ETH Zürich

Applicability of Three Water Tests for Detection of Fecal Contamination in Drinking Water in Households and Their Impact on Water-related Behavior

A Case Study for Eastern Uganda

A Thesis
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1 Abstract

Dissemination of contamination data has shown potential to reduce fecal contamination in drinking water in developing countries. Nevertheless, triggering and maintaining improved water, sanitation and health (WASH) practices is challenging. This study investigates how water testing influences reported behavior and subsequent water quality among 102 households in rural communities in Busia District, Uganda. For this purpose, the most suitable water test was selected by laboratory experiments and application in the field. In the end, the Pathoscreen test was chosen for its simplicity and accuracy. In the next step, all study participants received a general WASH-training on community level. Additionally, one-quarter of the participants attended the water testing of their community's sources. Two quarters experienced water testing in their own households, either applied by the researcher or by themselves. This interventions resulted in no significant change in fecal contamination, when water from the community's sources was publicly tested. But, a significant reduction was observed after having tested the water individually in the households. This improvement in water quality can only partially be explained by reported behavior change. Larger sample sizes and more robust study designs are required to confirm the findings in this study. However, implying water tests in common WASH-trainings seems to have potential to improve drinking water quality in developing countries.

2 Acknowledgments

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My special thanks go to Water School Uganda, who made my stay in Busia uncomplicated and very enjoyable. The support of this NGO was extremely important to me and this research project. Their professional team is highly recommendable. It is a privilege when coworkers become such good friends.

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6 List of Abbreviations

HWTS .... Hygiene, water treatment and sanitation
POU.. Point-of-use
FGD .... Focus group discussion
WASH.. Water, sanitation and hygiene
US EPA .... United States environmental protection agency
MPN .... Most probable number
CBT... Compartment bag test
PT .... Pathoscreen test
CDPT .... Compact dry plate test
HH .... Household
ETH... Eidgenössische Technische Hochschule
EAWAG .... Eidgenössische Anstalt für Wasserversorgung, Abwasserreinigung und Gewässerschutz

7 Introduction

748 Millions of people worldwide still lack access to an improved drinking water source. For the 325 million people in Sub-Saharan Africa without access to safe drinking water, waterborne diseases are a serious death threat (UNICEF, 2014). In Uganda, diarrhea deaths attributable to inadequate WASH are above 10,000 per year (WHO, 2014). It is urgent to improve water quality and water treatment routines. Recent studies show that the impact of information dissemination to the water consumer might have been underestimated [e.g. (Luoto, Levine et al. 2011), (Jalan and Somanathan 2008)]. They found improvement in WASH related behavior after interventions that were based on information events. However, the results of these studies are often equivocal and challenging to compare (Lucas, Cabral et al. 2011). Overall, interventions at a household (HH) level seem to be more effective than water source based interventions (Clasen, Schmidt et al. 2007).

One way to influence water-related behavior is the dissemination of contamination data of the drinking water to the study participant. But, in developing countries, the possibility to measure water contamination is often missing. E.Coli is a widely accepted indicator for fecal contamination. Various testing options are available to measure E.Coli in water samples. Where the standard membrane filtration has the highest accuracy. However, it requires lab equipment, electricity and scientific training of the user. The recent development of new and easy-to-use tests for fecal contamination reveals promising approaches to increase information about water quality at point-of-use (POU) [e.g. (Stauber, Miller et al. 2014), (Kanangire 2013)]. These rapid tests can be applied directly in the field without any need for electricity. Moreover, the accuracy of these test's measurements compare well to the ones of standard laboratory methods (Kanangire 2013).

So far, the effect of different actors performing the test on drinking water has never been investigated. This study examines this influence on water quality and WASH practices of study participants in Eastern Uganda. Hereby, it systematically selects three different tests following a list of criteria. In a focus group discussion (FDG) one of the three tests is chosen and is then applied exclusively in further steps. The effect of water testing is observed in four different groups. Each group experiences a general WASH-training. Furthermore, approach of water testing, which is only conducted in three of the four groups, differs from group to group. One group experiences water testing on community level. Two groups are visited individually at their households. In one of these two groups, the testing is conducted by the study participant. In the other group, the researcher does the testing.

This master thesis studies how water testing can influence the water-related behavior and the water quality of study participants' households. Moreover, it investigates the feasibility to include simple and rapid water tests in future HWTS (hygiene, water treatment and sanitation)-interventions in order to increase motivation to apply improved WASH practices. If the implementation of these tests is feasible, which test should be applied? Furthermore, it attempts to increase drinking water quality at POU and improve WASH-practices. Which intervention leads to the most significant improvements in water quality at POU? How is the quality change reflected in behavioral changes?

8 Background and Literature Review

8.1 Impact of Information Dissemination on Behavioral Change

Contaminated drinking water is a major health threat in large parts of the developing world (UNICEF 2014). To scale this threat down various approaches have been examined so far. One of them is the dissemination of WASH information. An increased knowledge of the risk that contaminated water poses, is a promising approach to improve water quality (Lucas, Cabral et al. 2011). The impact of simple information seem to have been underestimated before. Even though, convincing people to sustainably change their health related behavior seems to be difficult, it is important to know how to do so best (Luoto, Levine et al. 2011). In Jalan and Somanathan (2008), the information dissemination about the fecal contamination of households in rural India changed their water treatment strategy. After a positive result (contaminated water) households showed a by 11% increased likelihood of applying some sort of water purification before consumption. This increase can be compared to the impact of an additional year in school for one son in the household. The negative result didn't change the water treatment routine (Jalan and Somanathan 2008). Promising results were also found by Madajewicz et al. (2006), who conducted a door-to-door information campaign in Bangladesh. After having received information about the arsenic concentration in their households' water, people showed a likelihood of 37% of changing the well within one year. It seemed to be important that the information was carried out individually (Madajewicz, Pfaff et al. 2007). Also in Opar et al. (2005), people in Bangladesh could be motivated to change the well by public education, posting test results and installation of new wells. But out of 65% of people changing the well only 15% indicated health concerns motivated their change. Still, a significant reduction in households consuming arsenic groundwater could be achieved (Opar, Pfaff et al. 2007). Luoto et al

(2011) provided free POU treatment products to rural Kenyan households. If this intervention was coupled with information about local water quality, the water treatment rate observed was increased by 11-24%. Comparing the influence of community based and individual water quality information, they found no increase in POU-usage when information was individually disseminated (Luoto, Levine et al. 2011). Davis et al. (2011) evaluated the impact of information dissemination on the bacteria concentration on the mothers' hand palms and in the household's drinking water. They concluded that households, which received individual water quality test results, are more likely to report behavioral improvement but were equally or less likely to experience actual reduction in fecal contamination (Davis, Pickering et al. 2011). Hamoudi et al. (2012) tested drinking water in Indian households applying a H2S test. 90% of the samples were contaminated. People informed about their bad water quality were more likely to buy water from the local water vendor (1.5 increase). But they didn't apply more time intensive adjustments (Hamoudi, Jeuland et al. 2012). The research team tested the water by themselves.

For future research it might be interesting to observe the influence of study participants, testing their own water. Also, it would be important to observe the long-term change in behavior. Thereby evaluating, which sort of information leads to the most desirable behavior change (Jalan and Somanathan 2008). Furthermore, repeated exposure might be necessary to assure success of the intervention (Luoto, Levine et al. 2011).

It is important to use an explicit theoretical model about how the information is disseminated an under which contexts information is most likely to lead to behavior change (Lucas, Cabral et al. 2011). It was suggested to respect the following four points in future studies.

- The need for evidence of impact using robust methods (e.g. random allocation of study participants, use of non-intervention control group)
- The format of information provided (e.g. source and/or household, binary or continuous, risk or safety messages)
- The methods of information dissemination
- The use of community level interventions and outcomes

Lucas et al. (2011) reviewed scientific literature about impact of contamination data dissemination on consumer behavior. They found that studies are equivocal and diverse. Often the results are highly biased. There is an urgent need, especially for microbiological information dissemination studies.

8.2 Water Tests to Obtain Contamination Data

Clasen (2007) compared various interventions to improve water quality. The variety of different interventions is large (Clasen, Schmidt et al. 2007). Thereunder being the option of dissemination of contamination data (Lucas, Cabral et al. 2011). So far only the H2S was applied to present testing results to the households (presence/absence) [e.g. (Hamoudi, Jeuland et al. 2012)]. In the last decades, new rapid and robust water testing options have been developed and tested (Trottier 2010, Wright, Yang et al. 2012, Kanangire 2013, Stauber, Miller et al. 2014). Those tests often don't require electricity, lab equipment or scientific experience. Kanangire (2013) compared the compartment bag test (CBT), the compact dry plate test (CDPT) and the IDEXX Quanti-tray to standard lab methods and concluded that these tests are all viable to measure E.Coli concentrations. When applied at lower incubation temperatures than proposed by the producer, the incubation time should be extended to 48h (Brown, Stauber et al. 2011). After that time period all the three tests showed reliable measurements of E.Coli in water samples (Kanangire 2013). Overall, simple, inexpensive water tests can be divided in three larger groups: Presence/Absence tests, enzymatic semi-quantitative tests (most probable number [MPN]) and petri dish plating (Center for Disease 2010). This study will chose one test of each group.

8.3 Influences on Water Quality

Several aspects of reported and observed behavior can lead to improved water quality. Indicators that describe water-related behavior often are influenced by other socio-economic factors, such as wealth, education level, WASH-practices or demographics (Jalan and Somanathan 2008). In this study, the differences between the different groups at baseline are evaluated first. Afterwards, WASH-practices that affect water quality are compared between baseline and follow-up. Which practices are included depends on the region and on the specific goals of the study. Hamoudi et al. (2012) included variables such as water treatment method, storage vessel type, cleaning frequencies and hand washing measurements to examine behavioral changes after the intervention. As far as the data from the baseline permits, these factors are included in this study as well. A good attempt to measure wealth is to run a principal component analysis (PCA) [e.g. (Jalan and Somanathan 2008)]. As a measurement of wealth by a simple question is often imprecise, it is recommended to observe a households components and items. Afterwards the PCA computes the relative influences of these factors and creates a wealth index for all the households (Filmer and Pritchett 2001). The variables included in this study for the PCA are similar to the ones in Filmer and Pritchett (2001). As the baseline survey was carried out earlier, unfortunately not all the important variables were included in the questionnaire of the baseline survey. The variables included in the PCA can be reviewed in Table 8.1.

Table 8.1 Criteria included in the PCA

Owning a radio	Own simple latrine to defecate
Owning a TV	Charcoal is used for cooking
Owning a bicycle	Grass thatch roof
Owning a motorbike	Iron sheet roof
Owning a mobile phone	Cement walls
Bushes to defecate	Mud walls
Shared latrine to defecate	

8.4 Hypothesis and Outlook

It is shown that information dissemination can have a significant impact on drinking water quality at the household level. But, it is difficult to identify which population would benefit most from household which specific intervention. The search for the best intervention is still ongoing, and might vary due to cultural or regional differences. Generally, suggested WASH practices often are not applied by households (Luoto, Levine et al. 2011).

Showing the test results to the study participant might lead to higher acceptance rates. Moreover, so far no study evaluated the importance of changing the person, who is applying the test. This research therefore implies a sample group where the study participant himself is applying the test on his own water source. A follow-up questionnaire will examine the readiness of study participants to buy and apply water tests on their own, if they are available.

The hypothesis in this study is a decrease in contamination levels in all four groups. As every one of them is experiencing a WASH-training. The reduction is expected to be the smallest in group 1 (control) as no rapid tests are included. Larger reductions are expected in group 2 (researcher tests sources), where the source water is tested and the result is presented to the households. In group 3 (researcher tests HH) and 4 (study participant tests HH) reduction is expected to be the largest, because interventions are also carried out on an individual level. Possibly, the factor of study participant testing in group 4 (study participant tests HH) might decrease contamination levels even more. This decrease in contamination should be reflected in some changed behavior, which is difficult to predict. Important factors might be water treatment methods and regularity, container type and condition, or hand WASH routine.

9 Methods

9.1 General Outline

This study builds on a baseline evaluation that was carried out in autumn 2014.[1] For the baseline evaluation, a total of 316 households located in three communities, Busime, Lugala and Bulwande, in Eastern Uganda were randomly chosen by geographic sampling (see Figure 9.1). During the visits, their residents were interviewed about their WASH practices with a questionnaire (see appendix 13.1).

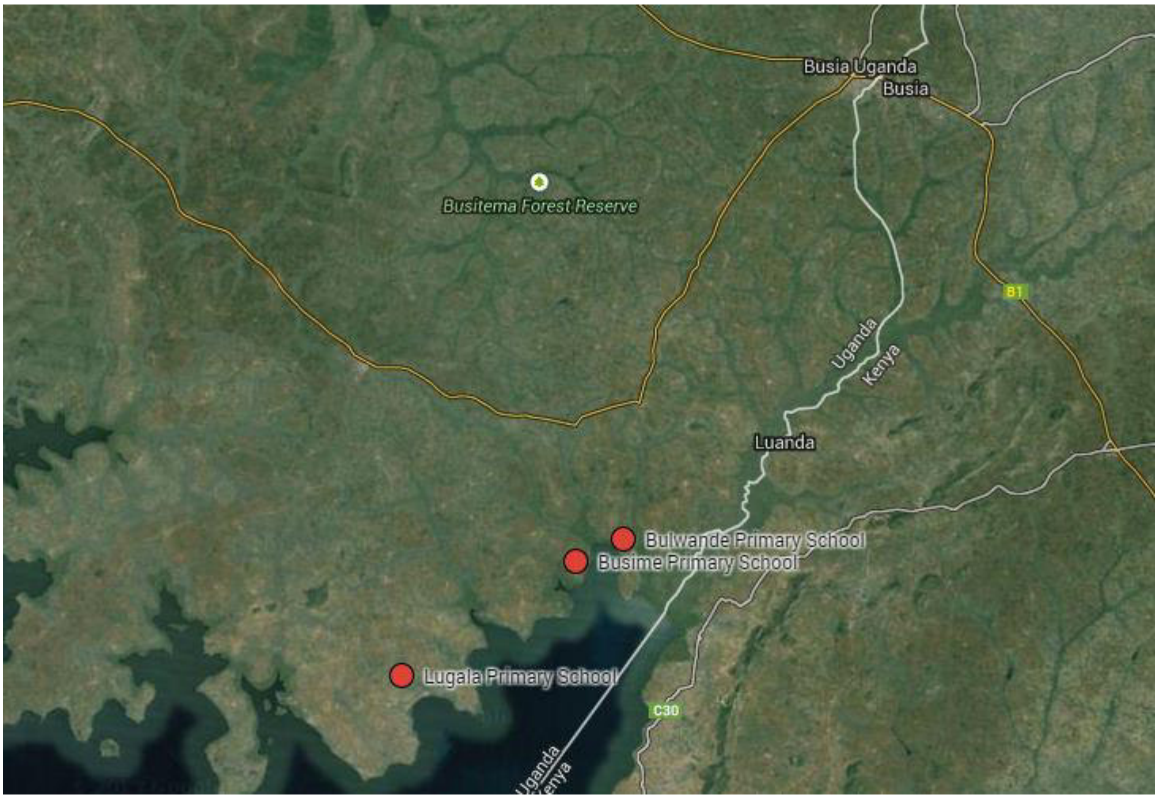

Figure 9.1 Location of the three communities near Lake Victoria included in this study. Source: Google Maps, 20.02.2015

All 170 households participating in this study were also part of the baseline study in 2014. Their selection is done randomly by geographic sampling. The distribution of the groups to

[1] Baseline evaluation was carried out by EAWAG in Busime, Lugala and Bulwande. For any additional information please contact Simon Weber.

the community was done by lottery. The interviews and interventions are carried out by employees of the Water School Uganda, an Ugandan NGO specialized in WASH-trainings and development projects. The questionnaires are stored on a Samsung Galaxy Pad 3. The interrogation is carried out using ODK collect and the results are transferred to an Excel sheet.

In order to choose a water test and investigate its impact on the behavior of study participants and the water quality at POU, this study is designed in four steps (see Figure 9.2).

Step 1 – Selection of Three Tests

Systematical search for water tests that are suitable for this study. Following a list of criteria three tests are chosen to be applied in this study.

Step 2 – Lab Analysis

Analysis of the three tests in the laboratory. Thereby comparing their performance under different temperature regimes and magnitudes of fecal contamination. The results are compared to a standard membrane filtration.

Step 3 – Test Selection by Study Participants

Selection of one test to be applied in further steps of the study. The three tests are applied in 10 households in Eastern Uganda. By answering a questionnaire and participation in a focus group discussion (FGD) the residents choose their favorite test.

Step 4 – Interventions to Study Impact of Water Testing

Four different groups undergo four different interventions. The drinking water quality is tested before and after each intervention. The comparison of the baseline and follow-up measurements describes the change in fecal contamination.

Group 1 (control)
Busime (40 HH)

Functions as a control group. The 40 households are invited to join a collective information event about:
- Water quality
- HWTS
- WASH

Group 2 (researcher tests sources)
Lugala (40 HH)

Receives the same information as group 1 (control) with additional information about the quality of their water source. The source of their water will be tested publicly using the water test chosen in step 3.

Group 3 (researcher tests HH)
Bulwande (40 HH)

Receives the same information as group 1 (control). The Households are visited individually and the test chosen in step 3 is applied for POU water testing by the researcher. The study participants are present during the water testing and follow the steps carefully. The tests are stored in a safe place. 48h after the testing, the households are visited again and the test results are communicated.

Group 4 (study participant tests HH)
Bulwande (40 HH)

Receives the same information as group 1 (control). The Households are visited individually and the test chosen in step 3 is applied for POU water testing by the study participants themselves under supervision by the researcher, who is giving the necessary instructions. The tests are stored in a safe place. 48h later the households are visited again and the test results are communicated.

Figure 9.2 Overview of the important steps in this study

9.2 Step 1 - Selection of Three Tests

The web and scientific literature was scanned for tests which could be included in this study. The scientific database of ETH (Eidgenössische Technische Hochschule) was the search engine of choice. It scans databases such as the Web of Science and Scopus. The resulting testing options are expected to fulfil a list of criteria, which were assembled from several expert interviews (see Table 9.1).

Table 9.1 List of criteria for test selection

No laboratory necessary	Approved by a certifier (e.g. United States environmental protection agency [US EPA])
No power-supply necessary	Applicable on drinking water in developing countries
A maximum of 48h until test results are obtained	Appearance in previous scientific literature is advantageous
Maximum price of 10 US-$ per test	Simple usage

The final three tests are chosen according to these criteria. The tests fulfilling the criteria best are applied in further steps of the study.

9.3 Step 2 - Lab Analysis

Evaluation of the three tests in the lab and comparison of the test results to a standard membrane filtration. The three tests are reviewed regarding their sensitivity to temperature changes and magnitudes of fecal contamination. Series of E.Coli measurements are performed by all the three tests and compared to a membrane filtration. There is a total of 12 measurements for every test. Water from four different sources is measured: River water, 99% river water + 1% waste water, 97% river water + 3% waste water and distilled water (blank). For all different water sources three samples are taken and tested. Afterwards, the tests are incubated in warming rooms at EAWAG (Eidgenössische Anstalt für Wasserversorgung, Abwasserreinigung und Gewässerschutz) at three different temperatures (293K, 298K and 310K). The three tests are stored in a carton box and put next to each other on a shelf. The test results are recorded 24h, 40h and 48h after incubation. Afterwards, the tests are safely disposed following the instructions on the test manual. The test procedures can be reviewed in appendices 13.3, 13.4 and 13.5.

9.4 Step 3 - Test Selection by Study Participants

Ten households from the baseline are randomly chosen. To select the ten households in this step the research team started from one random corner walking towards the center of Bulwande. Visiting every household on the trajectory that was in the baseline study. In each household, the person that participated in the baseline evaluation is called. After a short introduction, the person is asked to bring a drinking water sample. The workplace is cleaned and the three tests are prepared. Subsequently, every test is applied on this one water sample. The testing procedure is explained to the study participant. Thereby, his behavior is observed. At the end, the three tests are stored in a box and placed in a safe location in the community. Two days later, the test results are collected and communicated to the study participant. His experience and impressions during the test procedure are stored systematically by answering a quantitative questionnaire (see appendix 13.2). On the final day of step 3, all ten households are invited to a FGD, located in one of the household's gardens. A vivid discussion results in one test being chosen for application in the next step.

9.5 Step 4 - Interventions to Study Impact of Water Testing

160 random households are visited in the three communities. The households are chosen from the pool of baseline participants. Starting from a random corner of one community, following a trajectory towards the center, every household from the baseline is visited. After a short introduction, one 100ml water sample is collected from each household's main drinking water storage (see Figure 9.3).

Figure 9.3 Snapshot of a HH visit in step 4. The cooler boxes can be observed in the right pictures. People in the pictures are interviewers from Water School Uganda

If there is more than one water source, the resident is asked to bring a sample of the water all the household's inhabitants were drinking most during the last week. These samples are collected in sterile plastic bags and stored in a cooler box. In the evening, the water samples are analyzed in a hotel room. The working space is cleaned and the test material is prepared on the table in the hotel room. The fecal contamination is measured using compact dry EC plates and a portable membrane filtration. The testing is always finished 18 hours after collection of the samples in order to assure that no bacteria grows within the plastic bags.

At the end of the sample collection, the 160 households are asked to attend a community meeting about WASH in the next days. The households whose residents do not show up at the community information event are excluded from the study. In order to assure a household number higher than 30 per group, subsequent community events are organized. Everyone from the community has access to these meetings, also people not included in this study. In all groups this meeting is carried out in the same way and the training is led by an expert of the Water School Uganda (see Figure 9.5). Only in Group 2 (researcher tests sources) the water samples from the three main sources (see Figure 9.4) are tested in front of the audience during the meeting. Hereby, the test procedure is explained in detail and the result of the test is shown directly after. Hence, the water was tested two days before the meeting and the results were stored for presentation.

Figure 9.4 The three sources where households in Lugala get their water from: Lake (l.), borehole (m.), dug well (r.)

Figure 9.5 Snapshot of a WASH-training at community level held by Kennedy Wanyama of Water School Uganda

In group 3 (researcher tests HH), and 4(study participant tests HH) all the attendants from the community meeting participating in this study are visited at their home. Without any further information their water is tested with the test chosen in step 3. In group 3 (researcher tests HH), the test is applied for POU water testing by the researcher while the study participants are present, following the steps carefully. The tests are stored in a safe place. 48h after the testing, the households are visited again and the test results are communicated. In group 4 (study participant tests HH), households are visited and the test is applied for POU water testing by the study participants themselves while the researcher is giving the necessary instructions. The tests are stored in a safe place. 48h after the testing, the households are visited again and the test results are communicated.

After this intervention a break of two weeks is realized (see appendix 13.7 for detailed timeline).

Finally, the remaining households are visited again and without any additional information one 100ml water sample is collected from their main drinking water storage. If there is more than one water source, the resident is asked to bring a sample of the water all the household's inhabitants were drinking most during the last week. These samples are collected in sterile plastic bags and stored in a cooler box. They are tested in the same way as mentioned above. The study participants are asked to complete the same questionnaire again, which was used in the baseline study. In groups 2-4 additional questions about water testing are included in the second questionnaire (see appendix 13.1).

9.6 Statistical Analysis

The collected data is stored in Excel sheets and processed in STATA. The statistical analysis is executed in four steps. In the first step, the baseline data from the three communities is compared using oneway-ANOVA and chi^2-tests. Thereby, possible differences in the three regions are reviewed. In a second step, the changes in POU water quality are evaluated in every group. Using a t-test, the water quality from the first and second measurements is compared. Therefore, four different calculations are applied, for different test limits and risk categories. In a third step, changes in water-related behavior are evaluated using t-tests for each variable and group. The answers to the questionnaire from the baseline and follow-up study are compared. In a fourth step, multiple regressions are applied to evaluate the significant factors for the observed water quality changes. Hereby, a wealth factor computed by a principal component analysis (PCA) is included.

10 Results

10.1 Step 1 – Selection of Three Rapid Tests

The scan of the web and expert interview lead to the following pre-selection of possible testing options (see Table 10.1).

Table 10.1 Pre-selection of possible tests

Name	Producer	Method	Scientific Reviews
Petrifilm	3M	Petri plate	(Schraft and Watterworth 2005)
Compact Dry	Hyserve	Petri plate	(Kanangire 2013)
Easygel	Micrology Laboratories	Petri plate	(Trottier 2010)
Quanti-Tray	IDEXX	Most probable number (MPN)	(Kanangire 2013)
Compartment Bag Test	Aquagenx	Most probable number (MPN)	(Stauber, Miller et al. 2014)
Micro Tester Pro	Simpltek	Presence/Absence Test	
Bacteria Test Kit	PurTest	Presence/Absence Test	
H2S Test Medium	HiMedia	Presence/Absence Test	(Wright, Yang et al. 2012)
Pathoscreen	Hach Lange	Presence/Absence Test	(Wright, Yang et al. 2012)
Smartphone Sensor	Research Project	Quantum dot enabled detection	(Zhu, Sikora et al. 2012)
Surface-enhanced Raman scattering	Research Project	in Situ Coating with Ag Nanoparticles	(Zhou, Yang et al. 2014)

There are four major kind of water test applicable in development countries (Center for Disease 2010): presence/absence tests, MPN tests, simple petri dish tests, membrane filtration. Membrane filtration is too time consuming for the purpose of this study. The tests in this study should represent each category, to be as complete as possible. As the research budget is limited, the number of tests purchased cannot be higher than three. Therefore, one test for each other category above is chosen. The two research projects (last two in Table 10.1) sound very promising, but their products are not yet on the market. Therefore, no experience has been gathered using these tests, except for the studies mentioned. As a presence/absence test, the PT is chosen. It has already been applied in development countries by EAWAG. Also, the PT can be done in sterile plastic bags which don't produce a lot of waste and can easily be transported. Moreover, it is cheaper than other presence/absence tests. As MPN test the CBT was chosen over the IDEXX Quanti-Tray. Both achieved very good results compared to membrane filtration (Stauber, Miller et al. 2014). The CBT was designed to be applied in the field, while the IDEXX Quanti-Tray usually is applied in the lab. As a simple petri dish test the compact dray plate test was chosen, as EAWAG has already a lot of experience. The 3M-test is more fragile and therefore threatens to break during transport. Also it necessitates cooling before usage and therefore would not be applicable where no power supply is available.

The three tests chosen are:

Table 10.2: Selection of the three test

	CBT	CDPT	PT
Method	Growth in sample bottle. Compartments show colors according to contamination level.	Two chromogenic enzyme substrates: Magenta-GAL und X-Glucose	YES / NO test on presence of hydrogen sulfide producing bacteria
Targeted Organisms	E-Coli	E-coli and Total Coliforms	Salmonella, Citrobacter, Proteus, Edwardsiella, and some species of Klebsiella
Detection Limit	MPN: 1-100 E-Coli in 100ml sample	Counts: 1-300 in 1ml sample	Sensitivity: 1 CFU / 100ml
Time / Incubation	35-44.5°C: incubate 20-24 hours 30-35°C: incubate 24-30 hours 25-30°C: incubate 40-48 hours	24h at 37°C ± 2°C	24h at 25-35°C

Safety Aspect	Chlorine tablets are added to the used CBT. Safe disposal of compartment bag.	Petri dishes must be chlorinated or boiled and safely disposed	Chlorination of used sterile bags.
Price per Test	Ca. 5$, depends on number ordered	Ca. 1.5$, depends on number ordered	Ca. 1$
Certificates	US EPA / ISO	AOAC / ISO / MicroVal / NordVal	EPA
Remarks	Has already been compared to MF by Stauber, 2014	Lot of Experience in EAWAG, reviewed by Rick Johnson (EAWAG)	Tested in scientific literature. Used in EAWAG
Picture			
Source picture	http://www.aquagenx.com/wp-content/uploads/2015/02/CBT-I-1-300x280.jpg (20.02.2015)	http://www.hyserve.com/imglib/CompactDryEC-387x320.jpg (20.02.2015)	http://www.hach.com/asset-get.product.image.jsa?sku=2610696&size=M (20.02.2015)
Procedure	See appendix 13.3	See appendix 13.4	See appendix 13.5

10.2 Step 2 – Labor Analysis

In the Labor Analysis the three tests were compared to a standard membrane filtration.

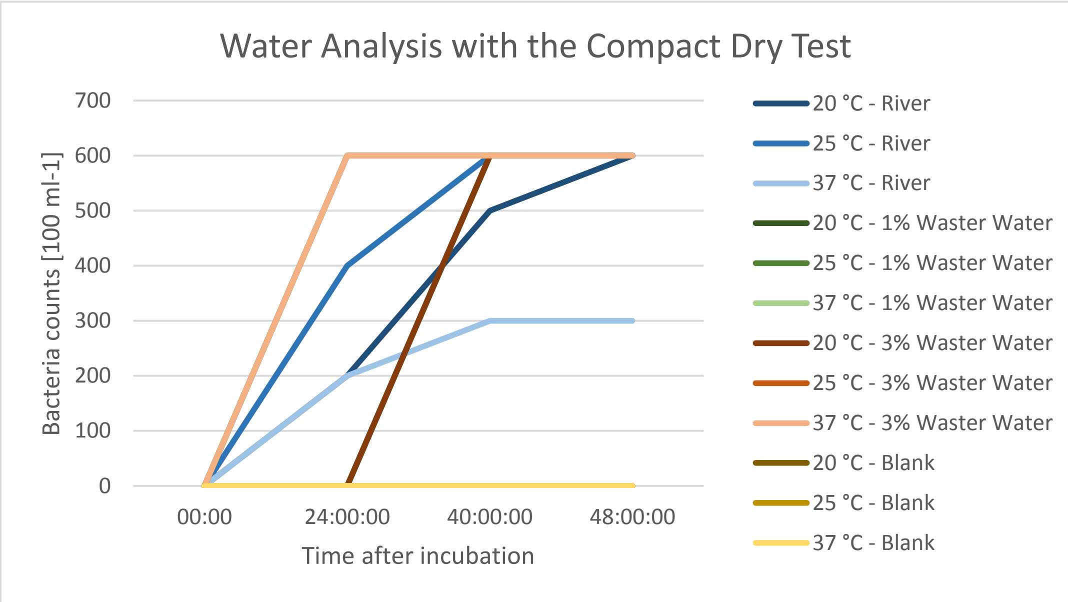

Figure 10.1 Measurements of E.Coli concentrations using the CDPT.

The CDPT measured the contamination in a 1ml sample. Therefore, results in Figure 10.1 are multiplied by factor 100. Overall, the test results of the CDPT were similar to the membrane filtration. When incubated at 20°C the bacteria had not achieved final growth levels after 24h. The most interesting sample was the river sample, as the other sources were too contaminated or not contaminated at all. The necessity for 48h incubation can be observed when incubated at 20°C or 25°C (and here also for 37°C). As the test is only measuring a 1ml sample. The differences between each sample from the same source might be due to heterogeneity in the water sample and not due to different incubation temperatures.

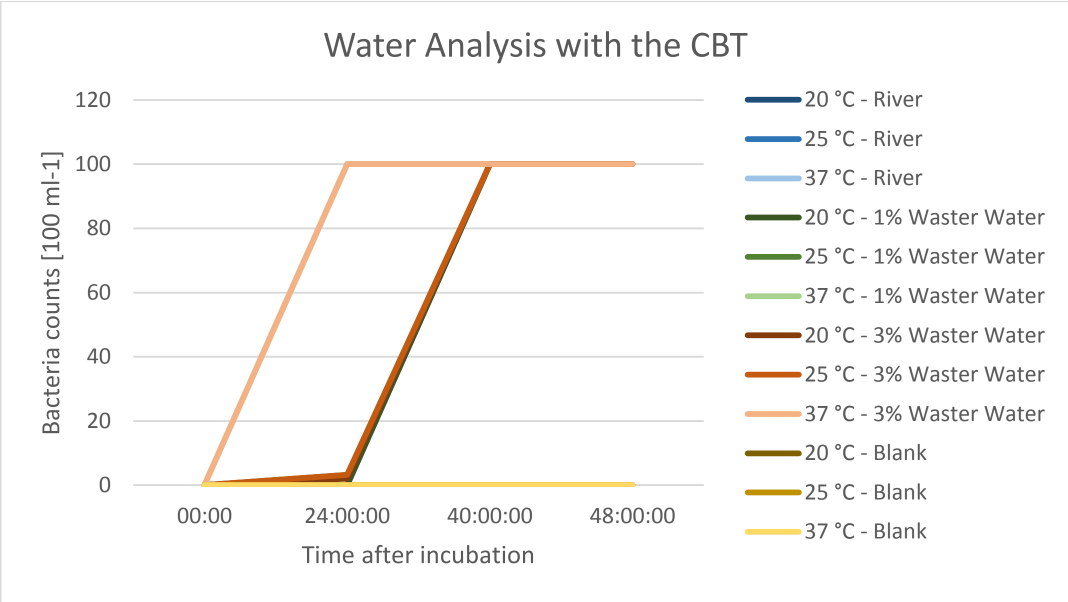

Figure 10.2 Measurements of E.Coli concentrations using the CBT

The CBT is measuring semi-quantitatively in contamination intervals. In these samples all the concentrations except the blank series were above 100 counts per 100ml (see Figure 10.2). Every CBT did test accurately for these concentration categories. When incubated at lower temperatures, the concentration was accurately measured at 40h, compared to the membrane filtration (see Figure 10.4).

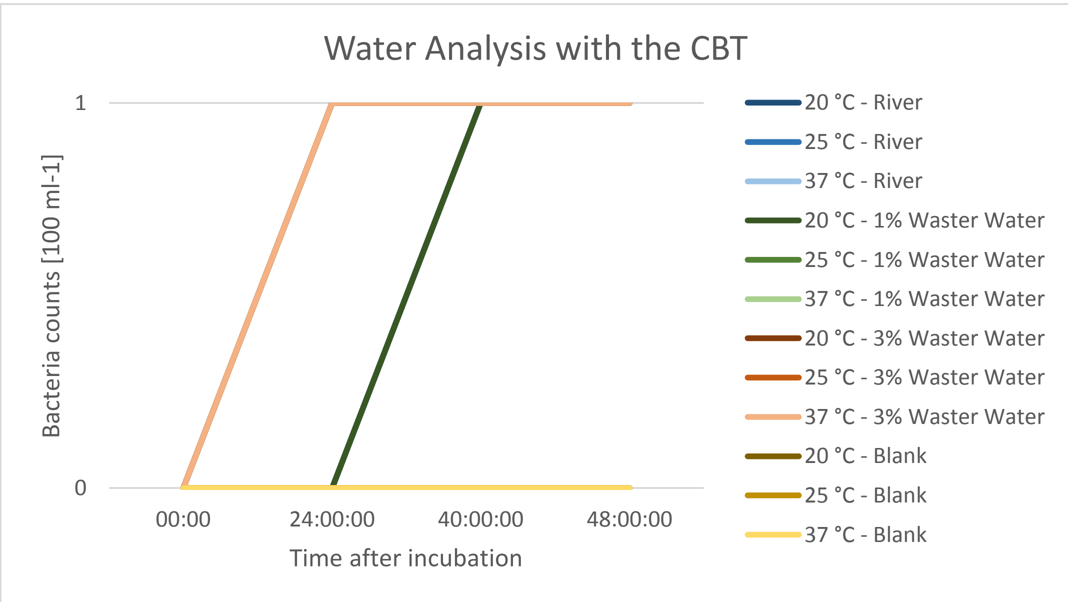

Figure 10.3 Measurements of E.Coli presence using the PT

The measurements of the PTs were all accurate. The presence / absence of bacteria was in every case right, compared with the membrane filtration. When incubated at lower temperatures this test also requires more than 24h to display the right result.

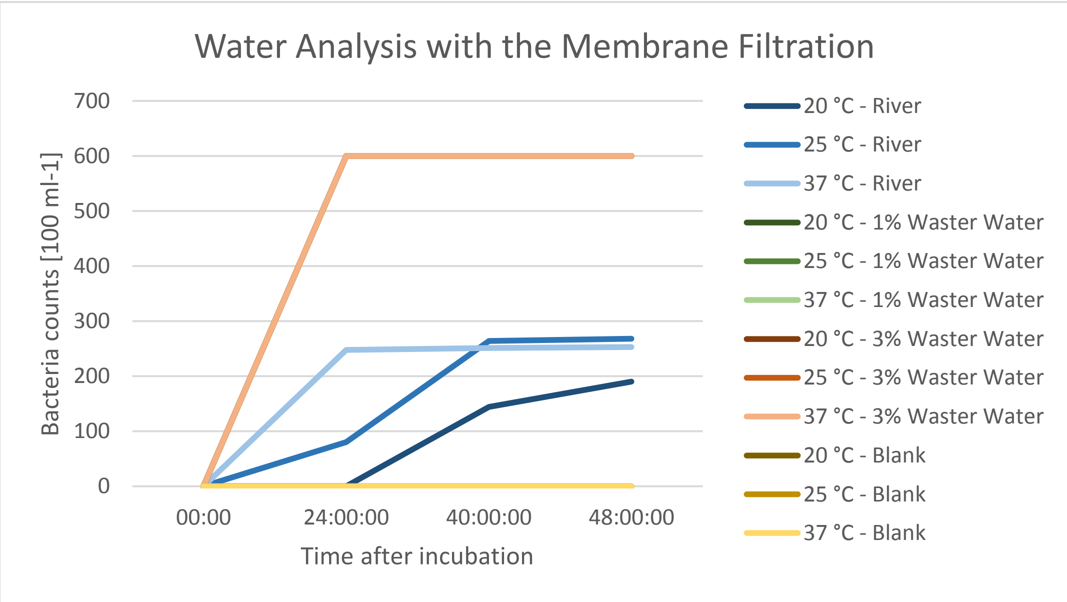

Figure 10.4 Measuring E.Coli concentrations using the membrane filtration

The concentrations in most samples exceeded the testing limits of the membrane filtration. The river samples showed the typical lag in concentration measurements when incubated at lower temperatures than 37°C. Interesting is, that the contamination level of river water when the measurement was incubated at 20°C did differ from the ones incubated at higher temp. Maybe longer incubation times would have been needed to obtain the same results.

Overall, the three tests achieved good results compared to the membrane filtration. When incubated at 20°C an incubation time of 48h instead of 24h is necessary. The tests are suitable for in-field application when incubated for 48h in a safe location above 20°C.

The CDPT displays real concentrations, but only in a 1ml sample and is therefore sensitive to inhomogeneous water samples. The CBT measures the MPN with a detection limit of 100 counts per 100ml, whereas the PT only tests for presence of bacteria. The FGD in the field will show which level of detailedness is requested by the study participants.

Unfortunately, the fecal concentration of the river was increased on the day of study. Leading to very high fecal contamination, overall. Therefore, the subsequent measurements didn't bring sufficient insight in the tests' properties. Because most of the tests were either not showing contamination or contamination above the tests' limits.

10.3 Step 3 - Selection of one Test

The possibility of testing their own water was highly appreciated by the study participants. All ten households in this step of the study have never tested their water before. On a scale from 1-5 they found it very useful to test their water with an average of 4.9/5 (see Table 10.3). Without knowing the tests before, they approved the collection of the three tests with a score of 4.6/5. Furthermore, they agreed on testing their water in the future on their own, if water tests are available at a reasonable price. The average willingness to pay from this sample group is 0.37 USD per test unit. Where 6/10 households preferred the PT over the other two for future testing. Due to the small sample size the standard deviations are high.

Table 10.3 Questions about the water testing experience in step 3 (1=strongly disagree – 5=strongly agree)

Question	Score	Std. Dev.
Do you find it useful to test your drinking water regularly?	4.9/5	0.32
Do you think these tests are the right choice to test your drinking water?	4.6/5	0.84
Which test would you prefer to use in the future?	1 CBT, 6 PT, 3 CDPT	

Would you measure your drinking water with these tests in the future, if they are available?	4.4/5	0.97
How much would you be willing to pay for one test?	1050 UGX = 0.37 USD	550 UGX

Participants were asked if they think the test measured their water's quality accurately, if it was easy to apply and whether they would use it in the future if available (see Figure 10.5). Regarding the accuracy they all had a similar mean score of around 4/5. Comparing their applicability, the CBT scored lower than the other two tests. Also in the FGD (7HH present) it was mentioned that the handling of the CBT was too difficult. It includes the most steps and needs the longest time to apply. When asked, whether they would be able to apply a test on their own in the future, the PT achieved the highest result. It was much appreciated, that only one pillow of powder and some sort of vessel is necessary. Also they appreciated the simplicity of the result. In the FGD it was often argued that a simple yes/no answer is sufficient.

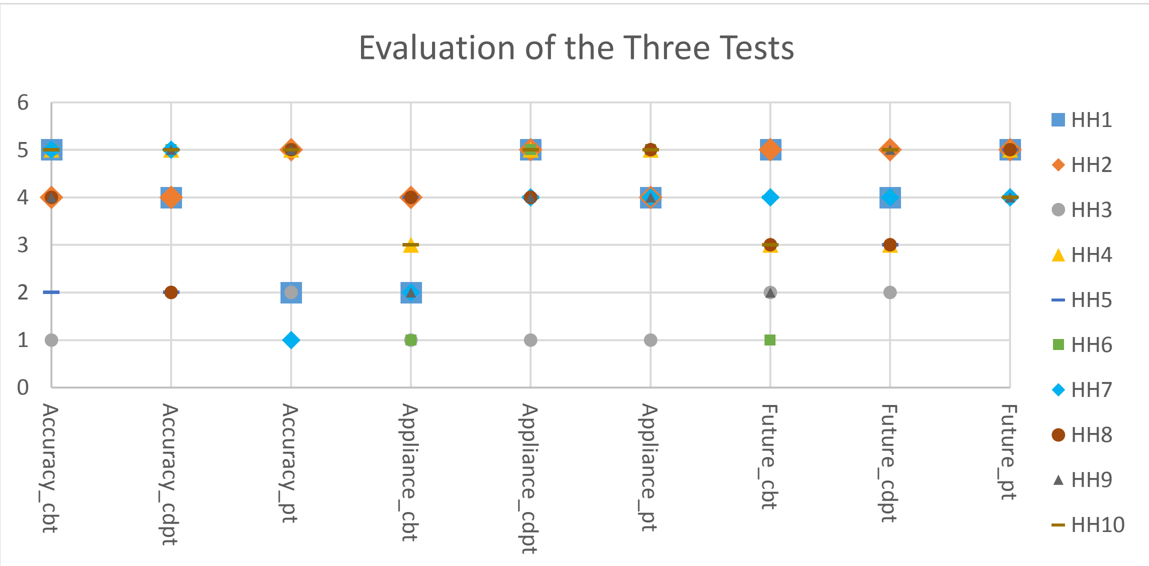

Figure 10.5 Comparison of the three tests in ten HH in Bulwande. (1=strongly disagree – 5=strongly agree)

The CBT was thought to be the most accurate test in the discussion, but too difficult to apply. Furthermore, some appreciated the possibility to count the bacteria in the CDPT.

Overall, every study participant was bothered by the smell of the PT and the CBT when bacteria were present. The CDPT remained rather odorless.

Finally, 4 participants of the FGD chose the PT, while 3 were voting for the CDPT. Some seemed to be influenced by their neighbors' opinions. Overall the decision between CDPT and PT was rather close. The PT was chosen because it had slightly more votes, higher agreement to use in the future, is less expensive and produces a simple yes/no answer, which was appreciated.

10.3.1 Evaluation of the Follow-up Questionnaire in Step 4, Focusing on the Water Tests

In groups 2-4 questions about the water tests were included in the follow-up questionnaire in step 4. The importance of regular water testing was estimated slightly lower than by the ten HH in step 3 (see Table 10.4). They agreed on the choice of the PT, scoring slightly below the collection of all three tests in the pre-study. The values for accuracy is similar as above. The application was estimated to be more difficult than above. Generally there is agreement to use tests in the future. When asked specifically about the PT the agreement was smaller by 0.19 points in Bulwande and 0.42 points in Lugala. The willingness to pay is lower in this bigger sample group. Overall the 10 households in step 3 that focused solely on the water tests scored higher results than the bigger sample of households in step 4.

Table 10.4 Evaluation of the water testing at follow-up (1=strongly disagree – 5=strongly agree)

	Bulwande	Std. Dev.	Lugala	Std. Dev.
Do you find it useful to test your drinking water regularly?	4.46/5	0.55	4.62/5	0.49
Do you think this test was the right choice to test your drinking water?	4.26/5	0.65	4.14/5	1.03
Do you think the test measured your water's quality correctly?	4.13/5	0.78	4.03/5	0.94
Do you think the test is easy to apply?	3.63/5	1.12	3.31/5	1.14

Do you think you would be able to apply the test on your own in the future?	3.80/5	1.02	3.55/5	0.91
Would you measure your drinking water with rapid tests in the future, if they are available?	3.89/5	0.97	3.97/5	0.78
How much would you be willing to pay for one test?	520 UGX = 0.18 USD	399 UGX = 0.14 USD	816 UGX = 0.28 USD	787 UGX = 0.27 USD

10.4 Step 4 - Interventions

10.4.1 Comparison of the Three Communities

The three communities are compared by a list of factors (see Table 10.5). These factors are taken from the questionnaire applied in the baseline study. The selection was obtained by expert interviews and comparison to relevant scientific material. It is important to compare the three communities before discussing the results of step 4 as different properties of the communities could influence the outcome of the study.

Table 10.5 List of factors measured at baseline and how they differ in the three communities (red = significant differences in complete (317HH) and reduced (102HH) baseline, blue = significant differences only in complete baseline, white=no significant differences)

Which water source do you use to collect drinking water?	Quality of drinking water (measured only in reduced baseline)
How important is it to treat the water?	How is the quality of the water you use for drinking?
Do you use any method for water treatment?	How safe is it to drink the water directly from the source?
Are water treatment devices visibly available in our around the house? Select the items available? (obs.)	How often do you treat your water?
Which methods for water treatment do you use?	What kind of containers do you use to collect & transport water from the source?
What kind of containers do you use to store the drinking water?	In which condition is the water storage container? (obs.)
How do you clean your safe storage container?	What kind of hand washing facilities does the HH have? (obs.)
Do you think it is important to wash your hands?	In which condition is the toilet? (obs.)
Where do you help yourself?	How many children go to school?
What type of roof does the main house have?	How many rooms does your house have?

What type of walls does the main house have?	What kind of fuel do you use for cooking?
How many people live in the household?	Have you ever received any information on water treatment, hygiene or sanitation?
What is your education level?	

Using ANOVA analysis tools, all the criteria were compared between the three communities. Observing various differences in the three communities. First, only the households which participated in this study are included for comparison. Second, all the households from the baseline evaluation were included. Variables that vary significantly on a 5%-level are highlighted in Table 10.5. One important factor for the big difference in significant variables is definitely the sample size.

10.4.2 Differences in Communities Based on Reduced Baseline

A very important variable is the source of drinking water. This variable can change locally and temporally. Depending on the source the water quality can vary significantly. From some sources the water quality was measured in the baseline, others are not evaluated. In Figure 10.6 the water sources are compared.

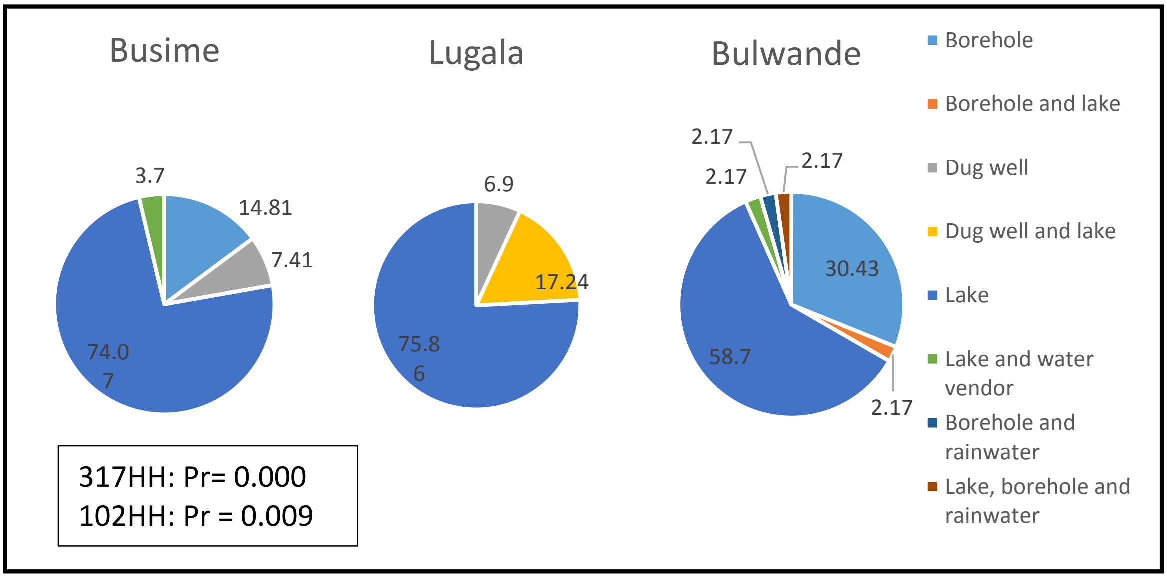

Figure 10.6 Drinking water source comparison. Which water source do you use to collect drinking water? The P-value is generated from a chi2-test between the three communities.

The largest source of drinking water in all three communities is Lake Victoria. Furthermore, in Lugala about 25% of drinking water is taken from a dug well. The water in the dug well is very turbid and contamination can easily occur, being an unprotected pond. In Bulwande 30% of water is taken from a borehole, in Busime its close to 15%. Rainwater is only used temporally in rainy season. This part of the study was conducted at the start of rainy season. Still, rainwater seems to be a minor source for drinking water. Overall, the lake is by far the most important water source.

The water quality at baseline in the three communities did only vary significantly when the categorized results were numerically compared. The mean contamination of the water samples is shown in Table 10.6.

Table 10.6 The water quality at baseline in the three communities compared. (0=low risk, 1=intermediate risk, 2=high risk, 3=very high risk)

Community	300 [100 ml^{-1}]	Std. Dev	600 [100 ml-1]	Std. Dev	Risk categories	Std. Dev
Bulwande	136	133	208	241	2.3	0.73
Busime	119	143	186	248	2.0	0.85
Lugala	195	157	247	222	2.5	0.63
P-values	0.106		0.621		0.037*	

The concentration measured are all high. 98% of households showed fecal contamination in their drinking water. The average contamination poses a severe risk to the consumer of this water. It is urgent to improve drinking water quality.

In the three communities the largest part of consumers does indeed treat their water. With around 34 %, Lugala has the largest number of people not treating their drinking water. Lugala also shows the highest levels of contamination in their water. Busime residents showing the lowest concentrations, treat their water by 93%, which is the highest rate.

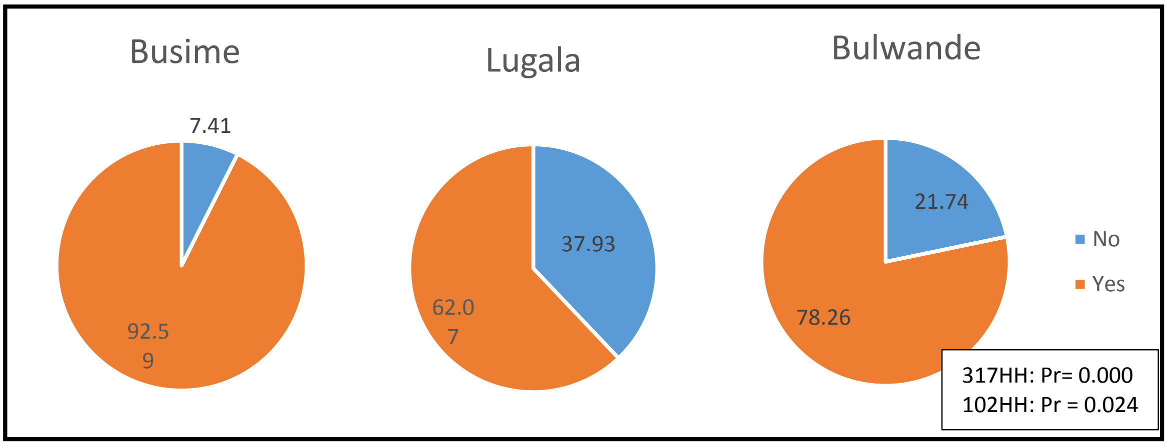

Figure 10.7 Water treatment comparison. Do you use any method for water treatment? The P-value is generated from a chi2-test between the three communities.

One possible explanation for the higher treatment rate in Busime might be the influence of previous information events. Most people mentioned that they were trained by the government. Also Water School Uganda, conducted several WASH-trainings in these communities before this study. Therefore, it might be possible that the people in the three communities also had a different background regarding WASH-practices. At the baseline survey, 77 households stated to have changed behavior after the previous WASH interventions, while 7 stated not to have changed anything (18 no response). As seen in Figure 10.8 the percentages of people having received WASH information before is remarkably similar to the percentages treating their water.

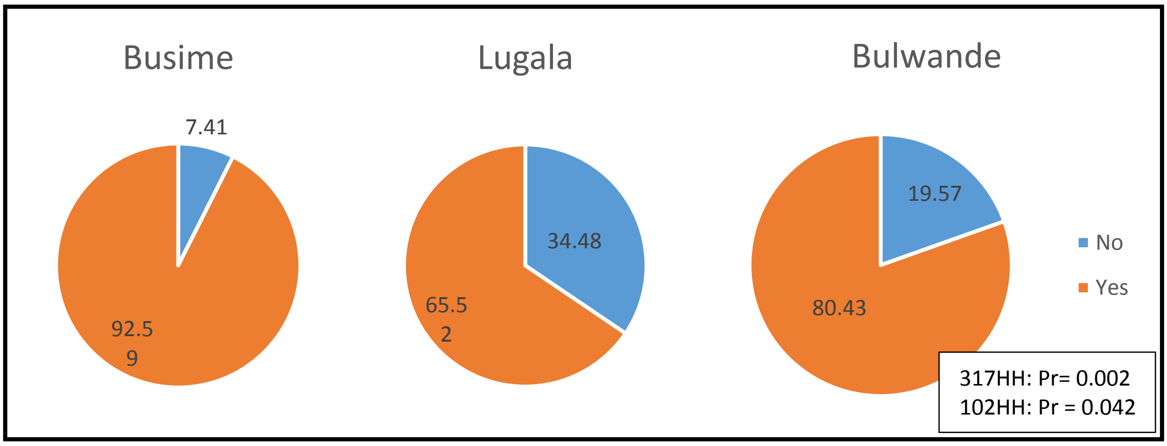

Figure 10.8 Wash info before comparison. Have you ever received any information on water treatment, hygiene or sanitation? The P-value is generated from a chi2-test between the three communities.

Another important indicator influencing water quality at POU is the hand washing behavior. In Lugala 97% of people didn't have any hand washing facility at their house. In Busime 26% of people had Tippy taps installed (see Figure 10.9).

Figure 10.9 A woman cleaning hands with a Tippy Tap. Source: http://2.bp.blogspot.com/-RmPSvX5R3N0/TmoHMIRam5I/AAAAAAAACKc/4B9cotsZ2kU/s320/IMG_1463.JPG, 15.02.2015

In Bulwande 24% used a bucket to poor water over the dirty hands. According to experts from Water School Uganda, Tippy Taps are the cleanest way to wash hands, because the hands never touch the water container.

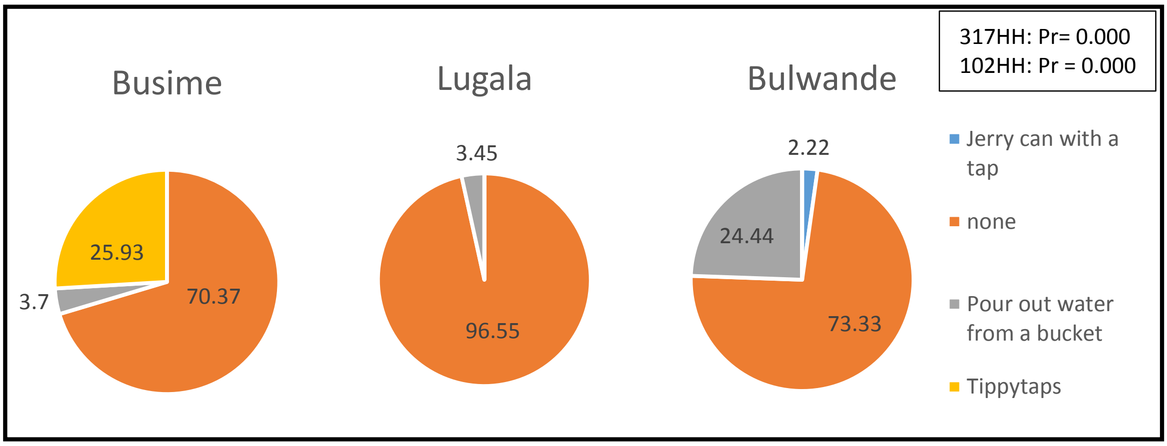

Figure 10.10 Hand wash facility comparison. What kind of hand washing facilities does the HH have? (obs.) The P-value is generated from a chi2-test between the three communities.

The last significant difference between the three communities is the place where people defecate. In Busime 93% of residents had their own simple latrine. In Lugala and Bulwande the percentages of sharing a toilet or using the bushes is higher. Not using a clean toilet can increase the contamination of drinking water (WHO 2014).

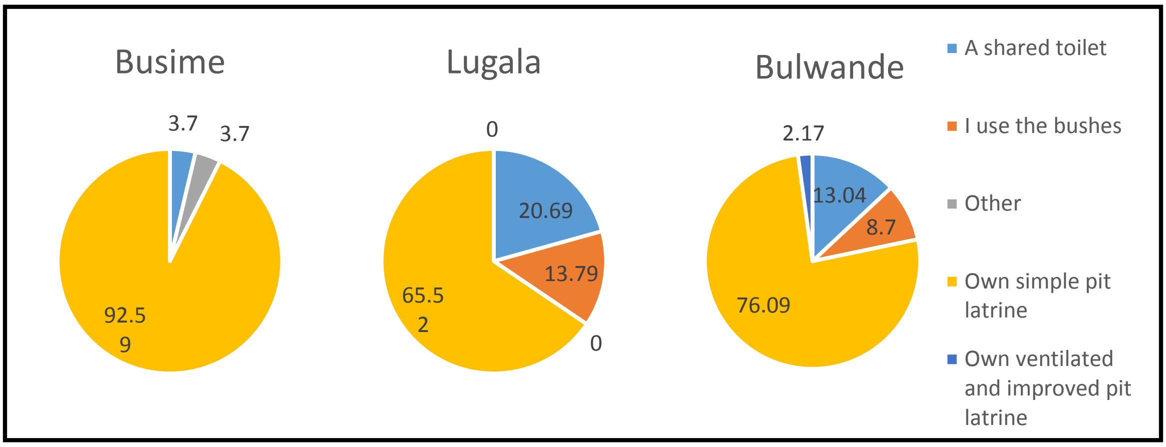

Figure 10.11 Comparison of toilet type. Where do you help yourself? The P-value is generated from a chi2-test between the three communities.

These factors describe differences between the three communities and might thereby influence the impact of further interventions. A statistically more well-founded comparison can be obtained by including all households from the baseline. In the next chapter the most interesting variables are shown. A complete table of all factors can be found in appendix 13.8.

10.4.3 Differences in Communities Based on Complete Baseline

Additionally to the variables above, some other were only significantly different when including all the households from the baseline survey. For example the regularity of the water treatment varied between the three communities. In Busime nearly 50% treat their water every day. In Bulwande and Lugala only 24% treat the water every day (see Figure 10.12).

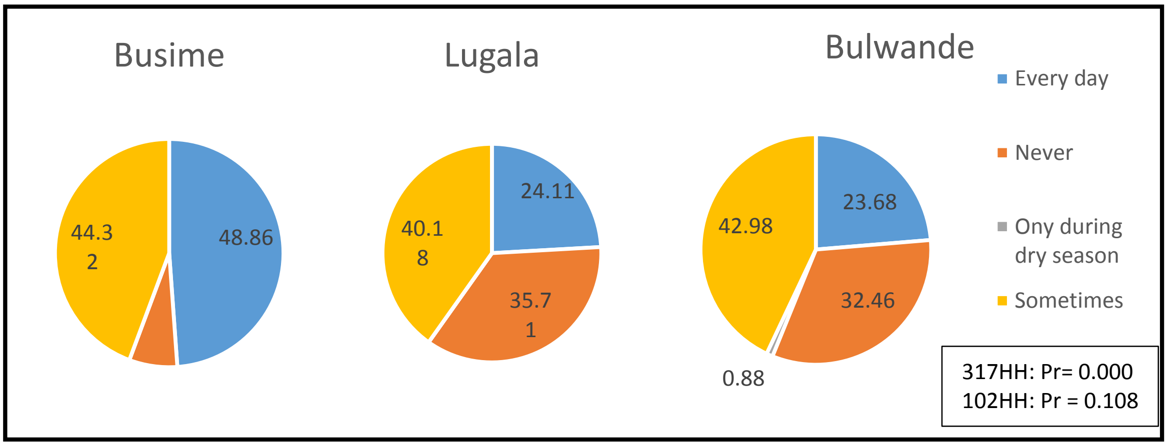

Figure 10.12 How often do you treat your water? The P-value is generated from a chi2-test between the three communities.

The three source in Lugala were all contaminated. The lake is the most important source in all three communities and it was tested unsafe. The estimation of the residents reflects this condition. In Busime every household thinks that drinking water directly from the source is at least a bit risky. In Lugala 3.5% think that the water from the source is quite safe for drinking. In Bulwande 13% think that water is quite safe or very safe to drink. Again the result indicates a higher risk awareness in Busime. A high risk awareness might influence the readiness to imply new water treatment and testing option (Hamoudi, Jeuland et al. 2012).

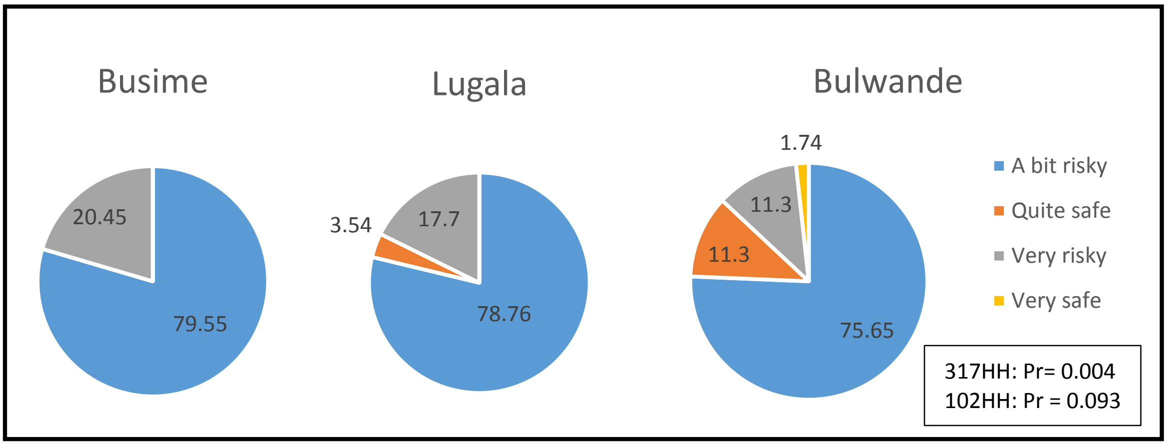

Figure 10.13 Comparison of risk estimation when drunk directly from source. How safe is it to drink the water directly from the source? The P-value is generated from a chi2-test between the three communities.

Contamination often occurs in dirty containers (UNICEF 2014). Bulwande shows the highest rate of people washing their container regularly with soap. While Lugala shows the lowest percentage of households. But, the answer “I wash it sometimes” is rather undefined. It therefore includes lots of possible cleaning behaviors. It is therefore difficult to determine the exact meaning of this answer. But, at least every household is cleaning their containers.

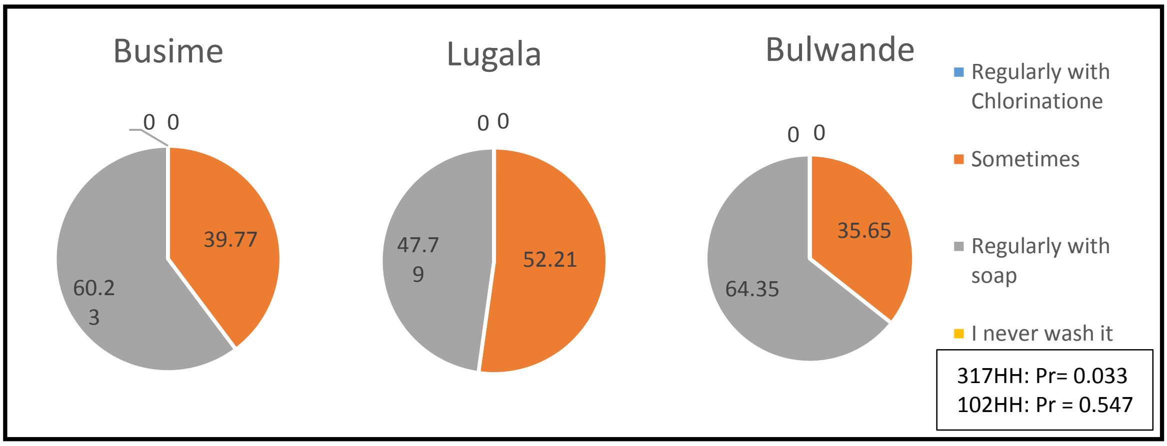

Figure 10.14 How do you clean your safe storage container? The P-value is generated from a chi2-test between the three communities.

Another important factors influencing water-related behavior is the education level. In this study the education level of the person interviewed did not vary significantly between the three communities. But, the number of children frequenting school is highest in Bulwande with an average of more than 4 per household (see Figure 10.15). Also the percentage of schoolchildren divided per number of people in the HH is significantly higher in Bulwande.

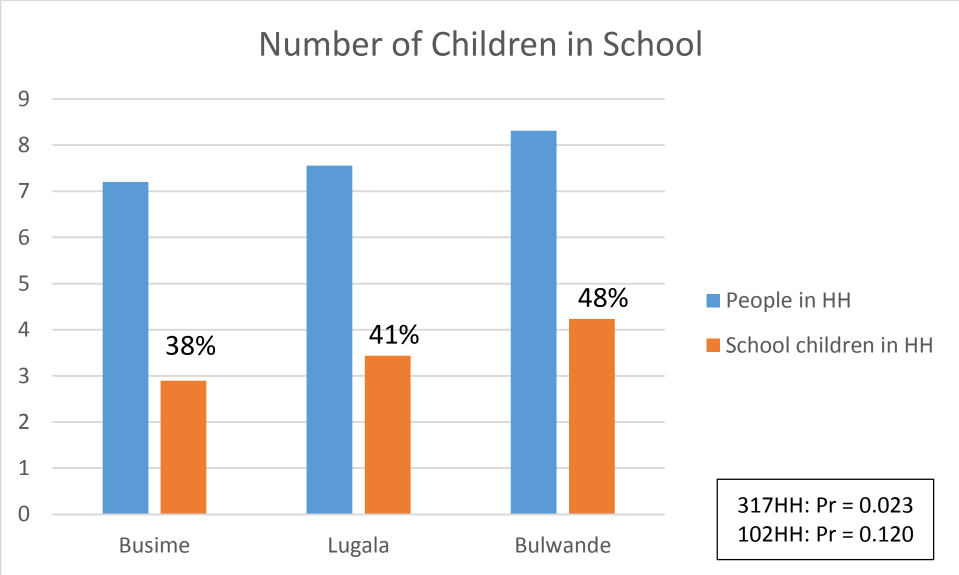

Figure 10.15 Comparison of people and school children per household. The percentage of schoolchildren/people in HH is shown in black. The P-value shows the significance of differences in the percentages.

Another factor that can affect the water-related behavior is the financial strength. It can be measured directly or by observing items belonging to the study participants. These items can be compared and converted into a wealth index using a principal component analysis (PCA). The estimated wealth obtained by a PCA showed scoring coefficients according to Table 10.7. The possession of the first items positively impacts the wealth index. Negative influences are the usage of simple own latrines and bushes to defecate. As well as a house that is built of mud walls and grass thatch.

Table 10.7 Results from the PCA.

Variable	Scoring coefficients	Mean	Std. Dev.
Owning a radio	0.160	0.559	0.499
Owning a TV	0.233	0.078	0.270
Owning a bicycle	0.161	0.667	0.474
Owning a motorbike	0.071	0.069	0.254
Owning a mobile phone	0.135	0.647	0.480
Bushes to defecate	-0.033	0.078	0.270
Shared latrine to defecate	0.128	0.127	0.335
Own simple latrine to defecate	-0.096	0.775	0.420
Charcoal is used for cooking	0.089	0.069	0.254
Grass thatch roof	-0.453	0.608	0.491

Iron sheet roof	0.453	0.392	0.491
Cement walls	0.462	0.225	0.420
Mud walls	-0.462	0.775	0.420

The differences in wealth index in the three communities are shown in Table 8.1. The differences are not statistically significant.

Table 10.8 Comparison of the wealth index between the three communities. P-value is obtained by oneway-ANOVA.

Community	Mean	Std. Dev.	Freq.	
Bulwande	0.353	2.109	46	
Busime	-0.644	1.389	27	
Lugala	0.040	1.941	29	
Total	0.000	1.921	102	Pr=0.099

Due to the small sample size the standard deviations are large. This derogates this stability of this analysis. But the tendencies seem to be reasonable. The scoring coefficients are therefore applied in the following regression analysis.

10.5 Water quality change

The change in E.Coli concentration is measured for every group. To reduce statistic artefacts the comparison is done in four different ways. First, all the measurements above 300 counts per 100ml are reduced to 300. Because the testing limit of the compact dry plates is at 300 counts. Second, all measurements above 600 counts per 100ml are set to 600. Applying the estimation procedure on the CDPT (app. 13.4), allows to measure up to 600 counts per 100ml. Third, the measurements are assigned to risk groups. The resulting risk group compilation is tested by a chi2-test. Fourth, the risk groups are substituted by numerical values from 0-3 and compared using a t-test.

10.5.1 Limit at 300 Count per 100ml

All bacteria counts above 300 per 100ml are set to 300 per ml. Where the test showed complete bacterial contamination (uncountable), the concentration was also set to 300 per 100ml. In Group 1 (control) and group 4 (study participant tests HH) the fecal contamination did not change significantly on a 5% level. In Group 2 (researcher tests sources) the fecal contamination increased significantly on a 3% level (see Table 10.9). In group 3 (researcher tests HH) the fecal contamination decreased significantly on a 3% level.

Table 10.9 Comparison of water qualities in the four groups with a maximal concentration of 300/100ml. The P-values show the significance between water quality at baseline and follow-up in each group. Negative difference stand for worsening of water quality (higher fecal contamination).

	Obs.	Mean conc. $[(100ml)^{-1}]$	Std. Err.	Std. Dev.	P-value
Group 1 (control) baseline	27	114.8	26.03	135.3	0.107
Group 1 (control) follow-up	27	176.8	23.04	119.7	
Group 1 (control) difference	27	-62.0	26.04	135.3	
Group 2 (researcher tests sources) baseline	29	172.3	22.04	118.7	0.025**
Group 2 (researcher tests sources) follow-up	29	216.7	17.79	95.8	
Group 2 (researcher tests sources) difference	29	-44.4	25.81	139.0	
Group 3 (researcher tests HH) baseline	24	155.8	25.91	126.9	0.019*
Group 3 (researcher tests HH) follow-up	24	75.5	22.24	109.0	
Group 3 (researcher tests HH) difference	24	80.3	31.91	156.3	
Group 4 (study participant tests HH) baseline	22	103.5	22.53	105.7	0.097
Group 4 (study participant tests HH) follow-up	22	50.7	20.27	95.1	
Group 4 (study participant tests HH) difference	22	52.8	31.40	147.3	

10.5.2 Limit at 600 Counts per 100ml

All bacteria counts above 600 per 100ml are set to 600. Where the test showed complete bacterial contamination (uncountable), the concentration was also set to 600 per 100ml. In Group 1 (control) & Group 2 (researcher tests sources) & group 4 (study participant tests HH) the fecal contamination did not change significantly. In group 3 (researcher tests HH) the fecal contamination increased significantly on a 3% level (see Table 10.10).

Table 10.10 Comparison of water qualities in the four groups with a maximal concentration of 600/100ml. The P-values show the significance between water quality at baseline and follow-up in each group. Negative difference stand for worsening of water quality (higher fecal contamination).

	Obs.	Mean conc. [(100ml)$^{-1}$]	Std. Err.	Std. Dev.	P-value
Group 1 (control) (control) baseline	27	185.9	47.75	248.1	0.125
Group 1 (control) (control) follow-up	27	266.4	45.04	234.0	
Group 1 (control) (control) difference	27	-80.5	50.80	264.0	
Group 2 (researcher tests sources) baseline	29	246.9	41.13	221.5	0.141
Group 2 (researcher tests sources) follow-up	29	327.3	40.31	217.1	
Group 2 (researcher tests sources) difference	29	-80.4	53.06	285.7	
Group 3 (researcher tests HH) baseline	24	266.7	54.34	266.2	0.020**
Group 3 (researcher tests HH) follow-up	24	100.5	35.80	175.4	
Group 3 (researcher tests HH) difference	24	166.1	66.54	326.0	
Group 4 (study participant tests HH) baseline	22	144.5	42.16	197.8	0.274
Group 4 (study participant tests HH) follow-up	22	78.0	37.58	176.3	
Group 4 (study participant tests HH) difference	22	66.5	59.18	277.6	

10.5.3 Categories of risk

Another factor to measure water quality is the health risk index defined in guidelines for drinking water quality (WHO 2010). The water quality is divided in 4 groups: low risk (0 per 100ml), intermediate risk (0-10 per 100ml), high risk (10-100 per 100ml) and very high risk (>100 per 100ml). The categorized test results of the four groups are shown in Figure 10.16.

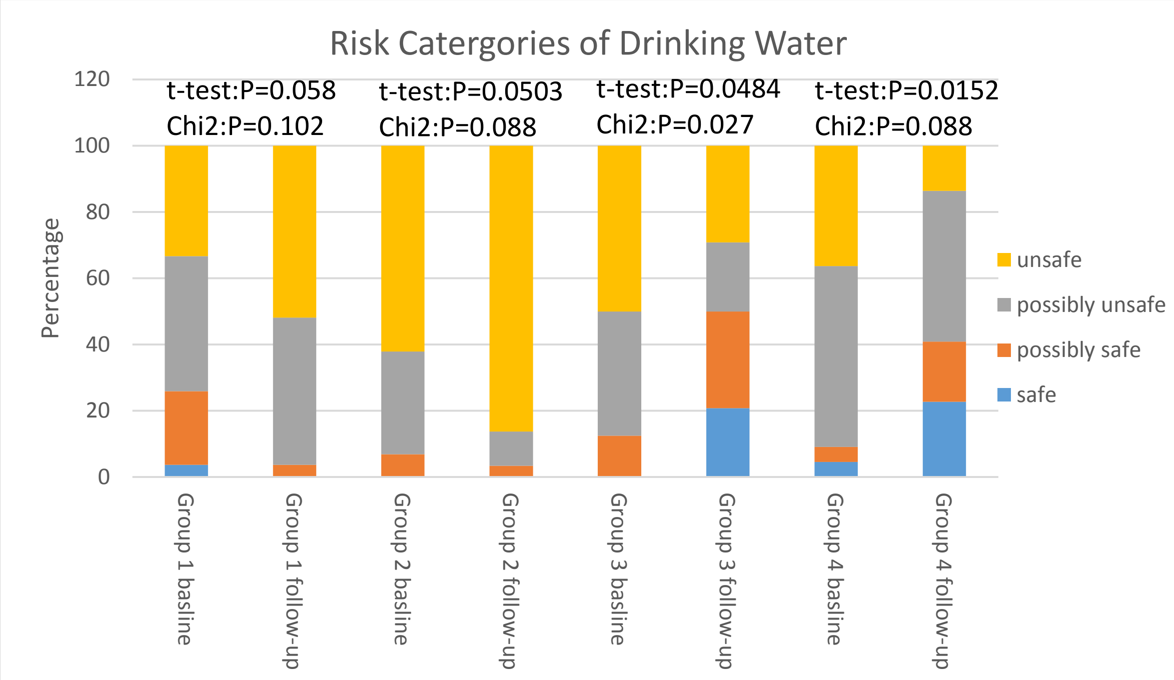

Figure 10.16 Comparison of Risk Categories in the four groups at baseline and follow-up. The P-values show were calculated using an F-test, categories were attributed with numeric values from 0=unsafe–3=safe. Group 1: Control, Group 2: Researcher tests source, Group 3: Researcher tests HH, Group 4: Study participant tests HH

A change to higher risk categories is observable in group 1 (control) & group 2 (researcher tests sources), while concentrations in group 3 (researcher tests HH) and group 4 (study participant tests HH) decreased. Statistically the evaluation equivocal. When categories are handled as numeric values from 0 to 3, group 3 (researcher tests HH) and 4 (study participant tests HH) changed their risk categories significantly. But when categories are handled as strings and compared by a chi2-test. Only group 3 (researcher tests HH) shows a significant alteration. The stronger significance observed when compared numerically can be explained. Changes over two risk categories are stronger weighted when categories are numerical. When they are compared as strings the scale is categorical instead of ordinal. Therefore, every possible change between two groups is statically equal.

Overall, group 1 (control) and 2 (researcher tests sources) increased contamination levels, group 3 (researcher tests HH) and 4 (study participant tests HH) decreased them. Only the change in group 3 (researcher tests HH) is significant in all statistical evaluations. The possible reasons for these changes are discussed further in the next two subchapters.

10.6 Changes in Behavior

When comparing the interview from the baseline with the follow-up interview, behavioral change can be observed. Displayed here are the most relevant indicators for behavioral change. For a complete review see appendix 13.11.

One important factor could be the change in the mean drinking water source. Especially in Bulwande where water contamination was decreasing in both groups (3 and 4), the water source changed significantly. At baseline only 30% were collecting water from the borehole, at the end more than 60% were observed. This change in water source is significant on a 1%-level. In Group 2 (researcher tests sources) at follow-up 60% collected their water from a dug well nearby or from this dug well and the lake. This change is also significant on a 1%-level. In Group 1 (control) the lake became an even larger source for drinking water (see Figure 10.17).

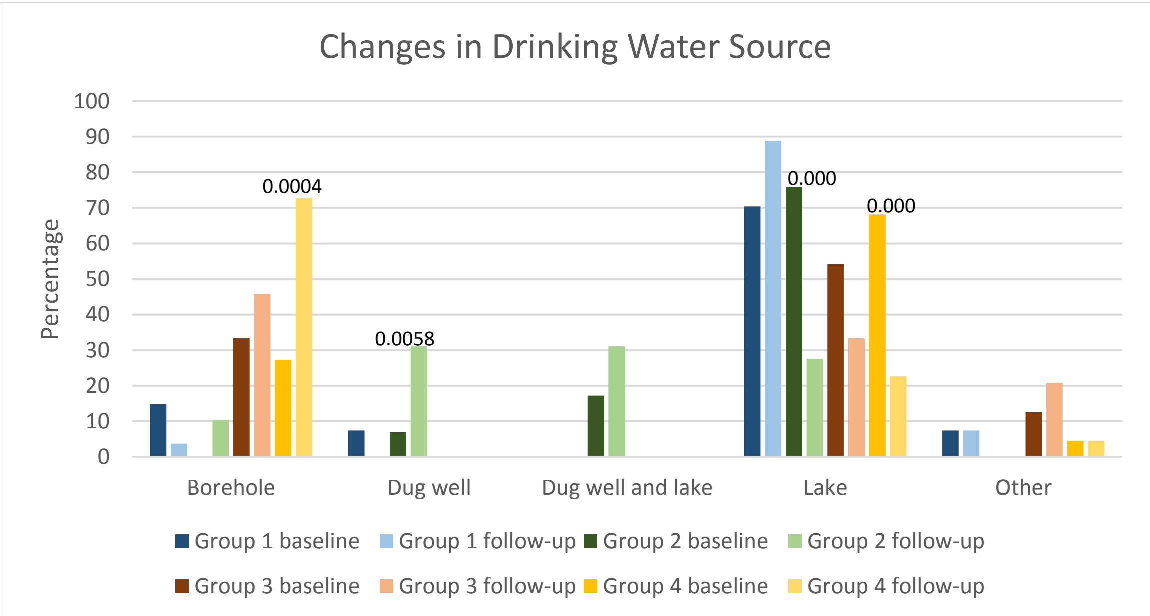

Figure 10.17 Changes in drinking water source between baseline and follow-up in every group. Where do you get your drinking water? P-values written over two columns reflect a significant change in this group

between baseline and follow-up. Group 1: Control, Group 2: Researcher tests source, Group 3: Researcher tests HH, Group 4: Study participant tests HH

This shifting of water collection points might have a large impact on the outcome of this study. When collecting water samples, study participants were asked to hand out the water from the source they drunk most during the last week. Unfortunate for the reliability of this study, the sources changed a lot between baseline and follow-up. One possible reason for the source change is the seasonality. The baseline survey was carried out at the beginning of wet season, whereas the follow-up survey took place at the end of wet season. Therefore, the surface reservoirs and boreholes might have been filled up during the course of the study and became more used sources. However, the change might have also been motivated by the interventions of this study. Even if people were not motivated to change the water source, the majority knows that boreholes are considered safer than surface water. Therefore, they might have changed the source because of the WASH-training. Surface water like dug wells or lakes have higher levels of fecal contamination than boreholes (see "improved water sources" in UINICEF, 2014). The shifting of water sources therefore, correlates with the changes in fecal contamination.

Another important factor is the treatment of drinking water. In group 3 (researcher tests HH) and 4 (study participant tests HH) an increase in people not treating their water was observed, while the distribution in Group 1 (control) and 2 stayed the same (see Figure 10.18).

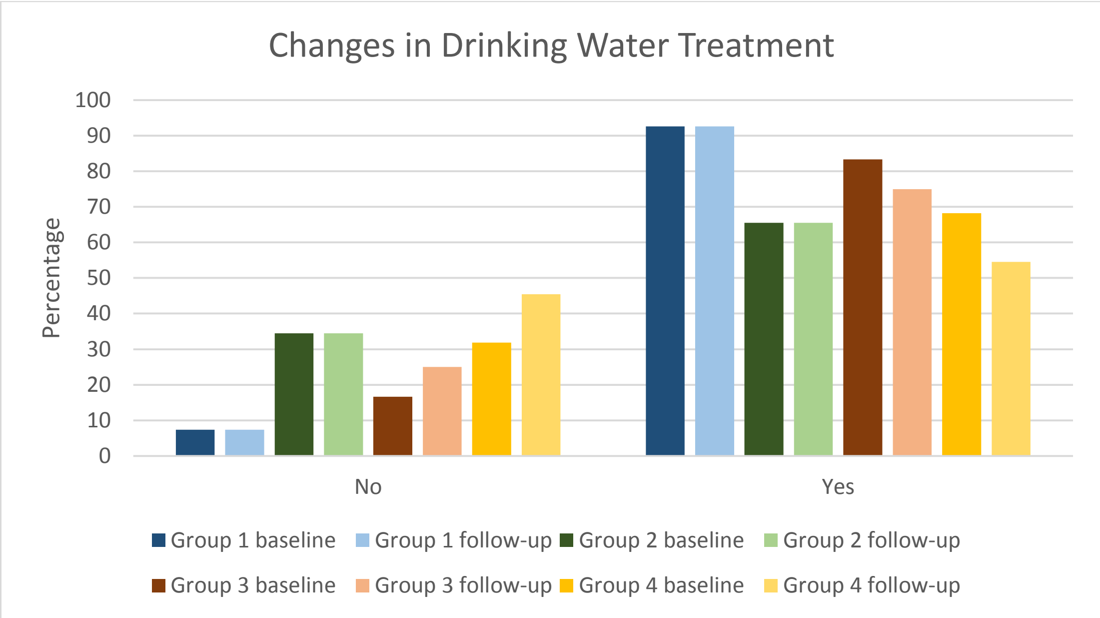

Figure 10.18 Changes in treatment of drinking water between baseline and follow-up in every group. Do you treat your water? P-values written over two columns reflect a significant change in this group between baseline and follow-up. Group 1: Control, Group 2: Researcher tests source, Group 3: Researcher tests HH, Group 4: Study participant tests HH

The changes in group 3 (researcher tests HH) and 4 (study participant tests HH) are surprising, because in these groups' water contamination levels decreased. One reason might be the change from lake water to borehole water. As seen in Figure 10.19 the estimation of the risk when water is drunk from the source directly changes in all groups. One explanation is that group 3 (researcher tests HH) and 4 (study participant tests HH) trusted the borehole water more than the lake water and therefore reduced treatment. In group 1 (control) and 2 (researcher tests sources) the risk was estimated to be higher than in the baseline. This might be influenced by the change in source, or could mean that the interventions were partly successful.

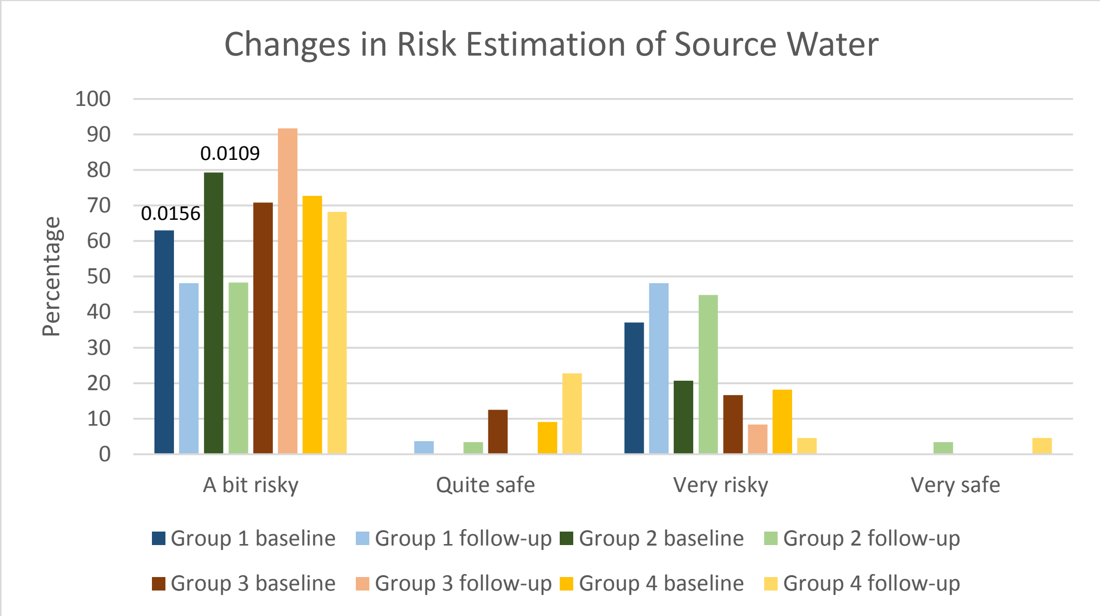

Figure 10.19 Changes in risk estimation of source water. Do you think it is risky to drink water directly from the source? P-values written over two columns reflect a significant change in this group between baseline and follow-up. Group 1: Control, Group 2: Researcher tests source, Group 3: Researcher tests HH, Group 4: Study participant tests HH

More changes in water treatment behavior are shown below in Figure 10.20. In Group 1 (control) and 2 (researcher tests sources) some people treat their water now every day instead of sometimes. At the same time the total amount of people treating their water stays the same. It seems like people intensified their water treatment. In group 3 (researcher tests HH) and 4 (study participant tests HH) the percentage of people treating their water "sometimes" decreased significantly. In exchange, the percentage of people treating the water every day or never was higher. This evolution is interesting as people tended to shift to the extremes. Some people might have been influenced by the trust they had in the new source (borehole) and therefore reduced their efforts in water treatment. Others might have been influenced by the WASH-training and reported to have intensified their treatment, similar to group 1 (control) and 2(researcher tests sources).

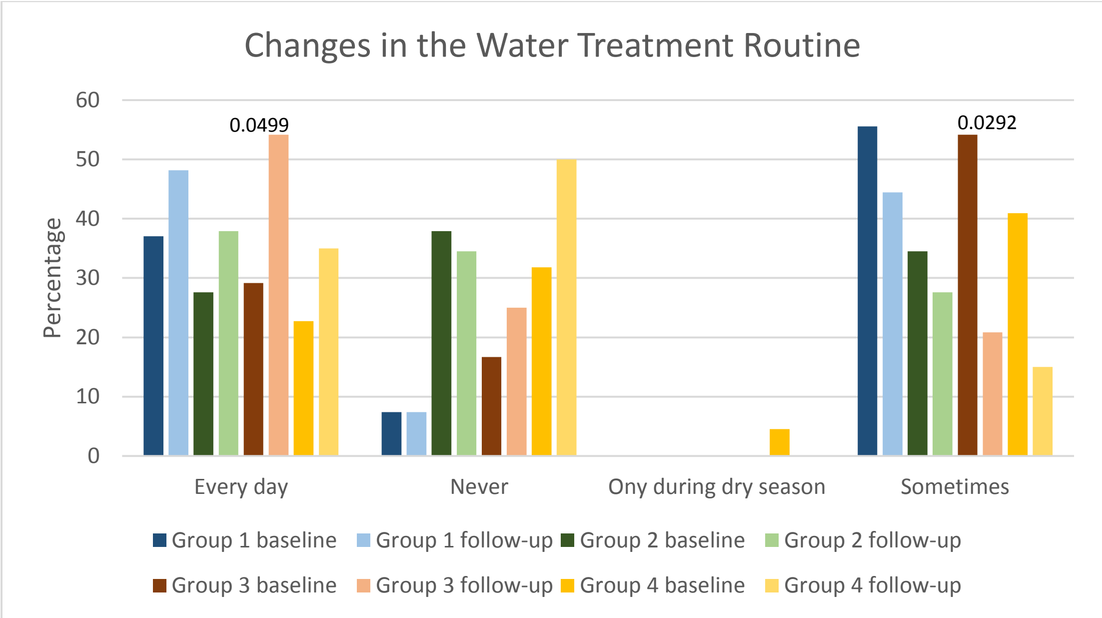

Figure 10.20 Changes in the water treatment routine. How often do you treat your water? P-values written over two columns reflect a significant change in this group between baseline and follow-up. Group 1: Control, Group 2: Researcher tests source, Group 3: Researcher tests HH, Group 4: Study participant tests HH

Other important factors are the condition of sanitary and drinking facilities. The observed condition of storage containers did not alter significantly, though. Remarkable is, that in group 2 (researcher tests sources) every single container was now clean (see app. 13.11). However, the observation that a container is clean, is rather subjective, and might depend on the interviewer's perception. On the contrary, the container cleaning routine changed significantly. In every group people started to wash their container more regularly with soap (see Figure 10.21). This might be another reason why water qualities increased in group 3 (researcher tests HH) and 4 (study participant tests HH).

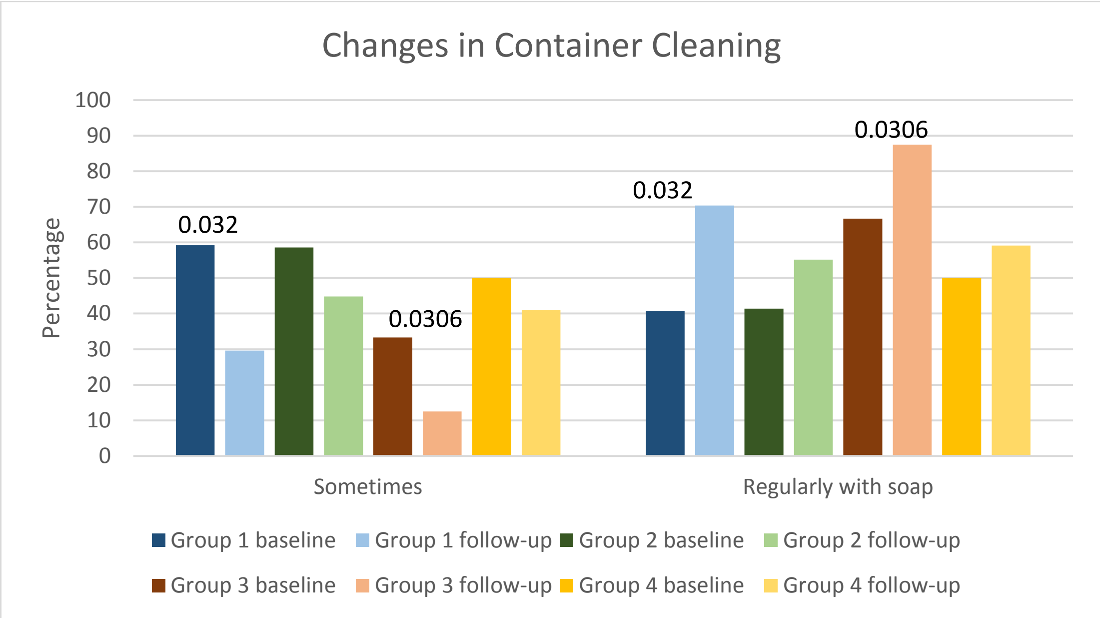

Figure 10.21 Changes in the container cleaning routine. How often do you clean your containers? P-values written over two columns reflect a significant change in this group between baseline and follow-up. Group 1: Control, Group 2: Researcher tests source, Group 3: Researcher tests HH, Group: Study participant tests HH

The condition of the toilet significantly improved in groups 2-4 (groups with water testing included) (see Figure 10.22). This might be another reason why contamination levels decreased in group 3 (researcher tests HH) and 4 (study participant tests HH), but somehow contradicts the increase in group 2 (researcher tests sources). Again, the classification as "clean" might be subjective to the interviewers' perception.

At the same time the number of observed hand washing facilities decreased in group 1 (control), 3 (researcher tests HH) and 4 (study participant tests HH). One person mentioned that she had to take away the Tippy Tap, because her children were always drinking from it. But otherwise it is hard to think of good reasons to remove hand washing facilities in this short time period. Maybe the interviewer at follow-up didn't register all of them.

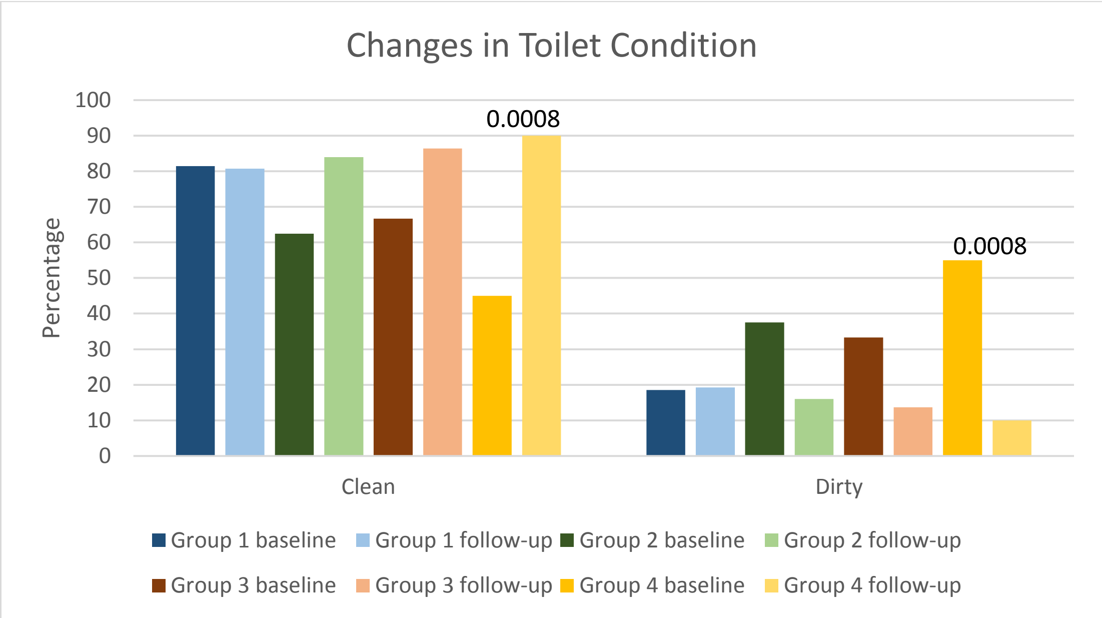

Figure 10.22 Changes in observed toilet conditions. P-values written over two columns reflect a significant change in this group between baseline and follow-up. Group 1: Control, Group 2: Researcher tests source, Group 3: Researcher tests HH, Group 4: Study participant tests HH

Overall water-related behavior did change in various cases. But it is hard to say what the exact reasons for the observed change were. When asked whether people have received WASH information before, the percentage reached 100% in every single group after our intervention. That at least means, that the participants did remember the community meetings. When asked directly if and which behavior they changed after the intervention in step 4 only one household stated not to have changed anything. All the others clean their toilets, compounds and containers more often; started to treat their water; implemented a new treatment option; installed a rubbish pit or changed their hand wash routine. No one stated to have changed the source because of the intervention. These information might be distorted by people telling what they think the researcher wants to hear. Still, it shows that people thought about the important factors influencing water quality. To evaluate which factors induced behavioral change and influenced water quality at follow-up, multiple regressions are applied in the next chapter.

10.7 Regression Analysis

To review which factors significantly influenced the water quality and water-related behavior at follow-up, multiple regressions are calculated. Thereby, water quality and WASH-practices at follow-up are compared to variables and water quality at baseline. The most relevant outputs are shown below, for a complete dataset of all regressions see appendix 13.12.

Above, it was estimated that the water source might have influenced the water quality. In the multiple regression we see that the water source at baseline isn't influencing water quality at follow-up significantly. As seen in Table 10.11 three factors significantly influenced the water quality at follow-up. Having experienced individual testing (group 3 ([researcher tests HH] and 4 [study participant tests HH]) lead to a significant decrease in fecal contamination. On the contrary, having higher water quality at baseline leads to slightly higher contamination at follow-up. However the influence of the water quality at follow up only shows a coefficient of 0.20, whereas being in group 3 (researcher tests HH) or 4 (study participant tests HH) shows high potential to reduce fecal contamination (-97 and -112).

Table 10.11 Multiple regression comparing the water quality at follow-up with several baseline variables as well as water quality and wealth index at baseline. Water quality is measured in counts per 100ml.

Water quality at follow-up	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Group 2 (researcher tests sources)	57.25	47.00	1.22	0.23	-36.14	150.64
Group 3 (researcher tests HH)	-96.86	41.65	-2.33	0.02**	-179.61	-14.10
Group 4 (study participant tests HH)	-111.96	44.31	-2.53	0.01***	-200.00	-23.92
Water quality at baseline	0.20	0.09	2.11	0.04*	0.01	0.38
Wealth Index	0.47	7.00	0.07	0.95	-13.44	14.38
Education level: Primary	-44.82	30.93	-1.45	0.15	-106.27	16.63
Education level: Secondary	-28.95	39.99	-0.72	0.47	-108.41	50.51
Education level: College and higher	-142.35	98.10	-1.45	0.15	-337.27	52.56
School children divided by people in HH	-80.69	56.09	-1.44	0.15	-192.13	30.75
Water source: Lake	-16.63	39.75	-0.42	0.68	-95.62	62.36
Water source: Borehole	-12.88	47.27	-0.27	0.79	-106.81	81.05

Water source: Dug well	-39.37	53.44	-0.74	0.46	-145.56	66.82
_cons	240.04	56.95	4.22	0.00	126.88	353.19

The same regression has been repeated when the water sources were handled in a different way. First the answers were taken as they were given by the participants. Meaning that multiple answers weren't split up. Afterwards in a third evaluation, the sources were divided into improved water sources (borehole=1) and unimproved (others=0). Those alterations had little impact on the regression. Only the water quality at baseline didn't significantly influence the water quality at follow-up, when multiple answers weren't split up. Overall, the interventions in group 3 (researcher tests HH) and 4 (study participant tests HH) seem to have led to a reduction in fecal contamination.

When evaluating water-related behavior at follow-up, it is rather difficult to reason the reduction in fecal contamination by improved WASH-practices. As seen in Table 10.12, participants of group 3 (researcher tests HH) started to use less safe containers to store their drinking water. Container with a tap or narrow opening were attributed with a 1, whereas other container were attributed with a 0. This finding is thereby contradicting the reduction in fecal contamination that was observed.

Table 10.12 Multiple regression comparing the storage container type at follow-up with several baseline variables as well as water quality and wealth index at baseline. Container with a tap / narrow opening = 1; bucket, container without tap = 0

What kind of water storage container do you use?	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Group 2 (researcher tests sources)	-0.06	0.18	-0.31	0.76	-0.41	0.30
Group 3 (researcher tests HH)	-0.40	0.16	-2.51	0.01***	-0.71	-0.08
Group 4 (study participant tests HH)	-0.31	0.17	-1.85	0.07	-0.64	0.02
Water quality at baseline	0.00	0.00	-0.66	0.51	0.00	0.00
Wealth Index	-0.05	0.03	-1.80	0.08	-0.10	0.00
Education level: Primary	0.04	0.12	0.37	0.72	-0.19	0.28
Education level: Secondary	0.30	0.15	1.97	0.05	0.00	0.60
Education level: College and higher	0.24	0.37	0.65	0.52	-0.49	0.98
School children divided by people in HH	-0.24	0.21	-1.12	0.27	-0.66	0.18

Water source: Lake	-0.21	0.15	-1.41	0.16	-0.51	0.09
Water source: Borehole	0.00	0.18	0.01	1.00	-0.35	0.36
Water source: Dug well	-0.30	0.20	-1.46	0.15	-0.70	0.11
_cons	0.96	0.22	4.43	0.00	0.53	1.39

The same regression was repeated for people boiling their water. Where an increase in people boiling their water was observed when people experienced the intervention in group 3 (researcher test HH). This might therefore be one possible explanation for the decrease in fecal contamination. As seen in the previous chapter, group 2 (researcher tests sources) experienced a significant increase in fecal contamination (in some statistic evaluations). This change might be partly explained by the fact, that the number of people in group 2 (researcher tests sources) filtering their water with a cloth, decreased (see app. 13.12). Additionally, people reporting to treat their water before drinking significantly decreased in group 2 (researcher tests sources).

Dou you treat your water? (yes/no)	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Group 2 (researcher tests sources)	-0.35	0.16	-2.17	0.03	-0.66	-0.03
Group 3 (researcher tests HH)	-0.05	0.14	-0.36	0.72	-0.33	0.23
Group 4 (study participant tests HH)	-0.15	0.15	-0.99	0.32	-0.45	0.15
water quality at baseline	0.00	0.00	0.90	0.37	0.00	0.00
Wealth Index	0.01	0.02	0.47	0.64	-0.04	0.06
Education level: Primary	0.04	0.11	0.34	0.73	-0.17	0.24
Education level: Secondary	-0.19	0.14	-1.42	0.16	-0.46	0.08
Education level: College and higher	0.18	0.33	0.54	0.59	-0.48	0.84
School children divided by people in HH	-0.06	0.19	-0.34	0.74	-0.44	0.31
Water source: Lake	0.25	0.14	1.87	0.06	-0.02	0.52
Water source: Borehole	0.06	0.16	0.35	0.73	-0.26	0.37
Water source: Dug well	0.22	0.18	1.21	0.23	-0.14	0.58
_cons	0.66	0.19	3.40	0.00	0.27	1.04

Limitations of these regressions are the small sample size, and the fact that the control group experienced significant changes in water quality between baseline and follow-up. As the other groups are compared to group 1 (control) the relative changes might not reflect the real changes.

10.8 Disturbing factors

Most of all, this study lacks sample size. The small sample size in each groups makes it difficult to obtain statistically significant results. Furthermore, it is problematic that the groups were allocated in three different communities. Two groups have been in the same community which is unfortunate, because changes in the community influence both groups, but not the other two groups. The differences in the communities, such as changing water sources, may have influenced the water quality. Multiple regression can account for some of these influences. But, the control group changed as well during the course of the study (but not significantly). Therefore, changes relative to this control group are equivocal. Furthermore, the changes in behavior (e.g. change in water source) may have been motivated by the interventions of this study. Explanation might therefore be circular. Cause and consequence could easily be misinterpreted. Also important is, that the baseline evaluation was not conducted by the same scientist. The questionnaire from the baseline, had to be taken, even if there were some important questions missing for this study. For the same reason, the interviewers were only partly the same. This can also lead to biased results, as every interviewer has a subjective perception. Reported behavior might be equivocal too, as study participants often tend to answer in a way to please the interviewer. Additionally, the seasonal change might have influenced the choice of the water source.

Overall, the changes in water quality seem to be significant, but it is difficult to connect them with improved WASH practices. There are many disturbing factors which should be eliminated in future studies. Also, the impact of this study should be reviewed again in a few month, to observe the long term sustainability of the fecal reductions.

11 Conclusion

Including water tests in traditional WASH-trainings seems to have potential to improve drinking water quality in developing countries. In this study, the PT was applied in all interventions since its simplicity and accuracy was highly appreciated. Its presence/absence measurements of fecal contamination often sufficed the expectations of the study participants. They appreciated to get informed about the safety of their drinking water. Furthermore, their confidence in the water test results was high.

The water quality change was different in all four groups. In group 1 (control) the water quality didn’t change significantly after the WASH-training. In group 2 (researcher tests sources), the water quality decreased significantly in one out of four calculations. On the contrary, group 3 (researcher tests HH) showed a significant increase in POU water quality in all four calculations. Water quality in group 4 (study participant tests HH) increased significantly in one out of four calculations. Therefore, one can conclude that water tests can indeed increase water quality at POU but only when applied on households’ drinking water. Reductions in fecal contamination were higher when the test was carried out by the researcher instead of being applied by the study participant. Hence, the most successful intervention in this study was the individual testing in the HH carried out by the researcher.

Overall, the observed change in fecal contamination couldn’t be fully explained by changing WASH-practices. However, the observed increase in fecal contamination in group 2 (researcher tests HH) could be explained by the measured decrease of people filtering their water with a cloth. In group 3 (researcher tests HH), the number of people boiling their water increased. This finding is consistent with the observed decrease in fecal contamination. On the other hand, storage containers in group 3 (researcher tests HH) and

4 (study participant tests HH) were less safe than before the intervention, which contradicts the decrease in fecal contamination.

Generally, due to a small sample size and many disturbing factors, the statistical analysis was equivocal. Future studies should increase their sample size by carrying out the same interventions in more groups distributed in a variety of communities. Moreover, sustainability of water improvement should be recorded over time. Since these simple water tests seem to be a cost efficient option to reduce fecal contamination in drinking water, they are definitely worth further investigation.

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13 Appendix

13.1 Questionnaire Applied in Baseline and in Step 4

Questionnaire Households
Evaluation of Water, Sanitation & Hygiene Conditions in the catchment area of 3 schools Uganda

Please select randomly households for this questionnaire. Conduct the interviews individually and start by explaining who you are and why you would like to ask them some questions about water, sanitation and hygiene for about 30 minutes. Explain them, that the selection was made randomly, that it is not an exam and that the results will be confidential. Do not give any hints or try to tell them what the "right" answer should be. Let them answer the questions honestly to the best of their ability.
Find a place where you can interview without having a crowd of many other people around you.

"Hello, my name is ... and I work for the Water School Uganda, an NGO that works in the field of water, sanitation and hygiene. We will be improving the water situation in the school of your children. Now, we would like to learn more about the water & hygiene situation in the children's' homes. Would you help us with this task and answer some Questions? It would take about 30 minutes and the results will be treated anonymously."

Question	Potential answers	Hint/ Instruction
INTERVIEW		
Section A: Introduction and general information:		
Date	date	
Name of the interviewer	text	
Note	introduction	
How many people live in the household?	number	
How many children go to school	number	
Section B: Access to water		
Which water source do you use to collect drinking water?	Piped water in the house Piped water in the village Rainwater harvesting Borehole Open dug well or pond River Lake Water Vendor Bottled Water	Select multiple
Which water source do you use to collect water for bathing and handwashing?	Piped water in the house Piped water in the village Rainwater harvesting Borehole Open dug well or pond River Lake Water Vendor Bottled Water	Select multiple
Which water source do you use to collect water for dish washing?	Piped water in the house Piped water in the village Rainwater harvesting Borehole Open dug well or pond River Lake Water Vendor Bottled Water	Select multiple

Which water source do you use to collect water for washing clothes and cleaning?	Piped water in the house Piped water in the village Rainwater harvesting Borehole Open dug well or pond River Lake Water Vendor Bottled Water	Select multiple
Distance to different sources	Number per source selected above	
Amount of water acquired daily	Number per source selected above	
How do you pay for the water from the sources selected	I pay monthly fees I pay per jerry can I pay nothing	Select one
Cost of water per 20l /10l	number	Number per sources selected
Cost of water per month	number	Number per sources selected
Section C: WASH practice, risk awareness & attitude		
Water		
How is the quality of the water you use for drinking?	Very good Good Medium Bad Very bad	Select one
Do you use any method for water treatment?	Yes No	Select one
How important is it to treat the water?	Very important Medium important Not important	Select one
How safe is it to drink the water directly from the source?	Very safe Quite safe A bit risky Very risky	Select one
Which methods for water treatment do you know?	Boiling Filtration with a cloth Flocculation and sedimentation Chlorination SODIS Ceramic or Membrane Filter None	Select multiple
Which methods for water treatment do you use?	Boiling Filtration with a cloth Flocculation and sedimentation Chlorination SODIS Ceramic or Membrane Filter None	Select multiple
How often do you treat your water?	Every day Sometimes Only during rainy season Only for sick people Never	Select one
Why do you not or not regularly treat your water?	It's not important It's not necessary I did not know about it I do not enjoy it It's not nice It's not attractive I forget to do it I do not have time do it	If "none" was selected in the question on "which methods for WT do you use" or if "sometimes", "only…", "never" was selected in the question on "how often do you treat your water" Select multiple

Do you enjoy treating your water?	Very much A bit I don't mind Not at all	Select one
Can you explain to me how the different methods for water treatment work?	Good explanation of 4 methods Good explanation of 3 methods Good explanation of 2 methods Satisfactory explanation of 1 method Cannot explain well	Let the person explain the different methods for water treatment Select one
Safe Storage		
What kind of containers do you use to collect & transport water from the source?	10 liter jerry can 20 liter jerry can Bucket Container with narrow opening Container with narrow opening and tap Other	Select multiple
Please specify other:	Text	If "other" was selected in previous question
What kind of containers do you use to store the drinking water?	10 liter jerry can 20 liter jerry can Bucket Container with narrow opening Container with narrow opening and tap Other	Select multiple
Please specify other:	Text	If "other" was selected in previous question
How do you clean your safe storage container?	I use Chlorine to disinfect it regularly I wash it regularly with soap I wash it sometimes I never wash it	Select one
Hand washing		
Do you think it is important to wash your hands?	Very important Medium important Not important	Select one
When do you wash your hands?	When they are dirty After going to toiled After cleaning baby's bottom Before eating After eating Before cooking There are no special occasions Never	Select multiple
Why do you wash your hands?	To remove dirt To remove pathogens To look nice and clean	Select multiple
Why do you not or not regularly wash your hands?	It's not important It's not necessary I did not know about it I do not enjoy it It's not nice It's not attractive I forget to do it I do not have time do it I regularly wash my hands	Select multiple
Do you enjoy washing your hands?	Very much A bit I don't mind Not at all	Select one
Sanitation		
Where do you help yourself?	I use the bushes A shared toilet	Select on

	Own simple pit latrine Own VIP latrine in the lake	A VIP Latrine (=ventilated improved latrine)
If you sometimes use the bushes – why do you not use a toilet?	It's not important It's not necessary I did not know about it I do not enjoy it It's not nice It's not attractive I forget to do it It's dangerous I don't have money to build a toilet	Select multiple
Do you think it is important to use a toilet?	Very important Medium important Not important	Select one
Diarrhoea		
What are the causes for diarrheal diseases?	• Faecal pathogens which were transmitted through hands, water or food • Dirty hand, water or food • Some pathogens • Explanation does not correspond with real cause • I don't know	Let the respondent explain the cause, tick the selection which matches the explanation best Select one
How many adults in your family suffered from diarrhea in the last 3 days?	number	
How many children in your family suffered from diarrhea in the last 3 days?	number	
Section D: Social norms		
How many neighbours do you have? What do you think if your neighbours don't treat their water?	It is bad It is common practice It is good I do not mind	Number Select one
What do you think if your neighbours do not wash their hands?	It is bad It is common practice It is good I do not mind	Select one
What do you think if your neighbours use the bushes to go for toilet?	It is bad It is common practice It is good I do not mind	Select one
What do your neighbours think if you do not treat your water?	It is bad It is common practice It is good They do not mind	Select one
What do your neighbours think if you do not wash your hands?	It is bad It is common practice It is good They do not mind	Select one
What do your neighbours think if you use the bushes to go for toilet?	It is bad It is common practice It is good They do not mind	Select one
How many of your neighbours treat their water?		
How many of your neighbours wash their hands at critical times?		
How many of your neighbours have their own toilet?		

Section E: Information on WASH practice		
Have you ever received any information on water treatment, hygiene or sanitation?	Yes No	Select one
From whom have you received the information?	Government Health worker Promoter of an NGO During school From the school of your children Media (radio or TV) Other	If "yes" was selected in previous question Select multiple
Please specify other:	Text	If "other" was selected in previous question
From whom would you prefer to receive information on water, hygiene and sanitation?	Government Health worker Promoter of an NGO During school From the school of your children Media (radio or TV) Other	Select multiple
Please specify other:	text	If "other" was selected in previous question
Was the information on water, hygiene and sanitation useful?	Yes No	
Did the information on water, hygiene and sanitation change your behavior?	Yes No	If "yes" was selected in previous question
Which behaviours were changed? Please specify:	Text	Enter the answer of the respondent
Section F: Market information		
From where would you purchase chlorine treatment?	Text	Enter the answer of the respondent
From where would you purchase a water filter?	Text	Enter the answer of the respondent
From where would you purchase soap?	Text	Enter the answer of the respondent
From where would you purchase a safe storage container?	Text	Enter the answer of the respondent
From where would you purchase materials to construct a toilet?	Text	Enter the answer of the respondent
Would you be interested to purchase chlorine if it is available in the market?	Yes No	Select one
Would you be interested to purchase a water filter if it is available in the market?	Yes No	Select one
How much would you be willing to pay for a bottle of water treated with chlorine?	number	Enter amount in UGX
How much would you be willing to pay for a bottle of water filter?	number	Enter amount in UGX
Would you be interested to buy treated and safe water from a water kiosk at the school of your children?	Yes No	Select one
How much would you be willing to pay per month for treated drinking water	number	Enter amount in UGX
How much would you be willing to pay per 20 liter jerry can for treated drinking water?	number	Enter amount in UGX
Section G: Wealth index		
What is your education level?	None/ Don't know Primary Secondary College and higher	Select one
How much money do you have available perm month?	number	Enter number in UGX

Does anyone from your household own any of these items?	Electricity Radio TV Mobile phone Bicycle Moterbike Car Fridge Watch other	List up items for respondant Select multiple
What kind of fuel do you use for cooking?	Wood Charcoal Kerosene Gas Electricity other	Select one
Are you the owner of your house?	Own house Rent house Other	Select one
How many rooms does your house have	number	Enter number below 6
What type of walls does the main house have?	Mud Stone Wood planks Corrugated iron Cement	Select one
What type of roof does the main house have?	Grass thatch Roof tiles/ Stone slates Corrgated iron	Select one
What type of floor does the main house have?	Earth Cement Floor tiles	Select one
OBSERVATION THROUGH THE INTERVIEWER **(your own observations, no answer from respondent needed)**		
Are water treatment devices visibly available in our around the house? Select the items available?	Chlorine solution Water filter SODIS bottles in house SODIS bottles on roof PUR (flocc & sedimentation) Cloth for filtration	Select multiple
What kind of container is used to store drinking water?	10 liter jerry can 20 liter jerry can Bucket Container with narrow opening Container with narrow opening and tap Other	Select multiple
Please specify other:	Text	If "other" was selected in previous question
In which condition is the water storage container?	Clean Dirty Broken Without lid With lid	Select multiple
What kind of toilet does the HH have on the compound?	No latrine Good Pit latrine VIP latrine Poor flush latrine	Select one
In which condition is the toilet?	Clean Dirty Hole without lid Hole with lid	Select multiple

13.2 Questionnaire Applied in Step 3

Questionnaire Rapid Test Comparison
Evaluation of the Applicability of Three Rapid Tests in Southern Ugandan Households

If I'm not evaluating myself:
Please select randomly households for this questionnaire. Conduct the interviews individually and start by explaining who you are and why you would like to ask them some questions about water testing options and water quality for about 15 minutes. Explain them, that the selection was made randomly, that it is not an exam and that the results will be confidential. Do not give any hints or try to tell them what the "right" answer should be. Let them answer the questions honestly to the best of their ability.
Find a place where you can interview without having a crowd of many other people around you.

"Hello, my name is … and I work for the Water School Uganda, an NGO that works in the field of water, sanitation and hygiene. We will be improving the water situation in the school of your children. Now, we would like to learn more about the water & hygiene situation in the children's homes. Can we show you some methods to test your drinking water and would you answer some questions? It would take about 30 minutes and the results will be treated anonymously."

Questionnaire: Rapid Tests				
Date				
Name of the interviewer				
Note				
How many people live in the household?				
How old are you?				
Sex:			m	f
Have you ever tested your water before?			Yes	No
Do you find it useful to test your drinking water regularly?				
1: strongly disagree	2: disagree	3: neutral	4: agree	5: strongly agree
Do you think rapid tests are the right choice to test your drinking water?				
1: strongly disagree	2: disagree	3: neutral	4: agree	5: strongly agree
Do you think the Compartment Bag test measured your water's quality correctly?				
1: strongly disagree	2: disagree	3: neutral	4: agree	5: strongly agree
Do you think the Compact Dry Plate test measured your water's quality correctly?				
1: strongly disagree	2: disagree	3: neutral	4: agree	5: strongly agree
Do you think the Pathoscreen test measured your water's quality correctly?				
1: strongly disagree	2: disagree	3: neutral	4: agree	5: strongly agree
Do you think the Compartment Bag test is easy to apply?				
1: strongly disagree	2: disagree	3: neutral	4: agree	5: strongly agree
Do you think the Compact Dry Plate test is easy to apply?				
1: strongly disagree	2: disagree	3: neutral	4: agree	5: strongly agree
Do you think the Pathoscreen test is easy to apply?				
1: strongly disagree	2: disagree	3: neutral	4: agree	5: strongly agree
Do you think you would be able to apply the Compartment Bag test on your own in the future?				
1: strongly disagree	2: disagree	3: neutral	4: agree	5: strongly agree
Do you think you would be able to apply the Compact Dry Plate test on your own in the future?				
1: strongly disagree	2: disagree	3: neutral	4: agree	5: strongly agree

Do you think you would be able to apply the Pathoscreen test on your own in the future?				
1: strongly disagree	2: disagree	3: neutral	4: agree	5: strongly agree
Which test would you prefer to use in the future?				
1:Compartment Bag test	2:Compact Dry Plate test	3:Pathoscreen test		
Would you measure your drinking water with rapid tests in the future, if they are available?				
1: strongly disagree	2: disagree	3: neutral	4: agree	5: strongly agree
How much would you be willing to pay for one test?				

13.3 Instruction Manual for the CBT

Aquagenx

Safe water for anyone, anywhere, anytime

Compartment Bag Test: Instructions for Use

The Compartment Bag Test (CBT) is a drinking water test that detects and quantifies *E. coli* bacteria in a 100 mL sample, the recommended fecal indicator and sample volume by the World Health Organization and U.S. Environmental Protection Agency. Portable, simple and self-contained, the CBT lets anyone, anywhere determine if drinking water poses a health risk.

CBT Kit includes supplies for 10 tests:

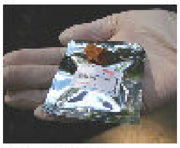
10 CBT bags
10 100 mL sample bottles
10 *E. coli* chromogenic culture medium test buds
30 chlorine tablets
1 reusable seal clip

A video on how to use the CBT is on our website:
http://www.aquagenx.com/how-to-use-the-cbt/

Kit Components

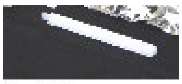
Compartment Bag

Sample Bottle



E. coli Medium

Chlorine Tablets



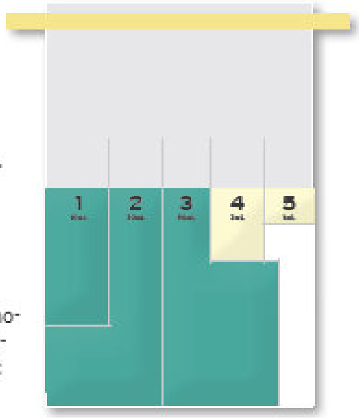
Seal Clip

Compartment Bag Volumes

The plastic bag has five compartments of different volumes, akin to five test tubes:

1 = 10 mL
2 = 30 mL
3 = 56 mL
4 = 3 mL
5 = 1 mL

Total = 100 mL



E coli medium contains a chromogenic substrate: 5-bromo-4-chloro-3-indolyl-beta-D-glucuronic acid (X-gluc)

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How to Use

1. Prepare work area

- Sanitize your work area using a disinfectant cleaning solution and plastic gloves

2. Collect 100 mL water sample

- Fill sample bottle to 100 mL mark
- Avoid touching inside of bottle and lid
- Record details for your sample

3. Mix water sample with growth medium

- Open growth medium pouch and add medium bud to water sample
- Do not touch medium with fingers or hands
- Put lid on bottle and dissolve medium for about 15 minutes, periodically swirling to mix
- The medium dissolves from carrier. When medium is completely dissolved, the carrier turns white or nearly white.
- The carrier itself does not dissolve

4. Pour sample into compartment bag

- Tear off the perforated seam at top of bag
- Before filling bag, label it, then rub two sides together with your fingers to make it easier to open the bag and pour sample into it
- Use white tabs at top of bag to hold bag open while pouring
- Slowly pour sample into bag
- Leave test bud in the bottle while pouring
- Shift bag to adjust water volumes in all compartments to the fill mark
- Fill marks are indicated by horizontal lines toward top of the compartments
- Fill marks are the same in each compartment and water levels should be even across the bag

5. Seal bag

- Roll down bag to fill level, close bag with yellow Whirl-Pak seal
- Attach white plastic two-piece clip. U-shaped part of clip goes across width of bag just above water level along the fill line but below top openings of the compartments
- Snap rod-shaped part of the clip on the front of bag into the back of the clip on other side of bag to lock it in place

Tip #1 Testing should begin within six hours of sample collection. Samples can be held for as long as four days if they are kept below 10 ºC (but not frozen).

Tip #2 Only the medium dissolves, not its carrier. The carrier just turns white or nearly white.

Dissolved medium indicated by carrier turning white.

Tip #3 Before filling the bag, label it, then rub the two sides with your thumb and fingers to help separate them so you can fill the compartments completely and evenly.

Fill marks are small horizontal lines.

Tip #4 Use the white two-piece clip to seal multiple bags together at the same time. Reuse clips.

6. Incubate

- Incubate the sealed compartment bag for bacterial growth
- Incubating at ambient temperature is fine for temperatures of 25ºC and above. For temperatures below 25ºC, use an insulated container or portable incubator.

Incubation Time and Temperature Recommendations:

35-44.5ºC:	incubate 20-24 hours
30-35ºC:	incubate 24-30 hours
25-30ºC:	incubate 40-48 hours

Tip #5 Incubating CBTs develop an odor. We recommend placing CBTs in another sealed plastic bag or insulated container during incubation period.

7. Score and record test results

- Yellow/yellow-brown indicates negative (absence) of *E. coli*, Blue/blue-green indicates positive (presence) of *E. coli*
- Concentration of fecal bacteria in the sample is estimated from the combination of positive and negative compartments, giving a Most Probable Number (MPN) estimate of *E. coli* per 100 mL
- Use MPN Table on next page to determine *E. coli* concentration
- Record MPN result

Yellow/Yellow-Brown = Absence of *E. Coli*
Blue/Blue-Green = Presence of *E. coli*

8. Decontaminate

- Open bag and add 3 chlorine tablets to top of bag. Agitate bag until chlorine tablets dissolve. Let bag stand for 45 minutes.
- After 45 minutes, pour liquid contents into a sink, toilet or hole in the ground and safely dispose of the empty bag
- Retain white plastic clip for reuse

Health Risk Based on World Health Organization Guidelines for Drinking Water Quality, 2011

Health Risk Category	*E. coli* CFU* per 100 mL
Safe	<1
Intermediate Risk/Probably Safe	1-10
High Risk/Probably Unsafe	>10-100
Very High Risk/Unsafe	>100

***MPN and CFU (colony forming units)** are equivalent terms, but MPN is obtained in quantal tests such as the CBT and CFU is obtained in colony-based tests such as membrane filtration.

Most Probable Number Table

The MPN Table represents World Health Organization "Guidelines for Drinking Water Quality," 4th Edition. Table 5.4 in the Guidelines has risk categories of drinking water based on *E. coli* levels as ranges: 0/100 mL = Safe; 1-10/100 mL = Intermediate Risk; 11-100/100 mL = High Risk; and >100/100 ml = Very High Risk.

The general consensus is drinking water should contain no *E. coli*, but in some countries *E. coli* numbers of up to 10/100 mL may be tolerated as being of intermediate risk.

Match your compartment bag volumes to one of these 32 possible outcomes:

Compartment #					MPN/100mL	Upper 95% Confidence Interval/100mL	Health Risk Category Based on MPN and Confidence Interval
1	2	3	4	5			
10mL	30mL	56mL	3mL	1mL			
					0.0	2.87	Low Risk/Safe
					1.0	5.14	Intermediate Risk/ Probably Safe
					1.0	4.74	
					1.1	5.16	
					1.2	5.64	
					1.5	7.81	
					2.0	6.32	
					2.1	6.85	
					2.1	6.64	
					2.4	7.81	
					2.4	8.12	
					2.6	8.51	
					3.2	8.38	
					3.7	9.70	
					3.1	11.36	Intermediate Risk/ Possibly Safe
					3.2	11.82	
					3.4	12.53	
					3.9	10.43	
					4.0	10.94	
					4.7	22.75	
					5.2	14.73	
					5.4	12.93	
					5.6	17.14	
					5.8	16.87	
					8.4	21.19	
					9.1	37.04	
					9.6	37.68	
					13.6	83.06	High Risk/Possibly Unsafe
					17.1	56.35	
					32.6	145.55	High Risk/Probably Unsafe
					48.3	351.91	
					>100	9435.10	Unsafe

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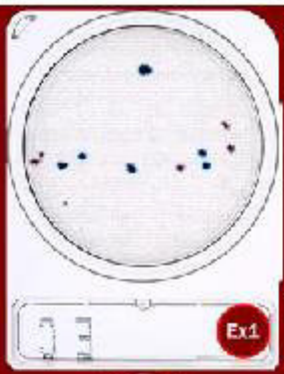
13.4 Instruction Manual for CDPT

Counting Examples & Precautions

User's Manual 4

(Print this page without margins using A4 (210 x 297 mm) paper, the pictures are printed out as the same as the actual Compact Dry (77 x 58 (x 7) mm).



○ : *E. coli* = 6 colonies
◇ : Coliform = 6 colonies

Ex Lighting from the back
Ⓔⓧ Lighting from the front

In case of more than 300 colonies, the number of colony should be estimated. The average number of colony in the grid (1 cm^2) is counted, and then the total number of colony is calculated by multiplying the average number by 20.

○ : *E.coli* = 29 colonies
◇ : Coliform = 30 colonies
Δ : the others = 29

Ex Lighting from the back
Ⓔⓧ Lighting from the front

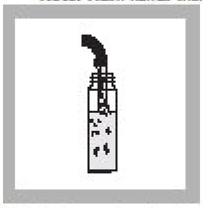
In case that numerous colonies are observed, a sample extraction should be diluted appropriately, and be inoculated again.

13.5 Instruction Manual for PT

PathoScreen™ Field Kit

Conducting the P-A Test with PathoScreen Medium

Note: *Wash hands thoroughly with soap and water to minimize contamination of sample.*



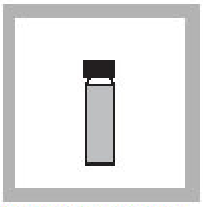
4. Fill the sterilized bottle to the shoulder with sample (approximately 20 mL).

5. Add the contents of one PathoScreen Medium powder pillow to the sample.

Note: *To avoid contamination, swab the pillow with alcohol before opening.*

6. Cap the bottle immediately. Invert to thoroughly mix the sample with medium.

Place the bottle in a location with constant temperature at 25–35 °C (77–95 °F) for 24 to 48 hours.



7. Evaluate the reaction after 24 hours (Table 1). If temperatures have varied significantly, continue to incubate negative samples for an additional 24 hours.

Table 1 Interpreting Results

Hydrogen Sulfide-Producing Bacteria			
Test Results	**Positive**	**Negative**	**Follow-up**
Color changes from yellow to black	X		—
Black precipitate forms	X		—
No color change		X	Incubate additional 12 to 24 hours and reevaluate. If there is no color change, record as negative.

13.6 The standard membrane filtration kit

1. Water is boiled and all the testing material is disinfected for 3 minutes.
2. The filter is added to the plastic cup-system and the cups are firmly locked to each other.
3. The water sample is added to the upper cup.
4. 1 ml of the water sample is taken with a pipette and added to the CDP.
5. The water is pumped from the upper to the lower cup, applying the syringe.
6. The cup-system is opened and the filter is removed.
7. The filter is placed on the CDP upside down.
8. Incubate the test for 24h at 37°C upside down.
9. Disinfect all the testing material for 3 minutes in boiling water

Always wear gloves and use the tweezers!

13.7 Timeline

Activity		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		November																													
Step 1: Visit 10 random HH in Bulwande and apply rapid tests - **one interviewer +**				■			■																								
Step 2: First visit and sample collection																															
Bullwande: 80HH **two interviewers**					■	■																									
Busime: 40HH **two interviewers**								■																							
Lugala: 40HH **two interviewers**											■																				
Step 3: Community information events / visit of construction sites																															
Bullwande: 80HH **one interviewer + Henry**												■	■					■													
Busime: 40HH **one interviewer + Henry**													■																		
Lugala: 40HH **one interviewer + Henry**														■					■												
Step 4: Rapid Test in Bulwande 80HH 14/d												■	■	■	■			■	■	■	■	■			■						
Buffer Time / Holiday / Visit construction sites / wrap up in 3 schools **only Henry**																												■	■		
		December																													
Buffer Time / Holiday / Visit construction sites / wrap up in 3 schools **only Henry**		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Step 5: Final visit of the remaining households, samples + questionnaires																															
Bullwande: 80HH **two interviewers**													■			■	■	■													
Busime: 40HH **two interviewers**											■	■																			
Lugala: 40HH **two interviewers**									■	■																					
Adieu und Kampala																					■	■	■								

13.8 Comparison of Communities at Baseline

Which water source do you use to collect drinking water?	Bulwande	Busime	Lugala	Total	
Borehole	30.43	11.36	8.85	17.41	
Borehole, lake	3.48	2.27	0.88	2.22	
Dug well	0	6.82	4.42	3.48	
Dug well, lake	0	1.14	5.31	2.22	
Lake	61.74	75	80.53	72.15	
Lake, water vendor	0.87	0	0	0.32	
Rainwater	0	1.14	0	0.32	
Rainwater, Borehole	1.74	2.27	0	1.27	
Rainwater, Borehole, lake	0.87	0	0	0.32	
Rainwater, lake	0.87	0	0	0.32	
Total	100	100	100	100	Pr=0.000
How is the quality of the water you use for drinking?	Bulwande	Busime	Lugala	Total	
Bad	53.91	75	74.34	67.09	
Good	16.52	4.55	9.73	10.76	
Medium	20	9.09	2.65	10.76	
Very bad	6.96	11.36	12.39	10.13	
Very good	2.61	0	0.88	1.27	
Total	100	100	100	100	Pr=0.000
Do you use any method for water treatment?	Bulwande	Busime	Lugala	Total	
No	30.43	6.82	30.97	24.05	
Yes	69.57	93.18	69.03	75.95	
Total	100	100	100	100	Pr=0.000
How important is it to treat the water?	Bulwande	Busime	Lugala	Total	
Medium important	2.63	0	3.54	2.22	
Not important	5.26	0	3.54	3.17	
Very important	92.11	100	92.92	94.6	
Total	100	100	100	100	Pr=0.103
Are water treatment devices visibly available in our around the house? Select the items available? (obs.)	Bulwande	Busime	Lugala	Total	
Chlorination	4.76	15.79	78.95	32.2	
Chlorination and a cloth for filtration	4.76	5.26	0	3.39	
Cloth for filtration	80.95	52.63	15.79	50.85	
PUR	0	0	5.26	1.69	
Sodis bottles on the roof	0	5.26	0	1.69	
Sodis bottles in the house	0	21.05	0	6.78	
Water filter	9.52	0	0	3.39	
Total	100	100	100	100	Pr=0.000
How safe is it to drink the water directly from the source?	Bulwande	Busime	Lugala	Total	
A bit risky	75.65	79.55	78.76	77.85	

Quite safe	11.3	0	3.54	5.38	
Very risky	11.3	20.45	17.7	16.14	
Very safe	1.74	0	0	0.63	
Total	100	100	100	100	Pr=0.004
Which methods for water treatment do you use?	Bulwande	Busime	Lugala	Total	
Boiling	25.32	7.32	18.42	16.88	
Boiling, chlorination	5.06	2.44	6.58	4.64	
Boiling, Filtration with a cloth	35.44	18.29	13.16	22.36	
Boiling, Filtration with a cloth, chlorination	2.53	1.22	5.26	2.95	
Boiling, Filtration with a cloth, chlorination, ceramic filter	1.27	0	0	0.42	
Boiling, Filtration with a cloth, sodis	0	1.22	0	0.42	
Boiling, sodis	0	1.22	0	0.42	
chlorination	5.06	8.54	15.79	9.7	
Filtration with a cloth	20.25	39.02	23.68	27.85	
Filtration with a cloth, chlorination	2.53	7.32	11.84	7.17	
Filtration with a cloth, sodis	0	9.76	0	3.38	
None	2.53	1.22	5.26	2.95	
Sodis	0	2.44	0	0.84	
Total	100	100	100	100	Pr=0.000
How often do you treat your water?	Bulwande	Busime	Lugala	Total	
Every day	23.68	48.86	24.11	30.89	
Never	32.46	6.82	35.71	26.43	
Only during dry season	0.88	0	0	0.32	
Sometimes	42.98	44.32	40.18	42.36	
Total	100	100	100	100	Pr=0.000
What kind of containers do you use to collect & transport water from the source?	Bulwande	Busime	Lugala	Total	
Container with narrow opening	0	2.27	0	0.63	
Ten liter jerry can	0	1.14	2.65	1.27	
Ten liter jerry can, Twenty liter jerry can	14.78	5.68	7.08	9.49	
Twenty liter jerry can	85.22	90.91	89.38	88.29	
Twenty liter jerry can, bucket	0	0	0.88	0.32	
Total	100	100	100	100	Pr=0.045
What kind of containers do you use to store the drinking water?	Bulwande	Busime	Lugala	Total	
Bucket	1.74	1.14	0	0.95	
Bucket Container with narrow opening	0.87	0	0	0.32	
Bucket other	0	1.14	0	0.32	
Container with narrow opening	44.35	40.91	46.9	44.3	
Container with narrow opening other	0	6.82	0	1.9	
Container with narrow opening and tap	0.87	0	0	0.32	
Other	10.43	28.41	20.35	18.99	
Ten liter jerry can	0.87	0	2.65	1.27	
Ten liter jerry can Twenty liter jerry can	2.61	1.14	0.88	1.58	

Twenty liter jerry can	26.96	19.32	25.66	24.37	
Twenty liter jerry can Bucket	4.35	0	1.77	2.22	
Twenty liter jerry can Bucket Container with narrow opening	1.74	0	0	0.63	
Twenty liter jerry can Container with narrow opening	5.22	1.14	0.88	2.53	
Twenty liter jerry can other	0	0	0.88	0.32	
Total	100	100	100	100	Pr=0.001
In which condition is the water storage container? (obs.)	Bulwande	Busime	Lugala	Total	
Clean	74.76	84.93	70.27	75.61	
Dirty	25.24	15.07	29.73	24.39	
Total	100	100	100	100	Pr=0.074
Do you think it is important to wash your hands?	Bulwande	Busime	Lugala	Total	
Medium important	1.74	0	0	0.63	
Very important	98.26	100	100	99.37	
Total	100	100	100	100	Pr=0.172
What kind of hand washing facilities does the HH have? (obs.)	Bulwande	Busime	Lugala	Total	
A jerry can with a tap	0.98	0	0	0.34	
None	79.41	70.45	91.51	81.08	
Pour out water from a bucket	17.65	2.27	0.94	7.09	
Tippy Taps	1.96	27.27	7.55	11.49	
Total	100	100	100	100	Pr=0.000
Where do you help yourself?	Bulwande	Busime	Lugala	Total	
A shared toilet	16.52	10.23	21.24	16.46	
I use the bushes	8.7	2.27	14.16	8.86	
In the lake	0	0	0.88	0.32	
Other	0	1.14	0	0.32	
Own simple pit latrine	73.91	86.36	63.72	73.73	
Own ventilated and improved pit latrine	0.87	0	0	0.32	
Total	100	100	100	100	Pr=0.020
In which condition is the toilet? (obs.)	Bulwande	Busime	Lugala	Total	
Clean	54.26	62.35	50	55.64	
Dirty	45.74	37.65	50	44.36	
Total	100	100	100	100	Pr=0.268
Have you ever received any information on water treatment, hygiene or sanitation?	Bulwande	Busime	Lugala	Total	
No	17.39	11.36	30.97	20.57	
Yes	82.61	88.64	69.03	79.43	
Total	100	100	100	100	Pr=0.002
What is your education level?	Bulwande	Busime	Lugala	Total	
College and higher	3.48	1.14	0.88	1.9	
None / I don't know	20.87	30.68	28.32	26.27	
primary	59.13	54.55	59.29	57.91	

Secondary	16.52	13.64	11.5	13.92	
Total	100	100	100	100	Pr=0.448
What type of walls does the main house have?	Bulwande	Busime	Lugala	Total	
Cement	31.3	9.09	20.35	21.2	
Mud	67.83	90.91	79.65	78.48	
Stone	0.87	0	0	0.32	
Total	100	100	100	100	Pr=0.002
What type of roof does the main house have?	Bulwande	Busime	Lugala	Total	
Corrugated sheet iron	48.7	25	43.36	40.19	
Grass thatch	51.3	75	56.64	59.81	
Total	100	100	100	100	Pr=0.002
How do you clean your safe storage container?	Bulwande	Busime	Lugala	Total	
Regularly with Chlorination	0	0	0	0	
Sometimes	35.65	39.77	52.21	42.72	
Regularly with soap	64.35	60.23	47.79	57.28	
I never wash it	0	0	0	0	
Total	100	100	100	100	Pr=0.033
What kind of fuel do you use for cooking	Bulwande	Busime	Lugala	Total	
Charcoal	0	0	0.88	0.32	
Charcoal, kerosene	0.88	0	0	0.32	
Wood	90.35	98.86	92.92	93.65	
Wood, charcoal	8.77	1.14	6.19	5.71	
Total	100	100	100	100	Pr=0.169

People in HH	Mean	Std. Dev.	Freq.	
Bulwande	8.31	4.28	115	
Busime	7.20	3.38	88	
Lugala	7.56	3.72	113	
Total	7.73	3.87	316	Pr=0.107
school children in HH	Mean	Std. Dev.	Freq.	
Bulwande	4.23	2.97	115	
Busime	2.90	2.06	88	
Lugala	3.43	2.39	113	
Total	3.58	2.58	316	Pr=0.001
Rooms	Mean	Std. Dev.	Freq.	
Bulwande	2.02	1.36	115	
Busime	2.20	5.36	88	
Lugala	1.69	0.96	113	
Total	1.95	3.00	316	Pr=0.464
Schoolchildren / number of people in household	Mean	Std. Dev.	Freq.	
Bulwande	0.47	0.23	115	
Busime	0.38	0.23	88	
Lugala	0.41	0.22	113	
Total	0.43	0.23	316	Pr=0.023

13.9 Table of Water-Related Variables at Baseline

Which water source do you use to collect drinking water?	Group 1 (control) baseline	Group 2 (researcher tests sources) baseline	Group 3 (researcher tests HH) baseline	Group 4 (study participant tests HH) baseline	Total
Borehole	14.81	0	33.33	27.27	17.65
Dug well	7.41	6.9	0	0	3.92
Dug well and lake	0	17.24	0	0	4.9
Lake	70.37	75.86	54.17	68.18	67.65
Other	7.41	0	12.5	4.55	5.88
Total	100	100	100	100	100
How is the quality of the water you use for drinking?	Group 1 (control) baseline	Group 2 (researcher tests sources) baseline	Group 3 (researcher tests HH) baseline	Group 4 (study participant tests HH) baseline	Total
Bad	51.85	82.76	70.83	59.09	66.67
Good	3.7	3.45	4.17	18.18	6.86
Medium	22.22	3.45	25	13.64	15.69
Very bad	22.22	10.34	0	4.55	9.8
Very good	0	0	0	4.55	0.98
Total	100	100	100	100	100
Do you use any method for water treatment?	Group 1 (control) baseline	Group 2 (researcher tests sources) baseline	Group 3 (researcher tests HH) baseline	Group 4 (study participant tests HH) baseline	Total
No	7.41	34.48	16.67	31.82	22.55
Yes	92.59	65.52	83.33	68.18	77.45
Total	100	100	100	100	100
How important is it to treat the water?	Group 1 (control) baseline	Group 2 (researcher tests sources) baseline	Group 3 (researcher tests HH) baseline	Group 4 (study participant tests HH) baseline	Total
Medium important					
Not important	0	3.45	4.17	0	1.96
Very important	100	96.55	95.83	100	98.04
Total	100	100	100	100	100
Are water treatment devices visibly available in our around the house? Select the items available? (obs.)	Group 1 (control) baseline	Group 2 (researcher tests	Group 3 (researcher tests	Group 4 (study participant tests	Total

		sources) baseline	HH) baseline	HH) baseline	
Chlorination	25	66.67	25	0	31.58
Cloth for filtration	50	33.33	50	80	52.63
Sodis bottles in the house	25	0	0	0	5.26
Water filter	0	0	25	20	10.53
Total	100	100	100	100	100

How safe is it to drink the water directly from the source?	Group 1 (control) baseline	Group 2 (researcher tests sources) baseline	Group 3 (researcher tests HH) baseline	Group 4 (study participant tests HH) baseline	Total
A bit risky	62.96	79.31	70.83	72.73	71.57
Quite safe	0	0	12.5	9.09	4.9
Very risky	37.04	20.69	16.67	18.18	23.53
Very safe					
Total	100	100	100	100	100

Which methods for water treatment do you use?	Group 1 (control) baseline	Group 2 (researcher tests sources) baseline	Group 3 (researcher tests HH) baseline	Group 4 (study participant tests HH) baseline	Total
Boiling	8	10.53	15	20	12.66
Boiling, chlorination	0	10.53	5	0	3.8
Boiling, filtration with a cloth	24	36.84	40	33.33	32.91
Boiling, filtration with a cloth, chlorination	0	0	0	6.67	1.27
Boiling, filtration with a cloth, chlorination, ceramic filter	0	0	0	6.67	1.27
Chlorination	8	15.79	15	0	10.13
Filtration with a cloth	48	15.79	10	33.33	27.85
Filtration with a cloth, chlorination	0	5.26	15	0	5.06
Filtration with a cloth, sodis	8	0	0	0	2.53
None	0	5.26	0	0	1.27
Sodis	4	0	0	0	1.27
Total	100	100	100	100	100

How often do you treat your water?	Group 1 (control) baseline	Group 2 (researcher tests sources) baseline	Group 3 (researcher tests HH) baseline	Group 4 (study participant tests HH) baseline	Total
Every day	37.04	27.59	29.17	22.73	29.41
Never	7.41	37.93	16.67	31.82	23.53
Only during dry season	0	0	0	4.55	0.98
Sometimes	55.56	34.48	54.17	40.91	46.08

Total	100	100	100	100	100
What kind of containers do you use to collect & transport water from the source?	Group 1 (control) baseline	Group 2 (researcher tests sources) baseline	Group 3 (researcher tests HH) baseline	Group 4 (study participant tests HH) baseline	Total
Ten liter jerry can, Twenty liter jerry can	7.41	10.34	16.67	18.18	12.75
Twenty liter jerry can	92.59	89.66	83.33	81.82	87.25
Total	100	100	100	100	100
What kind of containers do you use to store the drinking water?	Group 1 (control) baseline	Group 2 (researcher tests sources) baseline	Group 3 (researcher tests HH) baseline	Group 4 (study participant tests HH) baseline	Total
Bucket	3.7	0	4.17	0	1.96
Container with narrow opening	51.85	41.38	33.33	68.18	48.04
Container with narrow opening, other	3.7	0	0	0	0.98
other	14.81	27.59	20.83	4.55	17.65
Ten liter jerry can	0	0	0	4.55	0.98
Ten liter jerry can, Twenty liter jerry can	0	3.45	4.17	0	1.96
Twenty liter jerry can	22.22	20.69	29.17	18.18	22.55
Twenty liter jerry can, Bucket	3.7	0	0	4.55	1.96
Twenty liter jerry can, Bucket, Container with narrow opening	0	0	4.17	0	0.98
Twenty liter jerry can, Container with narrow opening	0	3.45	4.17	0	1.96
Twenty liter jerry can, other	0	3.45	0	0	0.98
Total	100	100	100	100	100
In which condition is the water storage container? (obs.)	Group 1 (control) baseline	Group 2 (researcher tests sources) baseline	Group 3 (researcher tests HH) baseline	Group 4 (study participant tests HH) baseline	Total
Clean	88.46	75	72.73	72.73	77.55
Dirty	11.54	25	27.27	27.27	22.45
Total	100	100	100	100	100
How do you clean your safe storage container?	Group 1 (control) baseline	Group 2 (researcher tests sources) baseline	Group 3 (researcher tests HH) baseline	Group 4 (study participant tests HH) baseline	Total
Sometimes	59.26	58.62	33.33	50	50.98
Regularly with soap	40.74	41.38	66.67	50	49.02
Total	100	100	100	100	100

Do you think it is important to wash your hands?	Group 1 (control) baseline	Group 2 (researcher tests sources) baseline	Group 3 (researcher tests HH) baseline	Group 4 (study participant tests HH) baseline	Total
Medium important	0	0	0	4.55	0.98
Very important	100	100	100	95.45	99.02
Total	100	100	100	100	100
What kind of hand washing facilities does the HH have? (obs.)	Group 1 (control) baseline	Group 2 (researcher tests sources) baseline	Group 3 (researcher tests HH) baseline	Group 4 (study participant tests HH) baseline	Total
Jerry can with a tap	0	0	4.17	0	0.99
None	62.96	93.1	70.83	90.48	79.21
Pour out water from a bucket	11.11	6.9	25	9.52	12.87
Tippy taps	25.93	0	0	0	6.93
Total	100	100	100	100	100
Where do you help yourself?	Group 1 (control) baseline	Group 2 (researcher tests sources) baseline	Group 3 (researcher tests HH) baseline	Group 4 (study participant tests HH) baseline	Total
A shared toilet	0	20.69	20.83	9.09	12.75
I use the bushes	0	13.79	12.5	4.55	7.84
Other	0	0	4.17	0	0.98
Own simple pit latrine	100	65.52	58.33	86.36	77.45
Own ventilated and improved pit latrine	0	0	4.17	0	0.98
Total	100	100	100	100	100
In which condition is the toilet? (obs.)	Group 1 (control) baseline	Group 2 (researcher tests sources) baseline	Group 3 (researcher tests HH) baseline	Group 4 (study participant tests HH) baseline	Total
Clean	81.48	62.5	66.67	45	65.17
Dirty	18.52	37.5	33.33	55	34.83
Total	100	100	100	100	100
Have you ever received any information on water treatment, hygiene or sanitation?	Group 1 (control) baseline	Group 2 (researcher tests sources) baseline	Group 3 (researcher tests HH) baseline	Group 4 (study participant tests HH) baseline	Total
No	7.41	37.93	25	9.09	20.59

Yes	92.59	62.07	75	90.91	79.41
Total	100	100	100	100	100

13.10 Table of Water-Related Variables at Follow-up

Where do you get your drinking water?	Group 1 (control) follow-up	Group 2 (researcher tests sources) follow-up	Group 3 (researcher tests HH) follow-up	Group 4 (study participant tests HH) follow-up	Total
Borehole	3.7	10.34	45.83	72.73	30.39
Dug well	0	31.03	0	0	8.82
Dug well and lake	0	31.03	0	0	8.82
Lake	88.89	27.59	33.33	22.73	44.12
Other	7.41	0	20.83	4.55	7.84
Total	100	100	100	100	100
How is the quality of the water you use for drinking?	Group 1 (control) follow-up	Group 2 (researcher tests sources) follow-up	Group 3 (researcher tests HH) follow-up	Group 4 (study participant tests HH) follow-up	Total
Bad	44.44	37.93	70.83	27.27	45.1
Good	3.7	3.45	4.17	31.82	9.8
Medium	0	3.45	25	27.27	12.75
Very bad	44.44	44.83	0	9.09	26.47
Very good	7.41	10.34	0	4.55	5.88
Total	100	100	100	100	100
Do you use any method for water treatment?	Group 1 (control) follow-up	Group 2 (researcher tests sources) follow-up	Group 3 (researcher tests HH) follow-up	Group 4 (study participant tests HH) follow-up	Total
No	7.41	34.48	25	45.45	27.45
Yes	92.59	65.52	75	54.55	72.55
Total	100	100	100	100	100
How important is it to treat the water?	Group 1 (control) follow-up	Group 2 (researcher tests sources) follow-up	Group 3 (researcher tests HH) follow-up	Group 4 (study participant tests HH) follow-up	Total
Medium important	3.7	3.45	0	4.55	2.94
Not important	3.7	0	0	0	0.98
Very important	92.59	96.55	100	95.45	96.08
Total	100	100	100	100	100
Are water treatment devices visibly available in our around the house? Select the items available? (obs.)	Group 1 (control) follow-up	Group 2 (researcher tests sources) follow-up	Group 3 (researcher tests HH) follow-up	Group 4 (study participant tests HH) follow-up	Total
Chlorination					
Cloth for filtration					

Sodis bottles in the house	100			100	
Water filter					
Total	100			100	
How safe is it to drink the water directly from the source?	Group 1 (control) follow-up	Group 2 (researcher tests sources) follow-up	Group 3 (researcher tests HH) follow-up	Group 4 (study participant tests HH) follow-up	Total
A bit risky	48.15	48.28	91.67	68.18	62.75
Quite safe	3.7	3.45	0	22.73	6.86
Very risky	48.15	44.83	8.33	4.55	28.43
Very safe	0	3.45	0	4.55	1.96
Total	100	100	100	100	100
Which methods for water treatment do you use?	Group 1 (control) follow-up	Group 2 (researcher tests sources) follow-up	Group 3 (researcher tests HH) follow-up	Group 4 (study participant tests HH) follow-up	Total
Boiling	4.17	0	0	8.33	2.74
Boiling, chlorination	0	5.56	0	0	1.37
Boiling, filtration with a cloth	8.33	11.11	42.11	33.33	21.92
Boiling, filtration with a cloth, chlorination	0	11.11	10.53	0	5.48
boiling sodis	4.17	0	0	0	1.37
Chlorination	0	11.11	5.26	0	4.11
Filtration with a cloth	37.5	44.44	36.84	41.67	39.73
Filtration with a cloth, chlorination	0	5.56	5.26	8.33	4.11
Filtration with a cloth, chlorination, sodis	4.17	0	0	0	1.37
Filtration with a cloth, sodis	33.33	5.56	0	0	12.33
None	0	5.56	0	0	1.37
Sodis	8.33	0	0	8.33	4.11
Total	100	100	100	100	100
How often do you treat your water?	Group 1 (control) follow-up	Group 2 (researcher tests sources) follow-up	Group 3 (researcher tests HH) follow-up	Group 4 (study participant tests HH) follow-up	Total
Every day	48.15	37.93	54.17	35	44
Never	7.41	34.48	25	50	28
Sometimes	44.44	27.59	20.83	15	28
Total	100	100	100	100	
What kind of containers do you use to collect & transport water from the source?	Group 1 (control) follow-up	Group 2 (researcher tests sources) follow-up	Group 3 (researcher tests HH) follow-up	Group 4 (study participant tests HH) follow-up	Total
Container with a narrow opening	0	0	8.33	0	1.96

Ten liter jerry can, Twenty liter jerry can	3.7	20.69	0	0	6.86
Twenty liter jerry can	96.3	79.31	87.5	100	90.2
Twenty liter jerry can, bucket	0	0	4.17	0	0.98
Total	100	100	100	100	100
What kind of containers do you use to store the drinking water?	Group 1 (control) follow-up	Group 2 (researcher tests sources) follow-up	Group 3 (researcher tests HH) follow-up	Group 4 (study participant tests HH) follow-up	Total
Bucket	3.7	3.45	0	4.55	2.94
Container with narrow opening	37.04	48.28	25	40.91	38.24
Container with narrow opening, other	3.7	0	0	0	0.98
other	40.74	41.38	62.5	40.91	46.08
Twenty liter jerry can	11.11	3.45	12.5	13.64	9.8
Twenty liter jerry can, Container with narrow opening	3.7	0	0	0	0.98
Twenty liter jerry can, other	0	3.45	0	0	0.98
Total	100	100	100	100	100
In which condition is the water storage container? (obs.)	Group 1 (control) follow-up	Group 2 (researcher tests sources) follow-up	Group 3 (researcher tests HH) follow-up	Group 4 (study participant tests HH) follow-up	Total
Clean	80.77	100	70.59	76.47	83.33
Dirty	19.23	0	29.41	23.53	16.67
Total	100	100	100	100	100
How do you clean your safe storage container?	Group 1 (control) follow-up	Group 2 (researcher tests sources) follow-up	Group 3 (researcher tests HH) follow-up	Group 4 (study participant tests HH) follow-up	Total
Sometimes	29.63	44.83	12.5	40.91	32.35
Regularly with soap	70.37	55.17	87.5	59.09	67.65
Total	100	100	100	100	100
Do you think it is important to wash your hands?	Group 1 (control) follow-up	Group 2 (researcher tests sources) follow-up	Group 3 (researcher tests HH) follow-up	Group 4 (study participant tests HH) follow-up	Total
Medium important					
Very important	100	100	100	100	100
Total	100	100	100	100	100
What kind of hand washing facilities does the HH have? (obs.)	Group 1 (control) follow-up	Group 2 (researcher tests sources) follow-up	Group 3 (researcher tests HH) follow-up	Group 4 (study participant tests HH) follow-up	Total

None	76.92	93.1	82.61	95.45	87
Pour out water from a bucket	0	0	8.7	4.55	3
Tippy Taps	23.08	6.9	8.7	0	10
Total	100	100	100	100	100
Where do you help yourself?	Group 1 (control) follow-up	Group 2 (researcher tests sources) follow-up	Group 3 (researcher tests HH) follow-up	Group 4 (study participant tests HH) follow-up	Total
A shared toilet	7.41	27.59	25	22.73	20.59
I use the bushes	3.7	17.24	0	4.55	6.86
Own simple pit latrine	85.19	55.17	75	72.73	71.57
Own ventilated and improved pit latrine	3.7	0	0	0	0.98
Total	100	100	100	100	100
In which condition is the toilet? (obs.)	Group 1 (control) follow-up	Group 2 (researcher tests sources) follow-up	Group 3 (researcher tests HH) follow-up	Group 4 (study participant tests HH) follow-up	Total
Clean	80.77	84	86.36	90	84.95
Dirty	19.23	16	13.64	10	15.05
Total	100	100	100	100	100
Have you ever received any information on water treatment, hygiene or sanitation?	Group 1 (control) follow-up	Group 2 (researcher tests sources) follow-up	Group 3 (researcher tests HH) follow-up	Group 4 (study participant tests HH) follow-up	Total
Yes	100	100	100	100	
Total	100	100	100	100	

13.11 Comparisons of Water-Related Behavior at Baseline and Follow-up: P-Values for Comparisons in Each Group

Answer Options	Group 1 (control)	Group 2 (researcher tests sources)	Group 3 (researcher tests HH)	Group 4 (study participant tests HH)
Risk category	0.058	0.050	0.0484*	0.0152**
Borehole	0.185	0.083	0.328	0.0004***
Dug well	0.161	0.0058***		
Dug well and lake		0.161		
Lake	0.057	0***	0.135	0.0004***
Other	1.000		0.426	1.000
Treatment (yes/no)	0.663	0.787	0.747	0.492
A bit risky	0.057	0.0156**	0.0109**	1.000
Quite safe	0.327	0.161	0.083	0.427
Very risky	0.103	0.090	0.083	0.186
Very safe		0.326		0.329
Every day	0.490	0.375	0.0499*	0.267
Never	0.663	1.000	0.747	0.494
Only during dry season				0.330
Sometimes	0.185	0.415	0.0292**	0.163
Sometimes	0.032*	0.326	0.0306*	0.329
Regularly with soap	0.032*	0.326	0.0306*	0.329
Clean / Dirty	1.000	0.135	0.188	0.0008***

13.12 Outputs of All the Regressions

Water quality at follow-up	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Group 2 (researcher tests sources)	57.25	47.00	1.22	0.23	-36.14	150.64
Group 3 (researcher tests HH)	-96.86	41.65	-2.33	0.02	-179.61	-14.10
Group 4 (study participant tests HH)	-111.96	44.31	-2.53	0.01	-200.00	-23.92
water quality at baseline	0.20	0.09	2.11	0.04	0.01	0.38
Wealth Index	0.47	7.00	0.07	0.95	-13.44	14.38
Education level: Primary	-44.82	30.93	-1.45	0.15	-106.27	16.63
Education level: Secondary	-28.95	39.99	-0.72	0.47	-108.41	50.51
Education level: College and higher	-142.35	98.10	-1.45	0.15	-337.27	52.56
School children divided by people in HH	-80.69	56.09	-1.44	0.15	-192.13	30.75
Water source: Lake	-16.63	39.75	-0.42	0.68	-95.62	62.36
Water source: Borehole	-12.88	47.27	-0.27	0.79	-106.81	81.05
Water source: Dug well	-39.37	53.44	-0.74	0.46	-145.56	66.82
_cons	240.04	56.95	4.22	0.00	126.88	353.19
Water quality at follow-up	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Group 2 (researcher tests sources)	38.20	34.57	1.10	0.27	-30.47	106.88
Group 3 (researcher tests HH)	-95.54	39.83	-2.40	0.02	-174.67	-16.42
Group 4 (study participant tests HH)	-107.55	43.64	-2.46	0.02	-194.24	-20.87
water quality at baseline	0.19	0.09	2.07	0.04	0.01	0.38
Wealth Index	1.40	6.86	0.20	0.84	-12.23	15.02
Education level: Primary	-42.66	30.56	-1.40	0.17	-103.36	18.04
Education level: Secondary	-29.26	39.62	-0.74	0.46	-107.96	49.43
Education level: College and higher	-139.47	97.27	-1.43	0.16	-332.68	53.75
School children divided by people in HH	-78.85	55.77	-1.41	0.16	-189.63	31.93
Water source: Improved	-5.33	35.26	-0.15	0.88	-75.37	64.70
_cons	223.26	42.11	5.30	0.00	139.60	306.91
Water quality at follow-up	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Group 2 (researcher tests sources)	65.37	48.04	1.36	0.18	-30.15	160.88
Group 3 (researcher tests HH)	-86.78	44.08	-1.97	0.05	-174.43	0.87
Group 4 (study participant tests HH)	-103.72	45.59	-2.28	0.03	-194.37	-13.08
water quality at baseline	0.17	0.10	1.73	0.09	-0.03	0.37
Wealth Index	0.92	7.34	0.13	0.90	-13.67	15.51
Education level: Primary	-49.76	31.95	-1.56	0.12	-113.28	13.77
Education level: Secondary	-34.99	41.33	-0.85	0.40	-117.17	47.19
Education level: College and higher	-143.49	99.58	-1.44	0.15	-341.48	54.51
School children divided by people in HH	-73.45	57.50	-1.28	0.21	-187.79	40.88
Water source: Borehole	48.50	135.28	0.36	0.72	-220.48	317.48
Water source: Borehole and lake	124.27	153.28	0.81	0.42	-180.50	429.04
Water source: Dug well	47.91	147.42	0.33	0.75	-245.19	341.02
Water source: Dug well and lake	-1.23	147.19	-0.01	0.99	-293.88	291.41
Water source: lake	57.67	136.26	0.42	0.67	-213.26	328.60
Water source: Rainwater	103.05	162.76	0.63	0.53	-220.57	426.67

Water source: Lake, borehole and rainwater	16.03	159.72	0.10	0.92	-301.53	333.60
Water source: Rainwater lake	166.07	142.55	1.16	0.25	-117.37	449.50
Dou you treat your water? (yes/no)	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Group 2 (researcher tests sources)	-0.35	0.16	-2.17	0.03	-0.66	-0.03
Group 3 (researcher tests HH)	-0.05	0.14	-0.36	0.72	-0.33	0.23
Group 4 (study participant tests HH)	-0.15	0.15	-0.99	0.32	-0.45	0.15
water quality at baseline	0.00	0.00	0.90	0.37	0.00	0.00
Wealth Index	0.01	0.02	0.47	0.64	-0.04	0.06
Education level: Primary	0.04	0.11	0.34	0.73	-0.17	0.24
Education level: Secondary	-0.19	0.14	-1.42	0.16	-0.46	0.08
Education level: College and higher	0.18	0.33	0.54	0.59	-0.48	0.84
School children divided by people in HH	-0.06	0.19	-0.34	0.74	-0.44	0.31
Water source: Lake	0.25	0.14	1.87	0.06	-0.02	0.52
Water source: Borehole	0.06	0.16	0.35	0.73	-0.26	0.37
Water source: Dug well	0.22	0.18	1.21	0.23	-0.14	0.58
_cons	0.66	0.19	3.40	0.00	0.27	1.04
What kind of water storage container do you use?	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Group 2 (researcher tests sources)	-0.06	0.18	-0.31	0.76	-0.41	0.30
Group 3 (researcher tests HH)	-0.40	0.16	-2.51	0.01	-0.71	-0.08
Group 4 (study participant tests HH)	-0.31	0.17	-1.85	0.07	-0.64	0.02
water quality at baseline	0.00	0.00	-0.66	0.51	0.00	0.00
Wealth Index	-0.05	0.03	-1.80	0.08	-0.10	0.00
Education level: Primary	0.04	0.12	0.37	0.72	-0.19	0.28
Education level: Secondary	0.30	0.15	1.97	0.05	0.00	0.60
Education level: College and higher	0.24	0.37	0.65	0.52	-0.49	0.98
School children divided by people in HH	-0.24	0.21	-1.12	0.27	-0.66	0.18
Water source: Lake	-0.21	0.15	-1.41	0.16	-0.51	0.09
Water source: Borehole	0.00	0.18	0.01	1.00	-0.35	0.36
Water source: Dug well	-0.30	0.20	-1.46	0.15	-0.70	0.11
_cons	0.96	0.22	4.43	0.00	0.53	1.39
People treating water everyday	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Group 2 (researcher tests sources)	-0.19	0.18	-1.03	0.31	-0.55	0.17
Group 3 (researcher tests HH)	0.11	0.16	0.69	0.49	-0.21	0.43
Group 4 (study participant tests HH)	-0.06	0.17	-0.34	0.74	-0.40	0.28
water quality at baseline	0.00	0.00	1.53	0.13	0.00	0.00
Wealth Index	-0.01	0.03	-0.31	0.76	-0.06	0.05
Education level: Primary	-0.05	0.12	-0.42	0.67	-0.29	0.19
Education level: Secondary	-0.20	0.16	-1.29	0.20	-0.51	0.11
Education level: College and higher	0.38	0.38	0.98	0.33	-0.38	1.13
School children divided by people in HH	0.20	0.22	0.93	0.35	-0.23	0.64
Water source: Lake	0.23	0.15	1.52	0.13	-0.07	0.54
Water source: Borehole	0.18	0.18	0.98	0.33	-0.19	0.54
Water source: Dug well	0.27	0.21	1.32	0.19	-0.14	0.69

_cons	0.10	0.22	0.46	0.65	-0.34	0.54
People boiling water	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Group 2 (researcher tests sources)	-0.08	0.15	-0.54	0.59	-0.39	0.22
Group 3 (researcher tests HH)	0.33	0.14	2.44	0.02	0.06	0.60
Group 4 (study participant tests HH)	0.16	0.14	1.12	0.27	-0.13	0.45
water quality at baseline	0.00	0.00	0.62	0.54	0.00	0.00
Wealth Index	0.04	0.02	1.65	0.10	-0.01	0.08
Education level: Primary	-0.10	0.10	-1.04	0.30	-0.30	0.10
Education level: Secondary	-0.22	0.13	-1.71	0.09	-0.48	0.04
Education level: College and higher	-0.58	0.32	-1.83	0.07	-1.22	0.05
School children divided by people in HH	0.24	0.18	1.30	0.20	-0.13	0.60
Water source: Lake	0.04	0.13	0.31	0.76	-0.22	0.30
Water source: Borehole	-0.09	0.15	-0.58	0.56	-0.40	0.22
Water source: Dug well	0.15	0.17	0.84	0.40	-0.20	0.49
_cons	0.10	0.19	0.53	0.59	-0.27	0.47
People using filtration with a cloth	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Group 2 (researcher tests sources)	-0.43	0.17	-2.60	0.01	-0.76	-0.10
Group 3 (researcher tests HH)	0.08	0.15	0.52	0.60	-0.21	0.37
Group 4 (study participant tests HH)	-0.11	0.16	-0.68	0.50	-0.41	0.20
water quality at baseline	0.00	0.00	2.38	0.02	0.00	0.00
Wealth Index	0.04	0.02	1.54	0.13	-0.01	0.09
Education level: Primary	-0.04	0.11	-0.39	0.70	-0.26	0.17
Education level: Secondary	-0.32	0.14	-2.31	0.02	-0.60	-0.05
Education level: College and higher	-0.44	0.34	-1.28	0.21	-1.12	0.24
School children divided by people in HH	0.10	0.20	0.49	0.63	-0.30	0.49
Water source: Lake	0.28	0.14	2.04	0.05	0.01	0.56
Water source: Borehole	0.06	0.17	0.33	0.74	-0.27	0.38
Water source: Dug well	0.31	0.19	1.67	0.10	-0.06	0.69
_cons	0.42	0.20	2.10	0.04	0.02	0.82
People using chlorination	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Group 2 (researcher tests sources)	0.05	0.11	0.44	0.66	-0.17	0.27
Group 3 (researcher tests HH)	0.05	0.10	0.49	0.63	-0.15	0.24
Group 4 (study participant tests HH)	0.00	0.10	-0.01	1.00	-0.21	0.21
water quality at baseline	0.00	0.00	-1.11	0.27	0.00	0.00
Wealth Index	0.01	0.02	0.91	0.36	-0.02	0.05
Education level: Primary	0.07	0.07	1.00	0.32	-0.07	0.22
Education level: Secondary	0.01	0.09	0.07	0.94	-0.18	0.19
Education level: College and higher	0.97	0.23	4.22	0.00	0.51	1.43
School children divided by people in HH	0.04	0.13	0.29	0.77	-0.22	0.30
Water source: Lake	-0.04	0.09	-0.39	0.70	-0.22	0.15
Water source: Borehole	-0.06	0.11	-0.58	0.56	-0.28	0.16
Water source: Dug well	0.19	0.13	1.51	0.13	-0.06	0.44
_cons	0.06	0.13	0.47	0.64	-0.20	0.33
People using sodis	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Group 2 (researcher tests sources)	-0.43	0.11	-3.97	0.00	-0.65	-0.22

Group 3 (researcher tests HH)	-0.46	0.10	-4.72	0.00	-0.65	-0.26
Group 4 (study participant tests HH)	-0.43	0.10	-4.13	0.00	-0.63	-0.22
water quality at baseline	0.00	0.00	0.37	0.72	0.00	0.00
Wealth Index	-0.02	0.02	-1.45	0.15	-0.06	0.01
Education level: Primary	0.12	0.07	1.73	0.09	-0.02	0.27
Education level: Secondary	0.21	0.09	2.25	0.03	0.02	0.39
Education level: College and higher	0.11	0.23	0.50	0.62	-0.34	0.57
School children divided by people in HH	-0.13	0.13	-0.99	0.33	-0.39	0.13
Water source: Lake	0.02	0.09	0.24	0.81	-0.16	0.21
Water source: Borehole	0.06	0.11	0.56	0.57	-0.16	0.28
Water source: Dug well	0.06	0.12	0.51	0.61	-0.18	0.31
_cons	0.36	0.13	2.68	0.01	0.09	0.62

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