

1.19 **Elevation:** _____ meters

1.20 **GPS Unit ID: Emory #**[_____]

1.21 **Waypoint Number:** [____|____|____]

1.22 **Latitude:** **N** |____|____|.
|____|____||____|____|____|

1.23 **Longitude:** **E** |____|____|____|.
|____|____||____|____|____|

1.24 **Elevation:** _____ meters

1.25 Name(s) and titles/positions of person(s) that were interviewed:

Name: _____ position: _____

Name: _____ position: _____

Name: _____ position: _____

1.26 Which villages does this water point serve?

1. _____ 2. _____ 3. _____

4. _____ 5. _____ 6. _____

7. _____ 8. _____ 9. _____

1.27 When was this water point first developed? *(mm/yyyy)*

|____|____|/|____|____|____|____| *(European)*

1.28 If it is rehabilitated, when was it rehabilitated? *(mm/yyyy)*

|____|____|/|____|____|____|____| *(European)*

1.29 What type of water source is it? *(circle)*

17. River
18. Stream
19. Lake
20. Pond
21. Dam
22. Irrigation canal
23. UNprotected hand dug well
24. Protected hand dug well
25. Protected well with hand pump
26. Protected well with automatic pump
27. Protected spring
28. UNprotected spring
29. Rainwater tank
30. Piped water into house
31. Piped water to yard/plot of the house
32. Public tap/standpipe
33. Water vendor (sold from cart or drum)
34. Other: _____

Take photos. *(1st photo must be of first page of this survey for identification purposes)*

Take a water sample. Label it with the water point code in 1.03 above.

1.30 Turbidity reading: **_____** NTU

1.31 Temperature: _____ C pH: _____

1.32 Mark IDs given to each sample collected *(use water point code above, dash 1,2,3, etc. e.g. 015-1, 015-2, 105-3.)*

a) _____ b) _____ c) _____ d) _____

1.33 Time of sample collection: _____ *(use European style of time)*

1.34 Note color of water: *(circle):*

1. Very clear
2. Slightly cloudy (but can see through)
3. Very cloudy (but can see through)
4. Dark (cannot see through it)

2. Observations by data collector

2.01	Is there a water trough for animals to drink?	Yes	No	
2.02	Is there a water retention structure at this water point?	Yes	No	
2.03	How many people are queued at this source right now?	_____ people		
If this source is a river, pond, lake, or other open water body, <u>end the survey</u>. Otherwise, continue to answer the next questions.				
2.04	Is the water point currently functioning?	Yes	No	Partly
2.05	Please describe repair needs that you see:			
2.06	Are there signs of fecal contamination near the water point (such as animals at water point, feces on ground)?	Yes	No	
2.07	MEASURE: What is the flow rate at this source? *(Select the main water point and use a watch to determine the number of seconds it takes to fill a defined volume (e.g. a 10L jerrycan). Then calculate the # of liters that come out per second. For a hand pump you must pump one stroke per second)*	[_____] liters per second		

3. Interview with WASH Committee or caretaker or other				
3.01	Is this source managed by a WASH Committee?	Yes	No	
3.02	Does the water point have a caretaker?	Yes	No	
3.03	When did this source first become available?	(mm/yyyy) |____|____|/|___|___|___|___|		
3.04	Are there specific times that the water point is available for water collection?? If so, what are the times?	Hours it is open: *(Use European Time)*		
3.05	Are there ever times that this source is not able to be used?	Yes	No	Don't know
3.06	*If yes,* Please describe times during the year when this source is not functioning or not fully functioning and why:			
3.07	For how many days was this source NOT functional in the past 6 months? *(do not count days before source was created, if it is less than 6 months old)*	_____ days *(if always functional, write 0 days. If unsure, make an estimate)*		
3.08	How many households are **registered users** with this water point? *(confirm by records if available)*	[_____] households	Don't know	N/A (there is no registration for this source)
3.09	What makes a person eligible for registering to become a user? *Describe.*			
3.10	What is the process to become a registered user? *Describe.*			
3.11	Are there people who are eligible to become a user, but they CHOOSE to NOT be a user?	Yes	No	Don't know

3.12	*If yes,* why?			
3.13	Are all ethnic groups, individuals, and other groups able to become a user?	Yes	No	Don't know
3.14	*If no,* please describe which groups are not able to use the water point and why:			
3.15	In the past 6 months, were there people who were denied access because they were not registered users?	Yes	No	Don't know
3.16	How common is it for people who are NOT registered users to collect water from this source?	Very common *(many who collect water here are unregistered users)*	Somewhat common *(a few who collect water here are unregistered)*	Never. *(only registered users collect water here.)*
3.17	On average, how many liters of water per day are collected from this water point? *(take an average from the previous 7 days based on records, if available. Otherwise, ask for estimate)*	[_____] *Liters*		Don't know
3.18	Is there any restriction on the maximum number of liters a household can collect in one day? If so, how many?	[_____] *Liters maximum*		No restriction
3.19	Approximately how many people and how many livestock gathered water from this water point yesterday?	**a) # people**	**b) # livestock**	Don't know
3.20	At the most busy time, on average, how long do most people wait at this water point before they can collect water? (*Ask them to make their best estimate)*	[_____] *Minutes*		Don't know
3.21	Has there been any conflict regarding the use of this water point?	Yes	No	Don't know
3.22	*If yes,* was it resolved? *Please describe the issue:*	Yes (resolved)	No	Don't know

			(still ongoing)	
3.23	Do all users contribute fees regularly?	Yes	No	Don't know
3.24	How much does each user pay for using this water point?	[_____] birr *Circle whether it is per:* Jerrycan / liter / week / month / year / other: _____		Don't know
3.25	If there is a separate cost to water animals, what is the cost per animal?	[_____] birr per _____ [_____] birr per _____ [_____] birr per _____		
3.26	In the past 6 months, were there ever users who were unable to pay?	Yes	No	Don't know
3.27	If users were unable to pay, were they denied access to use of the water point?	Yes	No	Don't know
3.28	Are there any other reasons that people are unable to use the water point? *(describe below)*			

4.0 Comments from Committee about challenges they face, or anything else they'd like to say:

_____

5.0 Enumerator Observation Notes

Summarize things you observed or heard during this interview that help describe how this water point functions, level of access for all, etc:

_____

APPENDIX G: IRB Letter of Approval

EMORY UNIVERSITY | Institutional Review Board

18 May, 2012

RE: Determination: No IRB Review Required
57316- Title: *Water Access Equity in Rural Ethiopia*
PI: Matthew Freeman, MPH, PhD

Dear Dr. Freeman,

Thank you for requesting a determination from our office about the above-referenced project. Based on our review of the materials you provided, we have determined that it does not require IRB review because it does not meet the definition(s) of "research" involving "human subjects" or the definition of "clinical investigation" as set forth in Emory policies and procedures and federal rules, if applicable. Specifically, in this project, you will be evaluating efficacy Millennium Water Program-Ethiopia safe water intervention program.

This determination could be affected by substantive changes in the study design, subject populations, or identifiability of data. If the project changes in any substantive way, please contact our office for clarification.

Thank you for consulting the IRB.

Sincerely,

Julia Duckworth
Research Protocol Analyst
This letter has been digitally signed

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